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OF ESCHATOLOGICAL DOXIES AND HAUBERK HAUTEUR- A MODEL FOR FREE WILL AND DESTINY- PART ONE

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Abstract: Ising model with $h\neq 0$, where the **relation with** gauge theory **is used** to discuss the phenomenon of confinements is firmly established on terra firma. It has been concluded by many Physicists that quantum spin diffusion in one dimensional chains and a presentation of the chiral potts model which **illustrates** the physical effects that can **occur** when the Euclidean and Minkowski regions and they are not connected by an analytic continuation. We state that when Euclidian and Minkowski regions are **combined together** many interesting results that could have wide ranging amplitudinal ramifications with perceptual field and perceiving object could be studied and thrown light upon. Consciousness distinction with unconsciousness and temporal superposition of latent intents and manifest actions(See Robert Merton) is another example that may provide bewildering results ,notwithstanding the fact we have not approached with "open mind".N**onequilibrium statistical mechanics and its concomitant primary order and secondary organization with quantum field has been studied and investigated by** takafumi kita where a conception, creation, process oriented and system oriented a concise and self-contained introduction to non equilibrium statistical mechanics with quantum field theory by considering **an ensemble of interacting** identical bosons or fermions as an example. An analogue can be seen in verbal proliferation, visual representation and expressible sense for they are essentially process oriented and system proclivitisied. Matsubara formalism of equilibrium statistical mechanics such as Feynman diagrams, the proper self-energy, and dyson's equation are widely used in the subject matter in question. The author states that the aim is three pronged: (i) to **explain the** fundamentals of nonequilibrium quantum field theory as simple as possible on the basis of the knowledge of the equilibrium counterpart; (ii) **to elucidate** the hierarchy in **describing** nonequilibrium systems from Dyson's equation on the Keldysh contour to the Navier-stokes equation in fluid mechanics via quantum transport equations and the Boltzmann equation; (iii) **to derive** an expression of nonequilibrium entropy that **evolves** with time."Energy" Nonequilibrium green's function and the self-energy uniquely on the round-trip Keldysh contour, thereby **avoiding** possible confusions that **may arise** from **defining m**ultiple green's functions at the very beginning. Feynman **rules for the** perturbation expansion are well presented. Self-consistent perturbation expansion with the Luttinger-ward thermodynamic functional, i.e., Baym's phi-derivable approximation, which **has a crucial** property for nonequilibrium systems **of obeying** various conservation laws automatically. It is here we have to state in unmistakable terms that system changing, structure transformational, syllogistically disintegrational,configurationally **mutative** systems in control engineering has not had models and the models presented here serve the destructuration and disorgansitaion in such systems. We make an explicit assumption that disequilibrium of Tamás-Rajas-Sattva is responsible for the manifested actions. In the "Neuron DNA" class we include the "Latent intents" (See Merton) also. It is something like knowing what one is thinking. Two-particle **correlations** can be calculated within the phi-derivable approximation, i.e., an issue of how to handle the "Bogoliubov-born-green-Kirkwood-Yvons (bbgky) hierarchy". in the extant and existential model we converge some of the salient features of the quantum field theory, statistical mechanics, yang Baxter equations, Bose fermion equivalence, rational conformal field theory to present a holistic and consummate scenario of the asymmetric freedom and translations in space time. We intend to extend the model for virtual photons and mass energy momentum tensor. We HAVE Already defined the zero as the one that is analogous to the bank Assets and Liabilities that cancel out. Such a cancellation takes place without the relative displacement of an introduction to secondary variations. With the analogy applied to the Brahman-AntiBrahman combination, the equality

bearing infallible observatory to the fact that Anti Brahman is a part of Brahman and is reducible. Actions take place in the spatio temporal realization attributed to the stimulus –response mechanism and that takes place in the ambit of space and time **on** matter **which is a form** of energy. With the disequilibrium **created** in the tamogunas namely Tamás, Rajas and Sattva, and the individual discretionary power coming to the fore, the free will is **manifested.** There is nothing complicated in this. Free will is the exercise of discretionary power in in- discretionary way like the fat cats of Wall street did. It is shocking that even in USA the GDP is contributed by 5 to seven percent and rest live with average situation ally generalized goals. So you have indiscreetly exercised your discretionary power and hence you **pay for** it! This is destiny, the **reaction to** the injudicious and uncircumspective use of power. Not necessarily with money! It could be position, *power*, pelf, or a Rajat Gupta type maladroit man oeuvre, financial defalcation, or pecuniary embezzlement "as a matter of fact" couched in subtle languages. With that defined, we write to state "**association**" is the most important fact that the world and the human beings have learnt to exercise. If you are taught Green is for "Good -Go ahead", "Red" is for "Danger", it stays on your mind and never would you be able to reconcile to the opposites. This is also one of the reasons why very eminent scientists just **cannot reconcile** to the anti definitions of their theories, be it Einstein, Penrose, or Hawking, there has been a certain amount of "defensiveness till the end" feeling on all fronts. "**Association**" is the most "dangerous" of ailments of human race. Space and time is one of the phases of waking state, dream state and dreamless state. We do e**xperience** in dreams as we experience in everyday life. That we have been taught to "associate" space time with something is what makes us to "think" so without proliferation of expressible sense. Take an example you are shown leprosy stricken man every day. And the time comes that start screaming and screeching after some time. So "Association" is the situation ally generalized goal and in consonance in structural events. When you start associating something with "something" conceptually, then you have fallen in the "illusory" grip of "Brahman or Anti Brahman" .One most respected French philosopher questioned "Whether schizophrenics suffer from reality" .Now there is something called "coordination". If one electron **behaves a**s if it is **communicated** with one other from the laboratory it is coincidence. If most of them behave then it is "coordination. It is an opposition to structural events. If somebody spits at you it is coincidence, and if everyone does it, it is "well planned "coordination";"Association" thus is the most dangerous of human vices or virtues. How emphatically we write the equations **and equal** to zero with gusto and aplomb? Have we ever thought what does that mean, be it dissipation or accentuation? Addition implies you are adding milk to water and dissipation implies you are removing water from the milk by say distillation or heating. So, finally we have three statements to make in demarcation: (a) Higgs boson is its own anti particle and cancels out (b) Higgs boson gives mass to the particles and so the everyday matter exists (c) Hypothetical neuron DNA is one particle that has in its prodigious narrative phonetic modes all the actions, thinking of every one. It is a **Quantum register (Like Bank Ledgers which has both Debits and Credits)** of all the actions, thinking, and dreams everything about an individual. With these assumptions we set out to build the Model. **This is also what they mean by the statement that something comes out of nothing. "Nothing" is zero the cancellation and obliteration of two opposites like Assets and Liabilities in Banking.** For the present we take that Higgs Boson is its own anti particle, albeit intuitively one feels that one which gives matter essentially has to be inert and the lack of spin, angular momentum and charge etc., must be in the Anti Higgs Boson. We will not take this point further .We are sure that the 48 storey model that is extant and existential might **not be** enough and we may have change the glossary for another 48 storey and we shall do that. In the **next part,** when we are equipped with ninety six story variables types we shall present the congregation of the two models with the corporate signification, personalized manifestation, organizational individuation, and institutional designation. Neuron DNA it is to be noted that is based on both progressive and retroactive movement of semantemes, morphemes, and relational openness of human beings in general and individual in particular. In between we add a **model for Higgs Boson and Gluons** (with Higgs Boson taken as its own anti particle grudgingly!) which seem to have similar properties of Brahman-AntiBrahman syndrome. Temptation is irresistible. That makes the total storey's 144 storey's. These shall be consolidated in to a Final Solution in the **next part**.

Introduction:

Destiny and Freewill:

The opposite of good sense is not the other direction, for this direction is only recreation for the mind,; it becomes amusing initiative. But like in the case of passion we cannot differentiate or separate the two directions mentioned in the foregoing. There cannot be unique sense or consciousness for serious work and another consciousness for recreation; some people say i am retired; i will grow roses; but here also mind goes hammer and tongs about everything even the roses. In the eventuality of the fact that viscosity goes on accelerating itself, it would obliterate and obfuscate the reasons and raison d'être behind rest in an unpredictable sense. Which way which way? there is no way for consciousness has no direction; one for the "serious thought" the other worldy"light"thought. They are in fact one and the same. Corporeal depth and sonorous continuum remains the same for locus and focus of sense, expression and essence. rather we would say that consciousness goes in both the directions at once

DIRECTION OF CONSCIOUSNESS:

What is a paradox? We say it is anomalous expansion of water? Is it a paradox? What holds here and there simultaneously although the law ordains it to fulfill its conservativeness is a paradox? What is paradox in Banking and Finance? Creative accounting! Conservativeness of Assets and Liabilities are fine tuned in so that they remain conservative by the maladroit manipulation of books.

Than having given an explicit explanation of the paradox, would it be in the fitness of things to make a statement that so called good consciousness follows a direction other than the direction of paradox? And where does it go in the propositional subsistence and sustentative corporeality? Taking in to consideration the locus and focus of essence, sense and expression, we can say directional derivative or rather direction itself is from the least to the most differentiated. So does that mean that paradox is a signifier of logical attributes and state of affairs? Yes! In a certain sense of term! To repeat some of the famously stated examples, in the eventuality of the acceleration of viscosity or for that matter temperature accentuation continuously, can we predict? We can say the paradox essence states so! But why not? Are things taking place in the other direction? Then this so-called other directions in which the viscosity and temperature are taking place are also in the state of consciousness, or rather have consciousness. It has identifiable and unique consciousness without extrinsic relations of dysfunctional fissures.

Consciousness is not the finalization or determination of the direction of the paradox. Consciousness determines the principle of cosmic consciousness or its direction in general. Question that arises here is that whether the consciousness can determine the direction of cosmic consciousness and whether individual consciousness and cosmic consciousness have different directions? It appears so for most of the organizational consultants and life style teachers talk of evolutionary hypothesis of human consciousness.

Rather it must be noted (See Mark Lester) that consciousness has its movement churned out in both directions. Direction in fact, is a recreation of mind. For variety! For a change! Nothing else! Physicist Boltzmann explained the arrow of time, moving from past to future, functions in only individual systems and minds, or for those matter worlds. And such a functional representationalitiesof the arrow of time so stated, would be in relation to heterogeneous series and determined identities with respect to the "present" in the individual worlds so defined, with determined identities and efficacious variations.

We have the following systems:

1. **Brahman-AntiBrahman (Brahman is one that provides stimulus for "good "actions and Anti Brahman is one that provides stimulus for "bad "actions, and there shall be corresponding response to it.**
2. **Gratification-Deprivation (Gratification increases at AP and Deprivation at GP .ASCII character values are used to find the total balance in the individual account. And we assume such an account of individual is maintained. Reference is made to progenitor**

Bentham who quantized pleasure and pain. We have modified the definition to suit the IT age).

(3) Markov fields and Hilbert Spaces and Quantum Fields

(4) Space-Time

(5) Mass Energy

(6) Rajas-Tamás(Reactionary potential and Inertia)

(7) Rajas-Sattva (Reactionary potential the cataclysmic war, murder, mayhem, plunder, pillage, nemesis, apocalypse are "height" of the reactionary measure and the "silence" is a measure of the "depth "of the reactionary potential. Statistical Mechanics provides a rich repository and receptacle for the calculations of such "reactions" and "stimulus" taking in to consideration that each individual account will be maintained in the "Akasha", from which it can be down loaded. Please see "Neuron DNA" hypothetical particle. We are here talking of the stimulus and the concomitant response and the positive effects or detrimental ramifications that are caused by such response.)

(8) Freewill-Destiny(Freewill is the indiscreet usage of discretionary powers vested be it in giving Credits or allowing mortgages, and Destiny is what follows, be it Governmental intervention or suspension of "fat cats" of wall street!-Please see Abstract)

(9) Stimulus-Response (Quantum field theory of evanescent photons is proposed as one and only reliable quantum theory of fundamental macroscopic dynamics realized in the brain. External physical stimuli flowing into the brain are shown to generate macroscopic condensates of evanescent photons which can be interpreted as memory storage of the information carried by the incoming stimuli. Each macroscopic condensate manifests two different types of quantum dynamics; creation-annihilation dynamics of a finite number of evanescent photons requiring microscopic amount of energy, and that of an infinite number of them requiring macroscopic amount of energy. The former is a fundamental process of memory retrieval by which the macroscopic condensate of evanescent photons (memory storage) itself is kept unchanged. It can be induced by even a very small physical stimulus flowing into the brain. The latter is a macroscopic phase transition process in which the macroscopic condensate is deformed into another one, thus resulting in the development of memory storage. This can be induced only by large physical stimuli, and superposition of the information carried by such an external stimulus and the information previously stored in the macroscopic condensate is maintained in the new macroscopic condensate. Consciousness (and unconscious if necessary) can be understood as arising from those creation-annihilation dynamics of evanescent photons, thus mind lives in memory and by memory.))

(10) Lesser Brahman-Lesser AntiBrahman (in space and time. Here we have a mountain missionary or a stingray sacrosuchus imperator, purulent ptomaines, crabbed leprechaums, and lucubration cormorants that do not even leave little gold on a corpse. Such incidents are dime a dozen in India like Jack the ripper-essentially damagers of gratification. Today the world is seething, sizzling with ugly thoughts and unkempt emotions and a blatant, flagrant, calumniously clamoring, egregiously invidious, anachronistic groups, and antagonistic dispensionatory groups, who spread hatred and detestation, loathsomeness, abhorrence, abomination, which ever group they belong. Under this head come "Lesser Gods" who make simulations-dissimulations fons et origio for the usurious profits. Institutions, individuals, countries, all fall under this category. In fact, they are essentially managers and damagers of Gratification and deprivation which we have elucidated and enucleated)

(11) Subject-Object

(12) Perception-Imperceptions

(13) Simulation-Dissimulation

(14) Higgs Boson-Matter(Mass)

(15) Association-Discreteness

(16) Neuron DNA-Prakruti Kshobha (Highly reactionary potential-indoctrination ability)Neuron DNA-Prakruti Siddhi",st" (the one who never is reactionary and maintains calm)

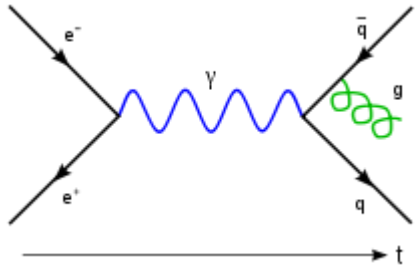
(17) Consciousness-Unconsciousness(We have defined the consciousness as Information Field capacity including visual representation, recurrences, and replications totaled with ASCII characters, and Unconsciousness is one where these factors do not have a deliberate accentuation role to play. In fact most of the neuroscientists hold that all we do is purely unconscious and there is no free will. Ramana maharishi stated there is neither freewill nor destiny .This is the ultimate truth. For us synthesis of co existentiality of all these and hold good wholly and in full measure and very substantially and the result is Freewill=Destiny, and Consciousness=Unconsciousness (see Jung)) This must provide valid reason to find a String Theory to tie for the cancel out and like Assets and Liabilities they exists only to obliterate each other.

(18) Platonic World-Mental World (See Penrose)

(19) Mental World-Physical world (See Penrose)

PARTITION FUNCTION:

Partition function (quantum field theory) (We have used Wikipedia and author home pages and Stanford encyclopedia for the preparation of the following introductory remarks).



in quantum field theory, we have a generating functional, z[j] of correlation functions and this value, called the partition function is usually expressed by something like the following functional integral:

$$Z[J] = \int \mathcal{D}\phi e^{i(S[\phi]+\int d^d x J(x)\phi(x))}$$

Where s is the action functional.

The partition function **in quantum field theory** is a special case of the mathematical partition function, and **is related** to the statistical partition function in statistical mechanics. the primary difference is that the countable collection of random variables seen in the definition of such simpler partition functions has been replaced by an uncountable set, thus necessitating the use of integrals over a field ϕ.

the prototypical **use of the** partition function **is to obtain** Feynman amplitudes by differentiating with respect to the auxiliary function(sometimes called the current) j. thus, for example:

$$\langle G(x_1, x_2)\rangle = -\frac{\delta}{\delta J(x_1)}\frac{\delta}{\delta J(x_2)} \log Z[J]\Big|_{J=0}$$

is the green's function, **propagator o**r correlation function for the field ϕ between points x_1 and x_2 in space.

Reactionary complex valued function:

Unlike the partition function in statistical mechanics, that in quantum field theory contains an extra factor of i in front of the action, making the integrand complex, not real. It is sometimes mistakenly implied that this has something to do with wick rotations; this is not so. Rather, the i **has to do with the fact** that the fields ϕ are to be interpreted as quantum-mechanical probability amplitudes, **taking on** values in the complex projective space (complex Hilbert space, but the emphasis is placed on the word projective**, because** the probability amplitudes are still normalized to one). By contrast, more traditional partition functions **involve** random variables that are real-valued, and range over a simplex--a simple, being the geometric way of saying that the total of probabilities **sum to** one. The factor of can be understood **to arise as** the Jacobian of the natural measure of volume in complex projective space. For the (highly unusual) situation where the complex-valued probability amplitude is to be replaced by some other field taking on values in some other mathematical, the i would **be replaced** by the appropriate geometric factor (that is, the Jacobian) for that space.

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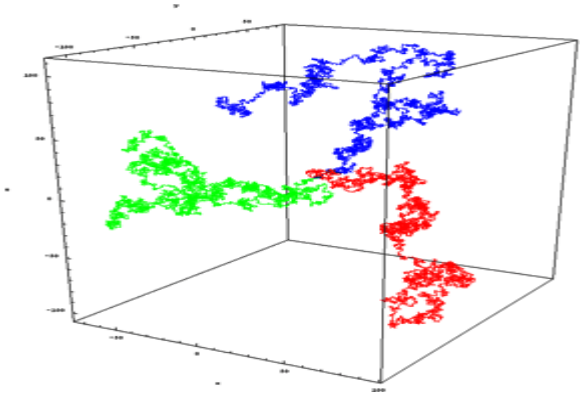
STATISTICAL MECHANICS:

Statistical mechanics was born at the beginning of the 20th century to provide a microscopic explanation of thermodynamics and then, for many years, it was used to understand the different aggregation states of matter. Quantum field theory instead was born in the context of sub nuclear physics as the basic method to describe the fundamental interactions between the ultimate constituents of matter. these two fields evolved independently for many years. Only at the end of the '60s was it realized that statistical

mechanics was able to provide the basic tools for a non-perturbative and rigorous definition of quantum field theory. On the other hand, quantum-field-theory concepts like renormalization group and scale invariance found their application in statistical mechanics.

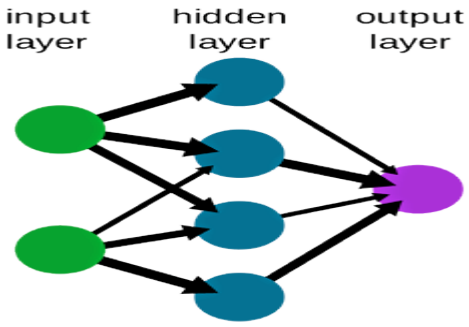


a three-arm polymer

Stochastic processes:

Since then the cross-fertilization of the two fields has provided important methods and tools which have been applied not only in physics but also in several different contexts spanning from computer science, chemistry, biology, geology, and social sciences. Since many years some groups are active both in quantum field theory and statistical mechanics, considering several problems which are relevant in elementary particle physics, condensed matter physics, biology, and mathematics, and which can be addressed by combining statistical-mechanics methods, quantum field theory, and the theory of **stochastic processes.**
in recent years much of our research concerns "random models", a vast class of systems which are the object of intense study in many disciplines — physics, biology, computer science, and mathematics to name a few. They have a complex phenomenology and many of their properties are still not understood. For instance, restricting to physical systems, random systems show a variety of new phenomena — slow relaxation and aging, memory and oblivion, and generalizations of the usual **dissipation-fluctuation** relations — which have been the object of intense experimental scrutiny. In this field many groups of physicists are extensively studying the critical behavior of several spin models **with** quenched disorder and phase separation in fluid systems, in particular colloid-polymer mixtures, in porous materials. Beside random systems, they also investigate, both numerically and analytically, the critical behavior of less-common magnetic systems, some properties of high-tc superconductors, and the finite-density behavior of solutions of polymers of different architecture. A parallel could be drawn between Gratification-Deprivation systems and Consciousness-Unconsciousness systems and that between quantum field and statistical mechanics, Markov fields, Hilbert spaces, Lie algebras and translations in space and time. Expansion of quantum field describing electrons or other fermions are also another analogy to the study of Brahman-AntiBrahman, Gratification-Deprivation Complex. Without making tall claims, we have to point that these structures like Markov Chains, Lie Algebras, and Translations in spatiotemporal realization are consistent in the Conscious Actions, How we talk, How the talk is heard, and the Learning mechanism models in Psychology. So called “Field” are the ones **created** by the “sphere of influence” one talks with so much emphasis in Political Science.”Learning by Doing” model is another example of how Human resources could be “associated” with in “organizational culture” to “obtain”, “necessary” results.

NEURAL NET WORKS:



a simple neural network

Other subjects under intensive investigation by our group are spin glasses and neural nets. The methods **at the basis of** their study combine the physical intuition, **accumulated through** the **use of** the replica trick and numerical simulations, **with the need for** a rigorous mathematical treatment. The essential ingredients are given by powerful interpolation methods, and **sum rules.** These methods **led in the** past years to the proof of relevant results, in particular concerning **the control** of the infinite volume limit, and **the mechanism of the** spontaneous replica symmetry breaking. For the neural nets of Hopfield type many physicists have developed interpolation method **which allows the** characterization of the replica symmetric approximation, and the possibility **of introducing** functional order parameters for the description of the replica symmetry breaking. The variational principle **arising in the expression** of the free energy in the infinite volume limit is of novel type, in **that it involves** a mini-max procedure, in contrast with the Sherrington-Kirkpatrick model for a spin glass. The theory of self-oscillating mechanical systems **has been exploited for** the study of speech formation, analysis and synthesis, and musical instrument functioning. It is possible **to apply** fully nonlinear schemes, by completely **avoiding any kind** of exploitation of the Fourier analysis. the **role of the** different peaks of the spectrum in the Fourier analysis is played **by the intervention of** successive landau instability modes for the self-oscillating system. Finally, in recent times, scientists have **developed the** possibility of giving simple models for the immunological system, **based on** stochastic dynamical systems of statistical mechanics far from equilibrium. The models are simple enough **to allow** practical evaluations**, in connection** with the known phenomenology, but they are very rich in the possibility of introducing all basic feature of the real system.

In this connection mention can be made of the studies done of the quantum field theory formulation of the relativistic Majorana equations, introduced in 1932 in a famous paper on Nuovo Cimento, and the study of slowing down, scattering and absorption of neutrons, original methods of fermi, wick, both, Heisenberg, with the purpose of a realistic assessment of the validity of the approximations introduced by them, in comparison with the modern methods of numerical **simulations** in the nuclear reactor theory.

SUBJECT-OBJECT DUALITY :

There exist extrinsic relations and dysfunctional fissures when it comes to subject object duality. Both are signifiers of logical attributes and states of affairs, in the spatiotemporal realization of events. Zen prevarications in to the manifest duality have prodigious phonetic modes into the natural world which proceeds from a radically different point of departure than science, and its methods differ correspondingly. Early pioneers of the scientific revolution, including Copernicus, Kepler, and Galileo, expressed and enucleated an initial interest in the nature of physical objects most far removed and diversified both in their thematic and discursive forms, from human subjectivity: such issues as the relative motions of the sun and earth, the surface of the moon, and the revolutions of the planets. And a central principle of scientific naturalism is the pure objectification of the natural world, free of any contamination of subjectivity, shorn of shibboleth of sentimentalities and susceptibilities and sensibilities. . This principle of objectivism demands that science deals with empirical facts testable by

empirical methods entailing testability by third-person means; and such facts must, therefore, be public rather than private, which is to say, they must be accessible to more than one observer. **Observation /observer is necessary for reality is what Quantum Mechanics, dilates upon.** .

Complementarity is an ontological, phenomenological, morphological, epistemological principle derived from the subject—object or observer—system dichotomy, where each side requires a separate mode of description that is formally incompatible with and irreducible to the other, and where one mode of description alone does not provide comprehensive explanatory power for the heterogeneous discursiveness and efficacious variations, systemic in nature.. The classical physics paradigmatic testament, on which biological, social and psychological sciences are modeled, completely suppresses the observer or subject side of this dichotomy in order to claim unity and consistency in theory and objectivity in experimental observations. Quantum mechanical measurements have shown this paradigm to be untenable. Explanation of events and proliferation of senses requires both an objective, causal representation and a subjective, prescriptive representation and a situational goal directed ness Corporation significations, personalized manifestations leads to relative displacements of secondary variations that are complementary. The concepts of description and function, destructuration, disorganization, in biological systems, and goals and policies in social systems, are found to have the same epistemological basis as the concept of measurement in physics, and sometimes look like syllabic and causal elongation with augmented accents. There are no sterile divisions but there certainly is propositional subsistence and sustentative corollary.. The concepts of rate-dependent and rate-independent processes are proposed as a necessary distinction for applying the principle of complementarity to explanations of physical, biological and social systems.

Giddens's duality of structure notion which is at the centre of his structuration theory, has in its diaspora errors of evolutionary analysis and reformative sonorities.. Concept of subject/object dualism, which is not seriously considered by structuration theory sometimes looks like a churlish renegades quibble. is as essential as the concept of duality for an understanding of how actors orient themselves and the predilections and proclivities to rules and resources as a virtual order, as well as to sets of interactions in time and space. All these are statements and theories that lead to progressive advancement towards goals.

On the basis of a fourfold typology referring to different definitions of the social-structure concept, and of a critique of Giddens's and Bourdieu's strategies for transcending the divide between objectivist and subjectivist sociologies, some papers argue that rapprochement rather than transcendence is the way to overcome the existing fragmentation and for bringing closer together structural/structuralism and interpretative paradigms in the social sciences, with singularities and antigeneralities **In whatever way you at this problem, one thing becomes clear be it intangible subject is equivalent to object or there exists a relationship of locus and focus of essence, sense and conception, between subject and object. Based on this statement we set out to incorporate these two factors in the model**.

HIGGS BOSON IN FICTION(We have used author's reference pages, Wikipedia, Stanford Encyclopedia, Cornell Library information NASA AND CERN reports to prepare this abstract)

In the science fantasy series *Lexx*, it is said that planets which **develop on** a path similar to Earth are type 13 planets which are sometimes **destroyed by** all-out nuclear war, but it is much more common for such planets to be **obliterated** by physicists attempting **to determine** the precise mass of the Higgs boson particle. The particle colliders **used to** perform the calculations **reach** critical mass at the moment the mass of the particle is known**, causing** an implosion which **destroys** the planet and then collapses it into a **nugget o**f super-dense matter "roughly the size of a pea." The mass of the particle was a repeating 131313 matching the name "type 13 planet" and this also is in the predicted range of the particles mass

In Robert J. Sawyer's *Flash-forward*, an experiment at CERN to find the Higgs particle **causes** the consciousness of the entire human race to be temporarily sent twenty-one years into the future.

Consciousness changes with time. Consciousness today is greater than consciousness after 20 years. Later, the experiment is repeated with the specific intention to view the future – however this time it instead **creates** the Higgs Boson

Into the Looking Glass

In John Ringo's *Into the Looking Glass*, the University of Central Florida is destroyed by a 60 kiloton explosion that is first thought to be a nuclear weapon, but turns out to be a mishap from a Higgs boson research experiment. Following the explosion, gateways to other **worlds are opened and** a war with the aliens on the other side of the gates begins.

The God Particle

In Richard Cox's *The God Particle*, American business man Steve Keeley is thrown out of a window and falls three stories, then wakes up and begins to see the world in a different way; he is able to accurately predict future events, read others' thoughts, and **manipulate** his environment

A Hole in Texas

In Herman Wouk's *A Hole in Texas*, the real science behind the Higgs boson is used as a backdrop for a attire on Washington politics, the chase for funding in scientific communities, and Hollywood blockbusters. In fact, the Hollywood portion of the satire has much to do with the wild flights of fancy in evidence in many of the other entries on this list. Much of the plot is based on the aborted Superconducting Super Collider project!

BALDIE HIGGS BOSON- HIGGS BOSON AT THE ORIGIN -NO MIND CONDITION AND CONDITION OF PURE CONSCIOUSNESS:

When we say Origin Higgs, we mean that at the origin when the world started, the Higgs Boson, a particle which has "nothing", neither symmetry nor mass, and other parameters naturally associated with subatomic particles. Zen verily say that from "nothing", the world came, and so did the matter.This is also what is called "pure consciousness" in Vedas. Then how did the Higgs Boson came out with a signature of circle in CERN. We shall say that it is the ramification of the "effect" of Higgs Boson on other subatomic particles, namely entrusting the particle with the mass. According to EPR, the truth is one who perceives it, the one who knows it and the one perceived, that is what it is. One feels Higgs Boson is the one which saw that mass less universe, gave mass, and still exists to see what happened henceforth.

What that statement means is that the Higgs particle (at least in the simplest predicted form by the standard model of particle physics) **does not possess** any of the normal things **that allow** the particle to have different states. Lack of parameters (eb) non occupation of different states. It just has mass. It **doesn't** have charge, spin, angular momentum, no parity, nor any quantum number associated with it. The only property it has is mass. The "hair" statement in the foregoing bears ample testimony to the fact it is something like "No mind "condition (**Non anagrammatism**). If the Higgs had hair, we'd be able to tell if it was parted/combed to the left or the right. But as it is, the particle is completely bald. Another (more common) word for this is symmetry. **Higgs boson particle is thought to add mass to matter, making possible the clustering together of particles to form shapes. We need to have signifier of logical attributes and states of affairs or we must have a particle identity.** Similarly, the Higgs should not come in particle and anti-particle varieties. It doesn't distinguish between particle and anti-particle. Or said differently, it is its own anti-particle. Put two Higgs in the Feynmans Diagram below.

Particle reconstruction(Following explanation and matter is reconstructed based on material in Wikipedia, Stanford Encyclopedia and Author's Home page and articles thereof. We pay our respectful homage to all the eminent sources)

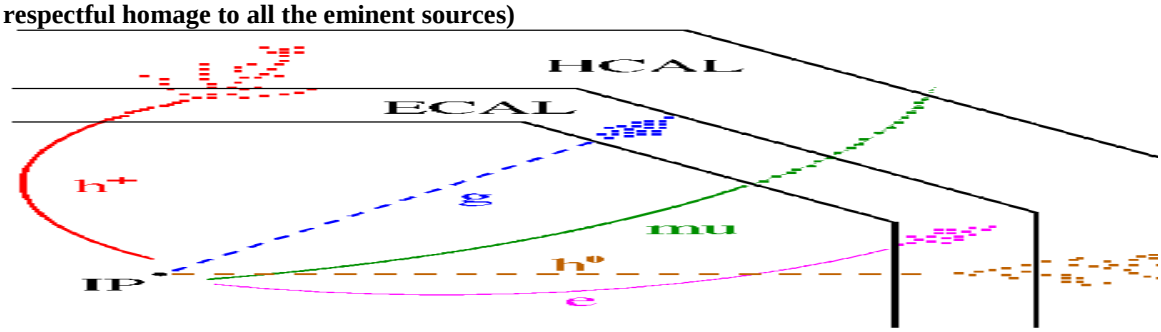


Figure 1: particles leave characteristic signatures in high energy physics detectors:

- **charged hadron in tracker, ECAL and HCAL**
- **photon in the ECAL**
- **muon as straight track everywhere**
- **neutral hadron in ECAL and HCAL**
- **electron contained in the ECAL**

Towards the end of comprehension of whatever happens during collision, we would like to **extract** the energy and momentum of all particles **created** in this collision. These quantities allow us to **extract** some fundamental properties of nature. They can be **determined** from measurements carried out with detectors. High energy physics detectors are disintegrated and divided into several sub detectors that surround each other. The main components, available in every high energy physics collision experiment are a tracking device and a calorimetric system. A sketch of the detector top view with an example of particle signatures is plotted in Fig1.

The tracker is located in the center, surrounding the place where the particles collide (interaction point: IP). It is designed to measure the tracks of all charged particles, e.g. electrons (e) or charged hadrons (h^+), passing through. From these tracks, we can determine the particles momenta, and we can also draw conclusions on the particle type, such as electron (e), or proton (h^+). The tracker is surrounded by a calorimetric system that is again divided into an electromagnetic and a hadronic part. The calorimeters are capable to measure the energy of charged and neutral particles, whereas the tracker can only detect charged ones. Usually the electromagnetically interacting particles, e.g. photons (g) and electrons (e) are caught in the electromagnetic calorimeter ECAL. Particles that consist out of quarks so called hadrons, e.g. protons (h^+) and neutrons (h^0) can traverse further into the hadronic calorimeter. Often the calorimetric system is completed by a muon system that can identify muons (mu). The combination of all sub detectors allows a precise reconstruction of the interesting physics during the collision of two high energetic particles.

The particle flow approach

Better resolution of the detectors, **produces** more precise experimentation and observation. We can **assign/ascribe/attribute/attach** the detector signal to an individual particle, and there shall be more humungous information about the initial collision. The momentum resolution **achieved** in the tracker is by far the more precise than the energy measurement in the calorimetric system. Therefore, the particle flow approach is to use the best suited detector to measure the individual particles. This means all charged particles should be reconstructed in the tracker and all neutral particles can be determined in the calorimetric system. The **combination** of either particle type and energy or particle type and momentum, allows us to draw conclusions on the momentum and energy, respectively. This implies the possibility to separate charged and neutral particles in the calorimetric system.

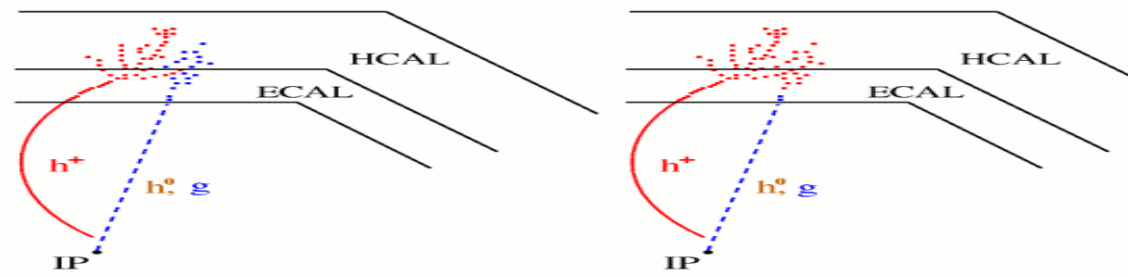


Figure 2: confusion problem - missing energy

- **left: close by neutral and charge particle shower in the calorimeters**
- **right: the energy of the neutral particle was allocated to the charged particle**

The problem in this reconstruction method is to disentangle the particles that left their signature close to each other (Fig.2, left). In such a case it is hard to distinguish between the energy deposited by the two nearby particles.

If part of, or all of the neutral particles (h^0, g) energy is **allocated to** the charged particle (h^+), as sketched in Fig2, the reconstructed energy is **too low**. The charged particle is correctly **reconstructed** by the tracker, and the calorimeter information of this particle is **not needed**. But the neutral particle is **invisible** in the tracker, and if its energy **is assigned** to the neighboring charged track, it's reconstructed **with** too low energy, or not at all. Hence, in the overall event energy is **missing.**

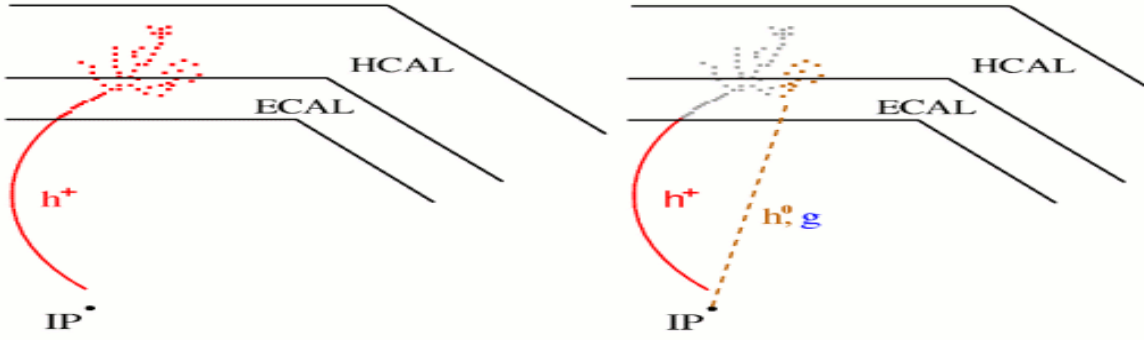


Figure 3: confusion problem - double counting (balancing error)

- **left: showing charged particle**
- **right: the charged particle was reconstructed as one charged plus one neutral particle**

On the other hand it can as well happen that the opposite effect **occurs.** Plotted in Fig3 is a case where the energy deposition of a charged particle (h^+) is only **partially assigned** to its track, the remaining energy can be **connected** to a neutral particle (h^0) that has never been there. In this case the charged particle would again be correctly **reconstructed** from the tracker information, but an additional particle would be **introduced**. This **results** in too much energy in the overall event.

PURE CONSCIOUSNESS (See Venkateshananada at speaking tree TOI. Interpretation is mine and reflects my own views)

Schrodinger famously stated on the Quantum Mechanics that "**Consciousness is Maya, an illusion**" What is an illusion? Thinking is anagrammatic. Subject Object duality does not exist. And the main kink in the armor is attributable to the fact that annihilation of object is not assumed by the Theories of

knowledge. Consciousness **falsely imagines** irrationally and without basis it is bound by the fabric of space and time. Mind itself is **anagrammatic** and all reductionism is bound to be give "spatiotemporal results". Whenever anagrammatism is extant and existentialist, there **shall be** duality. Duality is cause of all misunderstanding. Whenever "consciousness" (here we mean cosmic consciousness" in the sense of the knowledge of what is happening. This means for example that in my state Karnataka News paper reported that purportedly stated there were piscatorial piratishness and bubonic bucaneerishness, larceny, money defalcation, and horse trading in the leadership change. For a person without consciousness, everything looks "usual" and "normal "without seething of any political belligerencies or caste bellicosities. It just **does not register** in his mind. It **does not leave signature** in the mind) Due to the false assumption of ego sense, individual consciousness **thinks** that the world appearance is indeed real. It is the mind alone that is the **root cause** of experiencing the world as if it were real; but it cannot be truly considered such a **cause** since there can be no mind other than pure consciousness. Once you realize that the perceiving mind itself is unreal, virtual,(Note that No Mind Condition stated above refers to origin at which Higgs Boson took place) it becomes clear that the perceived world is unreal, too. Essentially mind divides, disintegrates; it never allows you to see the underlying unity.

In pure consciousness the **diversity of** sight, seer and scene, or of doer, act and action of knower, knowledge and known does not exist. Similarly, the distinction between 'i', and 'you' is imaginary (See subject Object duality delineated in the foregoing). The distinction between the one and the many is verbal. All these do not exist at all even as darkness does not exist in the sun. Opposites like substantially and insubstantiality, void and nonvoid are mere concepts. On enquiry, all these disappear and only unmodified pure consciousness remains. This exactly Higgs boson at the origin is.

It is to be understood in unmistakable terms that there exists both individual consciousness and collective consciousness. It understands by "intuition", "reading between lines" that one could fathom all. This infinite consciousness, which is unmodified and non-dual, can be realized by one in the single self-luminous inner light. It is pure and eternal, it is ever present and devoid of mind, it is unmodified and untainted, it is all the objects. In fact, it is witness consciousness which judges the system dispassionately without reacting to it be it analytical, survey wise, institutional, or mathematical, the "Truth" is beholden.

Consciousness, which is devoid of concepts and extremely subtle, knows itself. In self-forgetfulness, this consciousness entertains thoughts and experiences perceptions, though all this is possible because of the very nature of the infinite, consciousness, even as one who is asleep is also inwardly awake.

Pure Consciousness

By identification with its own object, consciousness seems to reduce itself to the state of thinking notion of the universe arises, but this unreality ceases with when you understand the cosmological interpretation that "you" are just a "vibration" in "space and time"

When individual consciousness becomes aware of itself within cosmic consciousness, the ego sense arises. With just a little movement though, this ego sense falls down as a rock rolls down the mountainside. However, even then it is consciousness alone that is the reality in all forms and all experiences. The movement of the vital air **brings about** vision within and an object which is apparently outside. But the **experiencing of sight** is the pure consciousness. The apparently inert vital air which is the tactile sensation comes into contact with its object and there is the sense of touch. But the awareness of the tactile sensation is again pure consciousness.Higgs Boson has no anti particle(albeit we doubt the statement) they say. This of course is to not unequivocal, although we take the statement that Higgs Boson is the antiparticle of itself. . In the same way, it is the vital air that enables the nose to smell the scents which are modifications of the same energy, while the awareness of the smell is pure consciousness. If the mind is **not associated** with the sense of hearing, no hearing is possible. Again, it is pure consciousness that is the experience of hearing.

Action **springs from** thought, thought is the **function of** the mind, mind is **conditioned** (anagrammatic) consciousness, but consciousness **is unconditioned**. The universe is but a **reflection** in consciousness but evolved consciousness is **not conditioned** by such reflection. Jiva is the vehicle of consciousness, ego sense is the vehicle of jiva, intelligence of ego sense, mind of intelligence, prana of the mind; the sense of motion is karma. Because prana is the vehicle for the mind, where the prana takes it, the mind goes. But when the mind is **merged** in the spiritual heart, prana does not move. And if the prana does not move, the mind attains a quiescent state. Where the prana goes, the mind follows, even as the rider goes

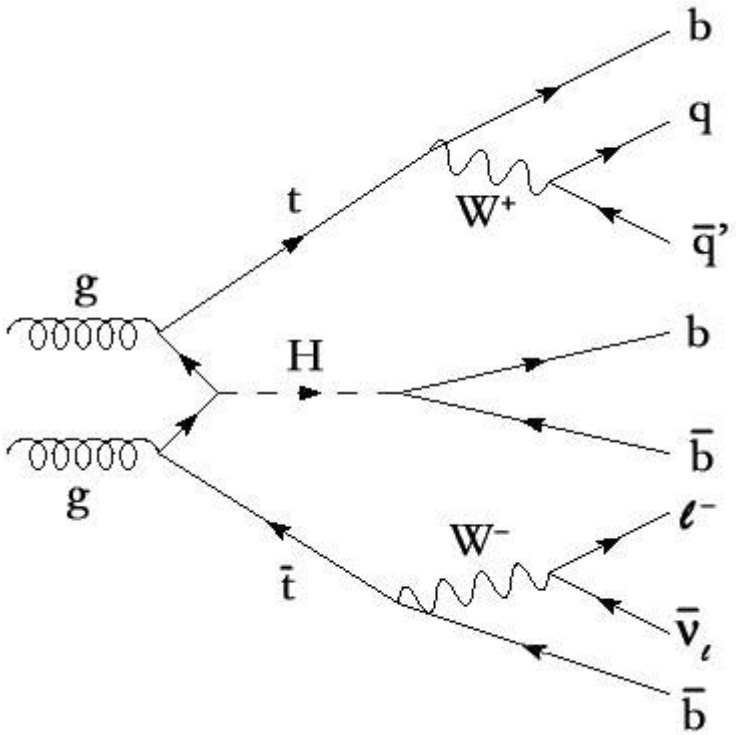
where the vehicle goes.

EJUSDEM GENERIS: THE ONE REALITY OR A FAUX PAS FOR BETTER ALTERNATIVE:

The reflection of consciousness within itself is known as puryastaka in Vedas. Matter production from Higgs Boson, only shows that matter has 12 +1 elementary particles. To this the Higgs Boson, its own antiparticle could be added. The organs of action, the senses, ignorance, desire, and karma or action). **Since all these arise in consciousness, exist in consciousness and dissolve in consciousness, that consciousness alone is the reality. What then brought out life? What then brought out mind? For the former we say it is "natural permutation and combination" and to the later we have assumed "neuron DNA" is the product of mind of sentient beings. In this connection reference is invited to author's paper entitled "Is Universe a simulated one with a giant Computer"**

But for the mind and prana, the body is an **inert** mass. Just as a piece of iron moves in the presence of a magnet, even so the jiva moves in the **very presence** of **COSMIC** consciousness that is infinite and omnipresent. The body is inert and dependant; it is made to function by the consciousness which believes itself to be similar to the prana or vital air. Thus, it is the karmatama, karma-self or the active self (**We have assumed that Quantum register is maintained of all the actions and thinking and that it is derived from Neuron DNA, which as at present is a hypothetical particle. Analogy of bank ledgers are again given for obtention of Gratification and deprivation balance based on "Karma" which is in "Neuron DNA" and assumed to be down loaded**). That keeps the body in motion. It is, however, the cosmic consciousness (one which has all accounts which depict the actions of everything, sentient and insentient) makes both the mind and the sentience as the **promoters** of life in the body. It is the consciousness itself, **assuming** inertia, which rides the mind as the jiva.

HIGGS BOSON AND GLUONS(MODEL FOR THIS IS GIVEN IN PART THREE OF THE SERIES)



The aim is to keep this kind of confusion **as low** as possible. This challenge can be **met by** a calorimetric system with very high granularity that allows us to **separate** close by particles, and well trained particle flow algorithms that are able to do effective clustering. We **build** and test high granular calorimeter prototypes and develop and test new reconstruction methods on test beam data, as well as on

full detector simulation and particle flow based reconstruction.

String theory suggests that the big bang was not the origin of the universe but simply the Outcome of a preexisting state (See for details Gabriele Veneziano)

Was the big bang really the beginning of time? Or did the universe exist before then? Such a question seemed almost blatant, flagrant, calumniously clamoring, temerariously adamant, and blasphemous only a decade ago. Most cosmologists insisted that it simply made no sense--that to contemplate a time before the big bang was like asking for directions to a place north of the North Pole. But developments in theoretical physics, especially the rise of string theory, have changed their perspective. The pre-bang universe has become the latest frontier of cosmology. It is entwined with a grand set of concerns, one famously encapsulated in an 1897 painting by Paul Gauguin: D'ou venons-nous? Que sommes-nous? Ou allons-nous? "Where do we come from? What are we? Where are we going?" The piece depicts the cycle of birth, life and death--origin, identity and destiny for each individual--and these personal concerns connect directly to cosmic ones. We can trace our lineage back through the generations, back through our animal ancestors, to early forms of life and protolife, to the elements synthesized in the primordial universe, to the amorphous energy deposited in space before that. Does our family tree extend forever backward? Or do its roots terminate? Is the cosmos as impermanent as we are?

String Cosmology

Greeks debated, deliberated and confabulated the origin of time fiercely. Aristotle, taking **the no-beginning side**, invoked the principle that out of nothing, nothing comes. Nothing **cannot produce** something. In the eventuality of the fact that Universe would have been produced from nothingness, then, it must always **have existed**. Towards the end of consummation and consolidation of this reasoning, time must **stretch** eternally into the past and future. Theologians had a pen chance, predilection, and proclivity **to assume** the opposite point of view. Augustine contended that God **exists outside** of space and time, able to bring these constructs into existence as surely as he could forge other aspects of our world. Time itself being part of God's creation, there was simply **no** before!"

Strings **abhor** infinity. They **cannot collapse** to an infinitesimal point, so **they avoid** the paradoxes that collapse would entail. Einstein's general theory of relativity led modern cosmologists to much the same conclusion. The theory holds that space and time are soft, malleable entities. On the largest scales, space is naturally dynamic, **expanding or contracting over time**, carrying matter like driftwood on the tide. Astronomers confirmed in the 1920s that our universe is currently **expanding:** distant galaxies **move apart** from one another. One **consequence, of** the current expanding universe is that as physicists Stephen Hawking and Roger Penrose proved in the 1960s, is that time **cannot extend back** indefinitely. As you **play or produce** cosmic history backward in time, the galaxies all come together **or converge** to a single infinitesimal point, known as a singularity--almost as if they were descending into a black hole. In fact **this leads** to a prognostication that Universe might have **started from** Blackhole. Each galaxy or its precursor is **squeezed down** to zero size. Quantities such as density, temperature and spacetime curvature **become** infinite. The singularity is the ultimate cataclysm, beyond which our cosmic ancestry cannot extend. **Beyond** singularity cosmic history does not **exist.**

Strange Coincidence

The unavoidable singularity poses serious problems for cosmologists. In particular, it sits uneasily with Two Views of the Beginning the high degree of homogeneity and isotropy that the universe exhibits on large scales. For the cosmos to look broadly the same everywhere, some kind of **communication (-&+)had** to pass among distant regions of space, **coordinating** their properties. But the idea of such communication **contradicts t**he old cosmological paradigm. To be specific, consider what has happened over the 13.7 billion years since the release of the cosmic microwave background radiation. The distance between galaxies **has grown** by a factor of about 1,000 (because of the expansion), while the **radius of the** observable universe has grown by the much larger factor of about 100,000 (because light outpaces the expansion). We **see** parts of the universe today that we could not have seen 13.7 billion years ago. Indeed, this is the first time in cosmic history that light from the most distant galaxies **has reached the** Milky Way. Nevertheless, the properties of the Milky Way are basically the same **as** those of distant galaxies. It is as though you showed up at a party only to find you were wearing exactly the same clothes as a dozen of your closest friends. If just two of you were dressed the same, it might be explained away as coincidence, but a dozen suggests that the partygoers had **coordinated** their attire in advance. In cosmology, the number is not a dozen but tens of thousands--the number of independent yet statistically

identical patches of sky in the microwave background.

One possibility is that all those regions of space were **endowed (+)at birth** with identical properties--in other words, that the homogeneity is mere coincidence. Physicists, however, have thought about two more natural ways out of the impasse: the early universe was much smaller or much older than in standard cosmology. Either (or both, acting together) would have made intercommunication possible. The most popular choice follows the first alternative. It postulates that the universe went through a period of accelerating expansion, known as inflation, early in its history. Before this phase, galaxies or their precursors were so closely packed that they could easily coordinate their properties. During inflation, they fell out of contact (separated) because light was unable to keep pace with the frenetic expansion. Pace of expansion was more that of the velocity of light. After inflation ended, the expansion **began to decelerate**, so galaxies gradually came back into one another's view. Physicists **ascribe** the inflationary spurt to the potential energy stored in a new quantum field, the inflaton, about 10-35 second after the big bang. Potential energy, **as opposed** (e) to rest mass or kinetic energy, **leads to(eb)** gravitational repulsion. Rather than **slowing down(-)** the expansion, as the gravitation of ordinary matter would, the inflaton(-) **accelerated(+)** it. Proposed in 1981, inflation has **explained** a wide variety of observations with precision [see "The Inflationary Universe," by Alan H. Guth and Paul J. Steinhardt; Scientific American, May 1984; and "Four Keys to Cosmology," Special report; Scientific American, February]. A number of possible theoretical problems remain, though, beginning with the questions of what exactly the inflaton was and **what gave** (-&+) it such a huge initial potential energy. A second, less widely known way to **solve** the puzzle follows the second alternative by **getting rid** of the singularity. If time **did not** begin at the bang, if a long era **preceded** the onset of the present cosmic expansion, matter could have had plenty of time to **arrange(isotropicness of the universe)** itself smoothly. Therefore, researchers have reexamined the reasoning that led them to **infer a** singularity. One of the assumptions--that relativity theory is always valid—is questionable. Close to the putative singularity, quantum effects must have been important, even **dominant**. Standard relativity takes **no account** of such effects, so accepting the inevitability of the singularity **amounts to** trusting the theory beyond reason. That shall be a travesty of truth and harbinger of pithy prognostication. To know what really happened; physicists need to **subsume** relativity in a quantum theory of gravity. The task has occupied theorists from Einstein onward, but progress was almost zero until the mid-1980s.

REVITALISATION AND RESURRECTION OF NEW THEORIES (See for details SAMUEL VELASCO)

Pre-Big Bang Scenario

One, going by the name of loop quantum gravity, **retains E**instein's theory essentially intact but **changes** the procedure for **implementing it** in quantum mechanics (see "Atoms of Space and Time," by Lee Smolin; Scientific American, January). Practitioners of loop quantum gravity have taken great strides and achieved deep insights over the past several years. Still, their approach may not be revolutionary enough to **resolve** the fundamental problems of **quantizing** gravity. A similar problem faced particle theorists after Enrico Fermi introduced his effective theory of the weak nuclear force in 1934. All efforts to **construct** a quantum version of Fermi's theory **failed** miserably. What was needed was not a new technique but the deep **modifications** brought by the electroweak theory of Sheldon L. Glashow, Steven Wein-berg and Abdus Salam in the late 1960s.The second approach, which is more promising, is string theory--a truly revolutionary modification of Einstein's theory. Proponents' precursors and primogenitures of loop quantum gravity claim to **reach** many of the same conclusions. Vestiges of the pre-banging epoch might **show up in** galactic and intergalactic magnetic fields, is their thinking.

Ekpyrotic Scenario-The Beginning of Thunderstorm Thermistor and Verkrampte reactionary:

Quarks are **confined inside** a proton or a neutron, as if they were **tied together** by elastic strings. In retrospect, the original string theory had **captured** those stringy aspects of the nuclear world. Only later was it revived, revitalized, rejuvenated, and resurrected as a candidate for **combining** general relativity and quantum theory. The basic idea is that elementary particles are not **point like** but rather infinitely **thin one-dimensional objects**, the strings. Zoo of elementary particles, each with its own characteristic properties, **reflects** the many possible vibration patterns of a string. How can such a simple-minded theory **describe** the complicated world of particles and their **interactions**? The answer can be found in what we may call **quantum string magic**. Once the rules of quantum mechanics are **applied** to a vibrating string--just like a miniature violin string, except that the vibrations **propagate** along it at the speed of light--new properties appear. All have profound **implications** for particle physics and cosmology. First, quantum strings **have a** finite size. Were it not for quantum effects, a violin string could be **cut i**n half, **cut** in half **again** and so on all the way down, finally **becoming** a massless point

like particle. But the Heisenberg uncertainty principle eventually intrudes and **prevents** the lightest strings from being **sliced** smaller than about 10 -34 meter. This **irreducible** quantum of length, denoted **ls**, is a new constant of nature introduced by string theory side by side with the speed of light, c, and Planck's constant, h. It plays a **crucial role** in almost every aspect of string theory, putting a **finite limit** on quantities that otherwise could **become** either zero or infinite. Quantum strings may **have** angular momentum even if they **lack** mass. In classical physics, angular momentum **is a property** of an object that **rotates** with respect to an axis. The formula for angular momentum (=) multiplies together velocity, mass and distance from the axis; hence, a massless object **can have no** angular momentum. But quantum fluctuations **change t**he situation. A tiny string can **acquire** up to two units of h of angular momentum **without gaining** any mass. This feature is propitious and felicitous welcome because it precisely matches the properties of the **carriers of** all known fundamental forces, such as the photon (for electromagnetism) and the graviton (for gravity). Historically, angular momentum is what clued in physicists to the quantum-gravitational implications of string theory .Third; quantum strings **demand and require** the **existence** of extra dimensions of space, in addition to the usual three. Whereas a classical violin string will vibrate **no matter** what the properties of space and time are, a quantum string is more finicky, fastidious, fussy and paranoid pernickety. The equations **describing** the vibration **become inconsistent** unless spacetime either is highly curved (in contradiction with observations) **or contains** six extra spatial dimensions. Fourth, physical constants--such as Newton's and Coulomb's constants, which appear in the equations of physics and **determine** the properties of nature--no longer, have arbitrary, fixed values. They **occur** in string theory as fields, rather like the electromagnetic field, that can **adjust** their values dynamically. These fields **may have taken** different values in different cosmological epochs or in remote regions of space, and even today the physical "constants" **may vary** by a small amount. Observing any variation would **provide a**n enormous boost to string theory. Assumption of different values in different cosmological epochs is the most important point to be noted and acts as a dissipation coefficient in the model, in addition to the progressive stages of cosmological stages. One such field, called the **dilaton**, is the master key to string theory; it **determines** the overall strength of all interactions. The dilaton fascinates string theorists because its value (Dilaton) can be (=) reinterpreted as the size of an extra dimension of space, giving a grand total of 11 spacetime dimensions. Instantaneousness of size may be mentioned. There does not appear to be time lag.

CONSUMMATION AND COSOLIDATION OF FRAGMENTS:

Finally, quantum strings **have introduced** physicists to some striking new symmetries of nature known as dualities, which **alter** our intuition for what **happens** when objects get extremely small. Already alluded to a form of duality: normally, a short string is **lighter** than a long one, but if we attempt to **squeeze down** its size **below** the fundamental length ls, the string **gets** heavier again. Strange ménage a trios this! Another form of the symmetry, T-duality, holds that small and large extra dimensions are **equivalent.** This symmetry **arises because** strings can move in more complicated ways than point like particles can. Consider a closed string (a loop) located on a cylindrically shaped space, whose circular cross section **represents** one finite extra dimension. Besides vibrating, the string can either turn as a whole around the cylinder or **wind** around it,(here unwound string length gets **reduced**) one or several times, like a rubber band wrapped around a rolled-up the energetic cost of these two states of the string **depends** on the size of the cylinder. The energy of winding is **directly proportional** to the cylinder radius: larger cylinders **require** the string to stretch more as it wraps around, so the windings **contain** more energy than they would on a smaller cylinder. The energy **associated** with moving around the circle, on the other hand, is **inversely proportional** to the radius: larger cylinders **allow for** longer wavelengths (smaller frequencies), which represent less energy than shorter wavelengths do. If a large cylinder is **substituted for** a small one, the two states of motion can **swap** roles. Energies that had been **produced** by circular motion are instead **produced** by winding, and vice versa. An outside observer **notices** only the energy levels, not the origin of those levels. To that observer, the large and small radii are physically **equivalent**. Although T-duality is usually **described in** terms of cylindrical spaces, in which one dimension (the circumference) is finite, a variant of it **applies** to our ordinary three dimensions, which appear to **stretch on** indefinitely. One must be careful when talking about the **expansion** of an infinite space. Its overall size **cannot change**; it remains infinite. But it can still **expand** in the sense that bodies embedded within it, such as galaxies, **move apart** from one another. The crucial variable is not the size of the space as a whole but its scale factor--the factor by which the distance between galaxies **changes**, **manifesting** itself as the galactic redshift that astronomers observe. According to T-duality, universes with small scale factors are **equivalent** to ones with large scale factors. No such symmetry is **present** in Einstein's equations; it **emerges** from the **unification** that string theory embodies, with the dilaton playing a central role. For years, string theorists thought that T-duality **applied** only to closed strings, as opposed to open strings, which have loose ends and thus **cannot** wind.

In 1995 Joseph Polchinski of the University of California at Santa Barbara realized that T-duality **did apply to** open strings, **provided** that the switch between large and small radii was accompanied by a **change** in the conditions at the end points of the string. Until then, physicists had postulated boundary conditions in which no force **acted** on the ends of the strings, leaving them free to flap around. Under T-duality, these conditions **become** so-called Dirichlet boundary conditions, whereby the ends stay put. Any given string can **mix** both types of boundary conditions. For instance, electrons may be strings whose ends can move around **freely** in three of the 10 spatial dimensions but are **stuck** within the other seven. Those three dimensions **form** a subspace known as a Dirichlet membrane, or D-brane. In 1996 Petr Horava of the University of California at Berkeley and Edward Witten of the Institute for Advanced Study in Princeton, N.J., proposed that our universe **resides** on such a brane. The partial mobility of electrons and other particles **produces** an explanation why we are unable to perceive the full 10-dimensional glory of space.

CHASTENING A BULWARK:

All the magic properties of quantum strings point in one direction: strings abhor e(e&eb) =e infinity. They cannot collapse to an infinitesimal point, so they avoid the paradoxes that collapse entails. Their (Quantum strings) nonzero size and novel symmetries set upper bounds to physical quantities that increase without limit in conventional theories, and they set lower bounds to quantities that decrease. String theorists expect that when one plays the history of the universe backward in time, the, such a chronological movement back in time produces curvature of spacetime starts to increase. But instead of going all the way to infinity (at the traditional big bang singularity), it eventually hits a maximum and shrinks once more. Before string theory, physicists were hard-pressed to imagine any mechanism that could so cleanly eliminate the singularity. Conditions near the zero time of the big bang were so extreme that no one yet knows how to solve the equations. Nevertheless, string theorists have hazarded guesses about the pre-bang universe. Two popular models are floating around. The first, known as the pre-big bang scenario, which (Dirichlet-Branes and Ramond-Ramond Charges) Joseph Polchinski began to develop in 1991,combines T-duality with the better-known symmetry of time reversal, whereby the equations of physics work equally well when applied backward and forward in time. The combination gives rise to new possible cosmologies in which the universe, say, five seconds before the big bang expanded at the same pace as it did five seconds after the bang. But the rate of change of the expansion was opposite at the two instants: if it was decelerating after the bang, it was accelerating before. In short, the big bang may not have been the origin of the universe but simply a violent transition from acceleration to deceleration. The beauty of this picture is that it automatically incorporates the great insight of standard inflationary theory--namely, that the universe had to undergo a period of acceleration to become so homogeneous and isotropic. In the standard theory, acceleration occurs after the big bang because of an ad hoc inflaton field. In the pre-big bang scenario, it occurs before the bang as a natural outcome of the novel symmetries of string theory. According to the scenario, the pre-bang universe was almost a perfect mirror image of the post-bang one. If the universe is eternal into the future, its contents thinning to a meager gruel, it is also eternal into the past. Infinitely long ago it was nearly empty, filled only with a tenuous, widely dispersed, chaotic gas of radiation and matter. The forces of nature, controlled by the dilaton field, were so feeble that particles in this gas barely interacted.

TIME- A TOPOLOGICAL TROJAN HORSE - FLIES:

As time went on, the forces gained in strength and pulled matter together. Randomly, some regions accumulated matter at the expense of their surroundings. Eventually the density in these regions **became** so high that black holes started **to form**. Matter **inside** those regions was then **cut off** from the outside, breaking up the universe into disconnected pieces. Inside a black hole, space and time **swap** roles. The center of the black hole is not a point in space but an instant in time. As the infalling matter approached the center, it **reached** higher and higher densities. But when the density, temperature and curvature **reached** the maximum values **allowed** by string theory, these quantities **bounced** and started **decreasing**. The moment of that reversal is what we call a big bang. The interior of one of those black holes became our universe. Not surprisingly, such an unconventional scenario has provoked controversy. Andrei Linde of Stanford University has argued that for this scenario to match observations, the black hole that **gave rise** to our universe would have to have formed with an unusually large size--much larger than the length scale of string theory. An answer to this objection is that the equations predict black holes of all possible sizes.

Our universe just happened to form inside a sufficiently large one. A more serious objection raised by

Thibault Damour of the Institut des Hautes Études Scientifiques in Bures-sur-Yvette, France, and Marc Henneaux of the Free University of Brussels, is that matter and spacetime would have behaved chaotically near the moment of the bang, in possible contradiction with the observed regularity of the early universe. I have recently proposed that a chaotic state would produce a dense gas of miniature "string holes"--strings that were so small and massive that they were on the verge of becoming black holes. The behavior of these holes could solve the problem identified by Damour and Henneaux. A similar proposal has been put forward by Thomas Banks of Rutgers University and Willy Fischler of the University of Texas at Austin. Other critiques also exist, and whether they have uncovered a fatal flaw in the scenario remains to be determined.

BLACK AND BLUE JUGGERNAUT AND ARMAGGEDDON::

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The other leading model for the universe before the bang is the ekpyrotic ("conflagration") scenario. Developed three years ago by a team of cosmologists and string theorists--Justin Khoury of Columbia

University, Paul J. Steinhardt of Princeton University, Burt A. Ovrut of the University of Pennsylvania, Nathan Seiberg of the Institute for Advanced Study and Neil Turok of the University of Cambridge—the ekpyrotic scenario relies on the idea that our universe is **one of** many D-branes floating within a higher dimensional space. The branes exert attractive forces on one another and occasionally collide. The big bang could be the impact of another brane into ours. In a variant of this scenario, the collisions occur cyclically. Two branes might hit, bounce off each other, move apart, pull each other together, hit again, and so on. In between collisions, the branes behave like Silly Putty, **expanding** as they recede and **contracting** somewhat as they come back together. During the turnaround, the expansion rate accelerates; indeed, the present accelerating expansion of the universe may augur another collision. The pre–big bang and ekpyrotic scenarios share some common features. Both begin with a large, cold, nearly empty universe, and both share the difficult (and unresolved) problem of making the transition between the pre- and the post-bang phase. Mathematically, the main difference between the scenarios is the behavior of the dilaton field. In the pre–big bang, the dilaton begins with a low value--so that the forces of nature are weak--and steadily gains strength. The opposite is true for the ekpyrotic scenario, in which the collision occurs when forces are at their weakest. The developers of the ekpyrotic theory initially hoped that the weakness of the forces would allow the bounce to be analyzed more easily, but they were still confronted with a difficult high-curvature situation, so the jury is out on whether the scenario truly avoids a singularity. Also, the ekpyrotic scenario must entail very special conditions to solve the usual cosmological puzzles. For instance, the about-to-collide branes must have been almost exactly parallel to one another, or else the collision could not have given rise to a sufficiently homogeneous bang. The cyclic version may be able to take care of this problem, because successive collisions would allow the branes to straighten themselves. Leaving aside the difficult task of fully justifying these two scenarios mathematically, physicists must ask whether they have any observable physical consequences. At first sight, both scenarios might seem like an exercise not in physics but in metaphysics--interesting ideas that observers could never prove right or wrong. That attitude is too pessimistic. Like the details of the inflationary phase, those of a possible pre-bangian epoch could have observable consequences, especially for the small variations observed in the cosmic microwave background temperature. First, observations show that the temperature fluctuations were shaped by acoustic waves for several hundred thousand years. The regularity of the fluctuations indicates that the waves were synchronized. Cosmologists have discarded many cosmological models over the years because they failed to account for this synchrony. The inflationary, pre-big bang and ekpyrotic scenarios all pass this first test. In these three models, the waves were **triggered by** quantum processes **amplified** during the period of accelerating cosmic expansion. The phases of the waves were **aligned.** Second, each model **predicts** a different distribution of the temperature fluctuations with respect to angular size. Observers have found that fluctuations of all sizes have approximately the same amplitude. (Discernible deviations occur only on very small scales, for which the primordial fluctuations have been **altered** by subsequent processes.) Inflationary models neatly **reproduce** this distribution. During inflation, the curvature of space changed relatively slowly, so fluctuations of different sizes were generated under much the same conditions. In both the stringy models, the curvature evolved quickly, increasing the amplitude of small-scale fluctuations, but other processes boosted the large-scale ones, leaving all fluctuations with the same strength. For the ekpyrotic scenario, those other processes involved the extra dimension of space, the one that separated the colliding branes. For the pre-big bang scenario, they involved a quantum field, the axion, related to the dilaton. In short, all three models match the data. Third, temperature variations can arise from two distinct processes in the early universe: fluctuations in the density of matter and rippling caused by

gravitational waves. Inflation involves both processes, whereas the pre-big bang and ekpyrotic scenarios predominantly **involve** density variations. Gravitational waves of certain sizes would leave a distinctive signature in the polarization of the microwave background [see "Echoes from the Big Bang," by Robert R. Caldwell and Marc Kamionkowski; Scientific American, January 2001]. Future observatories, such as European Space Agency's Planck satellite, should be able to see that signature, if it exists--providing a nearly definitive test. fourth test pertains to the statistics of the fluctuations. In inflation the fluctuations follow a bell-shaped curve, known to physicists as a Gaussian. The same may be true in the ekpyrotic case, whereas the pre-big bang scenario allows for sizable deviation from Gaussianity. Analysis of the microwave background is not the only way to verify these theories. The pre-big bang scenario should also produce a random background of gravitational waves in a range of frequencies that, though irrelevant for the microwave background, should be detectable by future gravitational wave observatories. Moreover, because the pre-big bang and ekpyrotic scenarios involve changes in the dilaton field, which is coupled to the electromagnetic field, they would both lead to large-scale magnetic field fluctuations. Vestiges of these fluctuations might show up in galactic and intergalactic magnetic fields. So, when did time begin? Science does not have a conclusive answer yet, but at least two potentially testable theories plausibly hold that the universe--and therefore time--existed well before the big bang. If either scenario is right, the cosmos has always been in existence and, even if it recollapses one day, will never end. ABRIELE VENEZIANO, a theoretical physicist at CERN, was the father of string theory in the late1960s--an accomplishment for which he received this year's Heineman Prize of the American Physica Society and the American Institute of Physics. At the time, the theory was regarded as a failure; it did not achieve its goal **of explaining** the atomic nucleus, and Veneziano soon shifted his attention to quantum Chromodynamics, to which he made major contributions. After string theory made its **comeback** as a theory of gravity in the 1980s, Veneziano became one of the first physicists **to apply it** to black holes and cosmology.

DISPUTATIOUS DIABOLIC AND BIVOAC BUCKAROO

Towards the end of a gritty narrative, which includes guile and scatological, vitriolic and voyeuristic, many UN conventional questions **are raised**. Cognitive theories of perception assume **there is a** poverty of stimulus. This (with reference to perception) is the claim that sensations are, by themselves, **unable** to provide a unique description of the world. There certainly is an inharmonious note and eneuretic franticness in this statement that is baffling and befuddling. Then what is the terra firma of perception?. Questions were raised whether “perception” itself was a discordant soprano and contralto and a falsetto? Sensations **are** “unfinished agenda” and “unfulfilled dreams”. Sensations **require** 'enriching’, a certain degree of verkrampte reactionariness to accentuate, corroborate and augment which is the role of the mental model. A different type of theory is the perceptual ecology approach of James J. Gibson. Gibson **rejected the** assumption of a poverty of stimulus by rejecting the notion that perception **is based in** sensations – instead, he investigated what information is actually **presented to** the perceptual systems. His theory "assumes untrammeled presence of **the existence** of stable, unbounded, and permanent stimulus-information in the ambient optic array. And it supposes that the visual system **can explore** and **detect** this information. So, the corporeal depth and sonorous continuum of Gibson’s Theory was perception is **information-based, not sensation-based**." He and the psychologists who work within this paradigm detailed how the world could be specified to a mobile, exploring organism **via the** lawful **projection of information** about the world into energy arrays. Specification is a one to one mapping of some aspect of the world **into a** perceptual array; given such a mapping, **no** enrichment is required and perception is direct perception.

Perception-in-action

An ecological understanding of perception **derived from** Gibson's early work is that of "perception-in-action", the notion that perception **is a requisite** property of animate action; **that without** perception action **would be** unguided, and without action perception would serve no purpose. Animate actions require both perception and motion, and perception and movement can be described as "two sides of the same coin, the coin is action". Gibson works from the assumption that singular entities, which he calls "invariants", already exist in the real world and that all that the perception process does is to home in upon them. A view known as constructivism (held by such philosophers as Ernst von Glasersfeld) regards the continual **adjustment** of perception and action to the external input as precisely what **constitutes** the "entity", which is therefore far from being invariant

ESSENTIALISTIC AND EXISTENTIAL MORDANT:

Glasersfeld considers an "invariant" as a target to be homed in upon, and a pragmatic necessity to allow an initial measure of understanding to be established prior to the **updating** that a statement aims to

achieve. The invariant **does not and need not** represent an actuality, and Glasersfeld describes it as extremely unlikely that what is desired or feared by an organism will never suffer change as time goes on. This social constructionist theory thus allows for a needful evolutionary adjustment.

A mathematical theory of perception-in-action has been devised and investigated in many forms of controlled movement, and has been described in many different species of organism using the General Tau Theory. According to this theory, tau information, or time-to-goal information is the fundamental 'percept' in perception.

Evolutionary psychology and perception

Many philosophers, such as Jerry Fodor, write that the purpose of perception is knowledge, but evolutionary psychologists hold that its primary purpose is to guide action For example, they say, depth perception seems to have evolved not to help us know the distances to other objects but rather to help us move around in space.[Evolutionary psychologists say that animals from fiddler crabs to humans use eyesight for collision avoidance, suggesting that vision is basically for directing action, not providing knowledge

Building and maintaining sense organs is metabolically expensive, so these organs evolve only when they improve an organism's fitness. More than half the brain is devoted to processing sensory information, and the brain itself consumes roughly one-fourth of one's metabolic resources, so the senses must provide exceptional benefits to fitness Perception accurately mirrors the world; animals get useful, accurate information through their senses.

Scientists who study perception and sensation have long understood the human senses as **.** Depth perception **consists of** processing over half a dozen visual cues, each of which is based on a regularity of the physical world. Vision evolved to respond to the narrow range of electromagnetic energy that is plentiful and that does not pass through objects. Sound waves provide useful information about the sources of and distances to objects, with larger animals making and hearing lower-frequency sounds and smaller animals making and hearing higher-frequency sounds. Taste and smell respond to chemicals in the environment that were significant for fitness in the EEA. The sense of touch is actually many senses, including pressure, heat, cold, tickle, and pain. Pain, while unpleasant, is adaptive. An important adaptation for senses is range shifting, by which the organism becomes temporarily more or less sensitive to sensation. For example, one's eyes automatically adjust to dim or bright ambient light. Sensory abilities of different organisms often coevolve, as is the case with the hearing of echo locating bats and that of the moths that have evolved to respond to the sounds that the bats make.

Evolutionary psychologists claim that perception demonstrates the principle of modularity, with specialized mechanisms handling particular perception tasks For example; people with damage to a particular part of the brain suffer from the specific defect of not being able to recognize faces (prospagnosia). EP suggests that this indicates a so-called face-reading module.

(1) BRAHMAN-ANTIBRAHMAN (BRAHMAN IS ONE THAT PROVIDES STIMULUS FOR "GOOD "ACTIONS AND ANTI BRAHMAN IS ONE THAT PROVIDES STIMULUS FOR "BAD "ACTIONS, AND THERE SHALL BE CORRESPONDING RESPONSE TO IT.

MODULE NUMBERED ONE

NOTATION :

G_{13} : CATEGORY ONE OF BRAHMAN

G_{14} : CATEGORY TWO OF BRAHMAN

G_{15} : CATEGORY THREE OF BRAHMAN

T_{13} : CATEGORY ONE OF ANTIBRAHMAN(AGAIN CLASSIFICATION IS FOR THE SYSTEMS /INDIVIDUALS/INSTITUTIONS/ORGANISATIONS WHO HAS BOTH BRAHMAN AND ANTIBRAHMAN PENCHANCE,PREDILECTION,AND PROCLIVITIES IN THEM FOR WHICH

THE THEORIES ARE APPLICABLE OR FOR THAT MATTER(INDIVIDUAL) SYSTEMS WHICH VIOLATES THE THEORIES MENTIONED.IT IS ASSSUMED THAT A QUANTUM REGISTER IS MAINTAINEDWHICH DELINEATESD AND DISSEMINATES THE ACTIONS PERFORMED BY THE INDIVIDUALS-SEE TALCOTT PARSONS-**ONLY THING WE MODIFY IS THAT INDIVIDUAL MAY RESORT TO DEPRIVATION AND THIS HAPPENS MOSTLY IN MANIAC DEPRESSSIVE STATES. MANY NEUROSCIENTISTS HOLD** THAT MANIC STATE IS THE RESULT OF DEPRESSSIVE STATES AND VICE VERSA)

T_{14} : CATEGORY TWO OF ANTIBRAHMAN

T_{15} :CATEGORY THREE OF ANTIBRAHMAN

(2) **GRATIFICATION-DEPRIVATION (GRATIFICATION INCREASES AT AP AND DEPRIVATION AT GP .ASCII CHARACTER VALUES ARE USED TO FIND THE TOTAL BALANCE IN THE INDIVIDUAL ACCOUNT. AND WE ASSUME SUCH AN ACCOUNT OF INDIVIDUAL IS MAINTAINED. REFERENCE IS MADE TO PROGENITOR BENTHAM WHO QUANTIZED PLEASURE AND PAIN. WE HAVE MODIFIED THE DEFINITION TO SUIT THE IT AGE).**

MODULE NUMBERED TWO:

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G_{16} : CATEGORY ONE OF GRATIFICATION

G_{17} : CATEGORY TWO OF GRATIFICATION

G_{18} : CATEGORY THREE OF GRATIFICATION

T_{16} :CATEGORY ONE OF DEPRIVATIONS

T_{17} : CATEGORY TWO OF DEPRIVATIONS

T_{18} : CATEGORY THREE OF DEPRIVATIONS

MARKOV FIELDS AND HILBERT SPACES:

MODULE NUMBERED THREE:

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G_{20} : CATEGORY ONE OF MARKOV SPACE(THERE ARE LOT OF MARKOV SPACES AND SOME SPACES COULD BE APPROXIMATED TO MARKOV SPACES AND MARKOV SPACES COULD BE MADE TO LOSE THEIR CHARACTERSTICS AND PARAMETERE UNDER SOME TRANSFORMATIONS.THESE POINTS ARE TO BE BORNE IN MIND.WE HERE SPEAK OF THE CHARACTERISED SYSTEMS FOR WHICH MARKOV THEORY IS APPLICABLE)

G_{21} :CATEGORY TWO OF CATEGORY ONE OF MARKOV SPACE(THERE ARE LOT OF MARKOV SPACES AND SOME SPACES COULD BE APPROXIMATED TO MARKOV SPACES AND MARKOV SPACES COULD BE MADE TO LOSE THEIR CHARACTERSTICS AND PARAMETERE UNDER SOME TRANSFORMATIONS.THESE POINTS ARE TO BE BORNE IN MIND.WE HERE SPEAK OF THE CHARACTERISED SYSTEMS FOR WHICH MARKO THEORY IS APPLICABLE

G_{22} : CATEGORY THREE OF CATEGORY ONE OF MARKOV SPACE(THERE ARE LOT OF MARKOV SPACES AND SOME SPACES COULD BE APPROXIMATED TO MARKOV SPACES AND MARKOV SPACES COULD BE MADE TO LOSE THEIR CHARACTERSTICS AND PARAMETERE UNDER SOME TRANSFORMATIONS.THESE POINTS ARE TO BE BORNE IN

MIND.WE HERE SPEAK OF THE CHARACTERISED SYSTEMS FOR WHICH MARKO THEORY IS APPLICABLE

T_{20} : CATEGORY ONE OF HILBERT SPACES AND QUANTUM, FIELDS

T_{21} :CATEGORY TWO OF HILBERT SPACES AND QUANTUM FIELDS

T_{22} : CATEGORY THREE OF HILBERT SPACES AND QUANTUM FIELDS

(4)SPACE-TIME

: MODULE NUMBERED FOUR:

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G_{24} : CATEGORY ONE OF TIME(QUANTUM FIELD THEORY-EVALUATIVE PARAMETRICIZATION OF SITUATIONAL ORIENTATIONS AND ESSENTIAL COGNITIVE ORIENTATION AND CHOICE VARIABLES OF THE SYSTEM TO WHICH QFT IS APPLICABLE)

G_{25} : CATEGORY TWO OF TIME

G_{26} : CATEGORY THREE OFTIME

T_{24} :CATEGORY ONE OF SPACE

T_{25} :CATEGORY TWO OF SPACE(SYSTEMIC INSTRUMENTAL CHARACTERISATIONS AND ACTION ORIENTATIONS AND FUNCTIONAL IMPERATIVES OF CHANGE MANIFESTED THEREIN)

T_{26} : CATEGORY THREE OF SPACE

(5)MASS(MATTER) AND ENERGY

:MODULE NUMBERED FIVE:

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G_{28} : CATEGORY ONE OF ENERGY

G_{29} : CATEGORY TWO OF ENERGY

G_{30} :CATEGORY THREE OF ENERGY

T_{28} :CATEGORY ONE OF MATTER

T_{29} :CATEGORY TWO OF MATTER

T_{30} :CATEGORY THREE OF MATTER

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(6) RAJAS-TAMÁS(REACTIONARY POTENTIAL AND INERTIA:

MODULE NUMBERED SIX:

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G_{32} : CATEGORY ONE OF RAJAS (DYNAMIC POTENTIALITIES OF THE INDIVIDUAKLS INSTITUTIONS AND THE ACTIONS MANIFESTED THEREOF. CLASSIFICATION IS BASED ON THE CHARACTERISAATION AND PARAMETRICIZATION OF THE SYSTEMS AND INDIVISUALS AND INSTITUTIONS AND SYSTEMS WHICH BEHAVE WITH DYNAMIC FACTORIALITY)

G_{33} : CATEGORY TWO OF RAJAS(DYNAMISM- Principle of spontaneously broken symmetry locates deeply hidden symmetries of nature at fundamental space-time scales and **explains** the emergence of diverse forces **from a**n initially unified field. Profound symmetry principle called super symmetry is capable of **unifying** force fields and matter fields in the context of a single field. Superstring theories, includes a discussion of quantum field theory, spontaneous symmetry breaking and the Higgs mechanism, electro-weak unification and grand unification, super symmetry, super gravity and superstring theories, with its quantum mechanical and field theoretic aspects of the systems under investigation. This is to be understood that all theories be they general are applicable to individual systems like the assets and Liabilities conservativeness of the Bank is applicable to conservativeness of individual Debit and Credits, and then the holistic "General Ledger "that is constitutive of the "general theory" we are trying to expound here..)

G_{34} : CATEGORY THREE OF RAJAS(DYNAMISM-DECISIVE REGULARITIES WITH RESPECT TOP SYSTEMIC CASES IN REGARD TO WHICH DYNAMIC FORCE FIELD ACTIVITIES AND ACTIONS ARE IN BORDER LINE TRANSITION)

T_{32} : CATEGORY ONE OF TAMAS (Inertia in individuals, policy paralysis in nations, we have seen and the pernicious ramifications and conjugatory confatalia thereof. These are instances which lead to measurable loss individually and nationally and internationally. At the subatomic level, inertia as Zero Point Lorentz force has been studied by many scholars notably Puthoff and Alfonso Rueda and Bernhard Haisch under the hypothesis that ordinary matter is ultimately made of sub elementary constitutive primary charged entities or ‘‘partons’’ bound in the manner of traditional elementary Planck oscillators (a time-honored classical technique), and is shown that a Lorentz force (specifically, the magnetic component of the Lorentz force) arises in any accelerated reference frame from the interaction of the partons with the vacuum electromagnetic zero-point field (ZPF). Partons, though asymptotically free at the highest frequencies, are endowed with a sufficiently large ‘‘bare mass’’ to allow interactions with the ZPF at very high frequencies up to the Planck frequencies. This Lorentz force, though originating at the sub elementary parton level, appears to produce an opposition to the acceleration of material objects at a macroscopic level having the correct characteristics to account for the property of inertia. And hence the proposition that inertia is an electromagnetic resistance arising from the known spectral distortion of the ZPF in accelerated frames. The proposed concept also suggests a physically rigorous version of Mach's principle. Moreover, some preliminary independent corroboration is suggested for ideas proposed by Sakharov (Dokl. Akad. Nauk SSSR *177*, 70 (1968) [Sov. Phys. Dokl. *12*, 1040 (1968)]) and further explored by one of H. E. Puthoff, Phys. Rev. A *39*, 2333 (1989)] concerning a ZPF-based model of Newtonian gravity, and for the equivalence of inertial and gravitational mass as dictated by the principle of equivalence.)

T_{33} : CATEGORY TWO OF TAMAS

T_{34} : CATEGORY THREE OF TAMAS

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== (7) Rajas-Sattva (Reactionary potential the cataclysmic war, murder, mayhem, plunder, pillage, nemesis, apocalypse are "height" of the reactionary measure and the "silence" is a measure of the "depth "of the reactionary potential. Statistical Mechanics provides a rich repository and receptacle for the calculations of such "reactions" and "stimulus" taking in to consideration that each individual account will be maintained in the "Akasha", from which it can be down loaded. Please see "Neuron DNA" hypothetical particle. We are here talking of the stimulus and the concomitant response and the positive effects or detrimental ramifications that are caused by such response)

MODULE NUMBERED SEVEN

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G_{36} : CATEGORY ONE OF RAJAS

G_{37} : CATEGORY TWO OF RAJAS(Unconditioned Consciousness, Infinite Information, Potential Energy, and Time are all interrelated to each other with ensorcelled frenzy and nonlinear franticness - interested reader is referred to Leon H.Maurer- Potential consciousness, time, mass/energy and infinite holographic information are rooted in original spin momentum **of unconditioned** pre-cosmic (empty) space – the absolute source of all relative phenomenal existence. One of the major problems in physics is that the origin and nature of time and consciousness, along with the experience of Consciousness, cannot be satisfactorily explained in physical/material terms without running into explanatory gaps and "hard problems" (Chalmers, 1995). How does the brain **produce** the experience of qualia? What is the nature of a color seen in the mind? Of what does the mind consist? How does the mind bind to the brain? Why and how is the experience of consciousness localized, e.g., feeling pain in a finger, taste on the tongue, smell in the nose, etc.? By what means of calculation does the brain and mind (or our thinking mechanisms) enable us to know (relative to our individual point of view) the exact coordinate position of any point or part of our body relative to any other point on the body, as well as relative to any point in the outer world view –Kind attention is also drawn to authors paper "**God does not put signature Nuncupative or Episcopal, wherein detailed explanation of sattva and Quantum field is investigated**)

G_{36} : CATEGORY THREE OF RAJAS (DYNAMISM AS EXPLAINED IN INDIVIDUALS,INSTITUTIONS, AND COUNTRIES ENERGY EXCITATION OF THE VACUUM AND CONCOMITANT GENERATION OF ENERGY DIFFERENTIAL-TIME LAG OR INSTANTANEOUSNESSMIGHT EXISTS WHEREBY ACCENTUATION AND ATTRITIONS MODEL MAY ASSUME ZERO POSITIONS)

T_{36} : CATEGORY ONE OF SATTVA (Individual here has measured reactionary potential, and that tendencies and predilections of murder mayhem, plunder ,pillage are nonexistent so the disastrous consequences are less .There were no initial conditions, disembodied resemblances, differential relations, contiguous similarities, presupposition antigeneralities, inherent nature, order, purpose, design, or underlying nonphysical existence from which the big bang emerged. Quantized gravity and Higgs fields were subject to invariant laws of nature. (For details see Boyer) Spontaneous symmetry breaking **lead to** congealed into stars, planets, organic molecules, living cellular organisms possibly with proto-conscious mentality, and later into humans with complex enough nervous systems **to generate** higher-order conscious behavior. This fragmented, reductive view is **associated** with a bottom up matter-mind-consciousness ontology. In this view, consciousness is an emergent property of random bits of matter/energy that **bind together** from lower-order physical **processes into** higher-order, unitary biological organisms which then develop apparent causal influence on their parts. How the closed chain of cause and effect could **unlink** itself and insert a conscious observer with causal efficacy in the physical is utterly mysterious. In this view, consciousness must be a powerless epiphenomenon, or be non-existent and thus a fundamental misperception in humans that begs explanation. This view is

characteristic of reasoning and sensory experience in the ordinary waking state of consciousness, in which there is a **fundamental fragmentation** of experience into the outer objective world and inner subjectivity that the reductive physicalist paradigm cannot reconcile. In contrast, the holistic view in Vedic science is a top down consciousness-mind-matter ontology, in which everything in nature progressively emerges within the perfectly orderly unified field, Pure Being (See Satre). All phenomenal existence remains **within the** unified field and **condenses** through sequential symmetry breaking into **manifest** creation (this is also attributed to disequilibrium in Rajas, Tamas, Sattva, without any exogeneous endomorphism), from higher order holistic processes to lower-order inert parts. That view is systematically unfolded in Rig Veda, and extensively described in Vedic literature such as Vedanta, Sankhya, and Ayurveda. It is consistent with developing unified field theories, spontaneous sequential symmetry breaking, quantum decoherence, the 'arrow of time,' and the 2ndlaw of thermodynamics that imply the universe emerged from the lowest entropy, supersymmetric unified state. From that view, the origin of the universe can be characterized as a 'Big Condensation' rather than 'Big Bang,' because all phenomenal existence remains within the unified field, rather than blasting out from nothing to create everything including space-time. These contrasting reductive and holistic views are reconciled in the natural development of higher states of consciousness beyond the ordinary waking state. The Vedic science of Yoga provides systematic means to validate the consciousness-mind-matter ontology, epistemology, and phenomenology through direct empirical experience of gross and subtle diversified fields of nature)

T_{37} : CATEGORY TWO OF SATTVA

T_{38} : CATEGORY THREE OF SATTVA

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(8)Freewill-Destiny(Freewill is the indiscreet usage of discretionary powers vested be it in giving Credits or allowing mortgages, and Destiny is what follows, be it Governmental intervention or suspension of "fat cats" of wall street!-Please see Abstract

MODULE NUMBERED EIGHT

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$G_{40}: CATEGORY\ ONE\ OF\ FREE\ WILL$

$G_{41}: CATEGORY\ TWO\ OFFREEWILL$(**Quantum mechanics and Free will is a -a wheedling in to will o the wisp .**On to quantum mechanics. Quantum mechanics is thought to restore the possibility of free will (also miracles, but that's another topic) **because it** is completely random and **therefore** non-deterministic. But the more accurate description is that quantum mechanics is stochastic, not random. You cannot predict the outcome of a particular measurement, but you can predict the probabilities of different outcomes. In fact, in principle you can predict those probabilities exactly. If there were any way to **influence** the outcomes of the probabilities, there would, in principle, be an experiment that measures this s**kewing** of probabilities. Such an experiment would **contradict** the stochastic nature of quantum mechanics)

$G_{42}: CATEGORY\ THREE\ OF\ FREEWILL$

$T_{40}: CATEGORY\ ONE\ DESTINY$

T_{41}:CATEGORY TWO OF DESTINY (DESTINY IS TAKEN AS THE CONSEQUENCE OF ACTIONS-PLEASE SEE ABSTRACT)

$T_{42}: CATEGORY\ THREE\ OF\ DESTINYRENORMALIZATION.$

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(1)BRAHMAN-ANTIBRAHMAN (BRAHMAN IS ONE THAT PROVIDES STIMULUS FOR "GOOD "ACTIONS AND ANTI BRAHMAN IS ONE THAT PROVIDES STIMULUS FOR "BAD "ACTIONS, AND THERE SHALL BE CORRESPONDING RESPONSE TO IT. 1

MODULE NUMBERED ONE

NOTATION : 2

G_{13} : CATEGORY ONE OF BRAHMAN

G_{14} : CATEGORY TWO OF BRAHMAN

G_{15} : CATEGORY THREE OF BRAHMAN

T_{13} : CATEGORY ONE OF ANTIBRAHMAN(AGAIN CLASSIFICATION IS FOR THE SYSTEMS /INDIVIDUALS/INSTITUTIONS/ORGANISATIONS WHO HAS BOTH BRAHMAN AND ANTIBRAHMAN PENCHANCE,PREDILECTION,AND PROCLIVITIES IN THEM FOR WHICH THE THEORIES ARE APPLICABLE OR FOR THAT MATTER(INDIVIDUAL) SYSTEMS WHICH VIOLATES THE THEORIES MENTIONED.IT IS ASSSUMED THAT A QUANTUM REGISTER IS MAINTAINEDWHICH DELINEATESD AND DISSEMINATES THE ACTIONS PERFORMED BY THE INDIVIDUALS-SEE TALCOTT PARSONS-**ONLY THING WE MODIFY IS THAT INDIVIDUAL MAY RESORT TO DEPRIVATION AND THIS HAPPENS MOSTLY IN MANIAC DEPRESSSIVE STATES. MANY NEUROSCIENTISTS HOLD** THAT MANIC STATE IS THE RESULT OF DEPRESSSIVE STATES AND VICE VERSA)

T_{14} : CATEGORY TWO OF ANTIBRAHMAN

T_{15} :CATEGORY THREE OF ANTIBRAHMAN

(3) **GRATIFICATION-DEPRIVATION (GRATIFICATION INCREASES AT AP AND DEPRIVATION AT GP .ASCII CHARACTER VALUES ARE USED TO FIND THE TOTAL BALANCE IN THE INDIVIDUAL ACCOUNT. AND WE ASSUME SUCH AN ACCOUNT OF INDIVIDUAL IS MAINTAINED. REFERENCE IS MADE TO PROGENITOR BENTHAM WHO QUANTIZED PLEASURE AND PAIN. WE HAVE MODIFIED THE DEFINITION TO SUIT THE IT AGE).**

MODULE NUMBERED TWO:

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G_{16} : CATEGORY ONE OF GRATIFICATION

G_{17} : CATEGORY TWO OF GRATIFICATION

G_{18} : CATEGORY THREE OF GRATIFICATION

T_{16} :CATEGORY ONE OF DEPRIVATIONS

T_{17} : CATEGORY TWO OF DEPRIVATIONS

T_{18} : CATEGORY THREE OF DEPRIVATIONS

MARKOV FIELDS AND HILBERT SPACES:

MODULE NUMBERED THREE:

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G_{20} : CATEGORY ONE OF MARKOV SPACE(THERE ARE LOT OF MARKOV SPACES AND SOME SPACES COULD BE APPROXIMATED TO MARKOV SPACES AND MARKOV SPACES COULD BE MADE TO LOSE THEIR CHARACTERSTICS AND PARAMETERE UNDER SOME TRANSFORMATIONS.THESE POINTS ARE TO BE BORNE IN MIND.WE HERE SPEAK OF THE CHARACTERISED SYSTEMS FOR WHICH MARKOV THEORY IS APPLICABLE)

G_{21} :CATEGORY TWO OF CATEGORY ONE OF MARKOV SPACE(THERE ARE LOT OF MARKOV SPACES AND SOME SPACES COULD BE APPROXIMATED TO MARKOV SPACES AND MARKOV SPACES COULD BE MADE TO LOSE THEIR CHARACTERSTICS AND PARAMETERE UNDER SOME TRANSFORMATIONS.THESE POINTS ARE TO BE BORNE IN MIND.WE HERE SPEAK OF THE CHARACTERISED SYSTEMS FOR WHICH MARKO THEORY IS APPLICABLE

G_{22} : CATEGORY THREE OF CATEGORY ONE OF MARKOV SPACE(THERE ARE LOT OF MARKOV SPACES AND SOME SPACES COULD BE APPROXIMATED TO MARKOV SPACES AND MARKOV SPACES COULD BE MADE TO LOSE THEIR CHARACTERSTICS AND PARAMETERE UNDER SOME TRANSFORMATIONS.THESE POINTS ARE TO BE BORNE IN MIND.WE HERE SPEAK OF THE CHARACTERISED SYSTEMS FOR WHICH MARKO THEORY IS APPLICABLE

T_{20} : CATEGORY ONE OF HILBERT SPACES AND QUANTUM, FIELDS

T_{21} :CATEGORY TWO OF HILBERT SPACES AND QUANTUM FIELDS

T_{22} : CATEGORY THREE OF HILBERT SPACES AND QUANTUM FIELDS

(4)SPACE-TIME

: MODULE NUMBERED FOUR:

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G_{24} : CATEGORY ONE OF TIME(QUANTUM FIELD THEORY-EVALUATIVE PARAMETRICIZATION OF SITUATIONAL ORIENTATIONS AND ESSENTIAL COGNITIVE ORIENTATION AND CHOICE VARIABLES OF THE SYSTEM TO WHICH QFT IS APPLICABLE)

G_{25} : CATEGORY TWO OF TIME

G_{26} : CATEGORY THREE OFTIME

T_{24} :CATEGORY ONE OF SPACE

T_{25} :CATEGORY TWO OF SPACE(SYSTEMIC INSTRUMENTAL CHARACTERISATIONS AND ACTION ORIENTATIONS AND FUNCTIONAL IMPERATIVES OF CHANGE MANIFESTED THEREIN)

T_{26} : CATEGORY THREE OF SPACE

(5)MASS(MATTER) AND ENERGY

:MODULE NUMBERED FIVE:

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G_{28} : CATEGORY ONE OF ENERGY

G_{29} : CATEGORY TWO OF ENERGY

G_{30} :CATEGORY THREE OF ENERGY

T_{28} :CATEGORY ONE OF MATTER

T_{29} :CATEGORY TWO OF MATTER

T_{30} :CATEGORY THREE OF MATTER

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(6) RAJAS-TAMÁS(REACTIONARY POTENTIAL AND INERTIA:

MODULE NUMBERED SIX:

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G_{32} : CATEGORY ONE OF RAJAS (DYNAMIC POTENTIALITIES OF THE INDIVIDUAKLS INSTITUTIONS AND THE ACTIONS MANIFESTED THEREOF. CLASSIFICATION IS BASED ON THE CHARACTERISAATION AND PARAMETRICIZATION OF THE SYSTEMS AND INDIVISUALS AND INSTITUTIONS AND SYSTEMS WHICH BEHAVE WITH DYNAMIC FACTORIALITY)

G_{33} : CATEGORY TWO OF RAJAS(DYNAMISM- Principle of spontaneously broken symmetry locates deeply hidden symmetries of nature at fundamental space-time scales and **explains** the emergence of diverse forces **from a**n initially unified field. Profound symmetry principle called super symmetry is capable of **unifying** force fields and matter fields in the context of a single field. Superstring theories, includes a discussion of quantum field theory, spontaneous symmetry breaking and the Higgs mechanism, electro-weak unification and grand unification, super symmetry, super gravity and superstring theories, with its quantum mechanical and field theoretic aspects of the systems under investigation. This is to be understood that all theories be they general are applicable to individual systems like the assets and Liabilities conservativeness of the Bank is applicable to conservativeness of individual Debit and Credits, and then the holistic "General Ledger "that is constitutive of the "general theory" we are trying to expound here..)

G_{34} : CATEGORY THREE OF RAJAS(DYNAMISM-DECISIVE REGULARITIES WITH RESPECT TOP SYSTEMIC CASES IN REGARD TO WHICH DYNAMIC FORCE FIELD ACTIVITIES AND ACTIONS ARE IN BORDER LINE TRANSITION)

T_{32} : CATEGORY ONE OF TAMAS (Inertia in individuals, policy paralysis in nations, we have seen and the pernicious ramifications and conjugatory confatalia thereof. These are instances which lead to measurable loss individually and nationally and internationally. At the subatomic level, inertia as Zero Point Lorentz force has been studied by many scholars notably Puthoff and Alfonso Rueda and Bernhard Haisch under the hypothesis that ordinary matter is ultimately made of sub elementary constitutive primary charged entities or ''partons'' bound in the manner of traditional elementary Planck oscillators (a time-honored classical technique), and is shown that a Lorentz force (specifically, the magnetic component of the Lorentz force) arises in any accelerated reference frame from the interaction of the

partons with the vacuum electromagnetic zero-point field (ZPF). Partons, though asymptotically free at the highest frequencies, are endowed with a sufficiently large ‘‘bare mass’’ to allow interactions with the ZPF at very high frequencies up to the Planck frequencies. This Lorentz force, though originating at the sub elementary parton level, appears to produce an opposition to the acceleration of material objects at a macroscopic level having the correct characteristics to account for the property of inertia. And hence the proposition that inertia is an electromagnetic resistance arising from the known spectral distortion of the ZPF in accelerated frames. The proposed concept also suggests a physically rigorous version of Mach’s principle. Moreover, some preliminary independent corroboration is suggested for ideas proposed by Sakharov (Dokl. Akad. Nauk SSSR *177*, 70 (1968) [Sov. Phys. Dokl. *12*, 1040 (1968)]) and further explored by one of H. E. Puthoff, Phys. Rev. A *39*, 2333 (1989)] concerning a ZPF-based model of Newtonian gravity, and for the equivalence of inertial and gravitational mass as dictated by the principle of equivalence.)

T_{33} : CATEGORY TWO OF TAMAS

T_{34} : CATEGORY THREE OF TAMAS

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== (7) Rajas-Sattva (Reactionary potential the cataclysmic war, murder, mayhem, plunder, pillage, nemesis, apocalypse are “height” of the reactionary measure and the “silence” is a measure of the “depth “of the reactionary potential. Statistical Mechanics provides a rich repository and receptacle for the calculations of such “reactions” and “stimulus” taking in to consideration that each individual account will be maintained in the “Akasha”, from which it can be down loaded. Please see “Neuron DNA” hypothetical particle. We are here talking of the stimulus and the concomitant response and the positive effects or detrimental ramifications that are caused by such response)

MODULE NUMBERED SEVEN

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G_{36} : CATEGORY ONE OF RAJAS

G_{37} : CATEGORY TWO OF RAJAS(Unconditioned Consciousness, Infinite Information, Potential Energy, and Time are all interrelated to each other with ensorcelled frenzy and nonlinear franticness - interested reader is referred to Leon H.Maurer- Potential consciousness, time, mass/energy and infinite holographic information are rooted in original spin momentum **of unconditioned** pre-cosmic (empty) space – the absolute source of all relative phenomenal existence. One of the major problems in physics is that the origin and nature of time and consciousness, along with the experience of Consciousness, cannot be satisfactorily explained in physical/material terms without running into explanatory gaps and “hard problems” (Chalmers, 1995). How does the brain **produce** the experience of qualia? What is the nature of a color seen in the mind? Of what does the mind consist? How does the mind bind to the brain? Why and how is the experience of consciousness localized, e.g., feeling pain in a finger, taste on the tongue, smell in the nose, etc.? By what means of calculation does the brain and mind (or our thinking mechanisms) enable us to know (relative to our individual point of view) the exact coordinate position of any point or part of our body relative to any other point on the body, as well as relative to any point in the outer world view –Kind attention is also drawn to authors paper “**God does not put signature Nuncupative or Episcopal, wherein detailed explanation of sattva and Quantum field is investigated**)

G_{36} : CATEGORY THREE OF RAJAS (DYNAMISM AS EXPLAINED IN INDIVIDUALS,INSTITUTIONS, AND COUNTRIES ENERGY EXCITATION OF THE VACUUM AND CONCOMITANT GENERATION OF ENERGY DIFFERENTIAL-TIME LAG OR

INSTANTANEOUSNESSMIGHT EXISTS WHEREBY ACCENTUATION AND ATTRITIONS MODEL MAY ASSUME ZERO POSITIONS)

T_{36} : CATEGORY ONE OF SATTVA (Individual here has measured reactionary potential, and that tendencies and predilections of murder mayhem, plunder ,pillage are nonexistent so the disastrous consequences are less .There were no initial conditions, disembodied resemblances, differential relations, contiguous similarities, presupposition antigeneralities, inherent nature, order, purpose, design, or underlying nonphysical existence from which the big bang emerged. Quantized gravity and Higgs fields were subject to invariant laws of nature. (For details see Boyer) Spontaneous symmetry breaking **lead to** congealed into stars, planets, organic molecules, living cellular organisms possibly with proto-conscious mentality, and later into humans with complex enough nervous systems **to generate** higher-order conscious behavior. This fragmented, reductive view is **associated** with a bottom up matter-mind-consciousness ontology. In this view, consciousness is an emergent property of random bits of matter/energy that **bind together** from lower-order physical **processes into** higher-order, unitary biological organisms which then develop apparent causal influence on their parts. How the closed chain of cause and effect could **unlink** itself and insert a conscious observer with causal efficacy in the physical is utterly mysterious. In this view, consciousness must be a powerless epiphenomenon, or be non-existent and thus a fundamental misperception in humans that begs explanation. This view is characteristic of reasoning and sensory experience in the ordinary waking state of consciousness, in which there is a **fundamental fragmentation** of experience into the outer objective world and inner subjectivity that the reductive physicalist paradigm cannot reconcile. In contrast, the holistic view in Vedic science is a top down consciousness-mind-matter ontology, in which everything in nature progressively emerges within the perfectly orderly unified field, Pure Being (See Satre). All phenomenal existence remains **within the** unified field and **condenses** through sequential symmetry breaking into **manifest** creation (this is also attributed to disequilibrium in Rajas, Tamas, Sattva, without any exogeneous endomorphism), from higher order holistic processes to lower-order inert parts. That view is systematically unfolded in Rig Veda, and extensively described in Vedic literature such as Vedanta, Sankhya, and Ayurveda. It is consistent with developing unified field theories, spontaneous sequential symmetry breaking, quantum decoherence, the 'arrow of time,' and the 2ndlaw of thermodynamics that imply the universe emerged from the lowest entropy, supersymmetric unified state. From that view, the origin of the universe can be characterized as a 'Big Condensation' rather than 'Big Bang,' because all phenomenal existence remains within the unified field, rather than blasting out from nothing to create everything including space-time. These contrasting reductive and holistic views are reconciled in the natural development of higher states of consciousness beyond the ordinary waking state. The Vedic science of Yoga provides systematic means to validate the consciousness-mind-matter ontology, epistemology, and phenomenology through direct empirical experience of gross and subtle diversified fields of nature)

T_{37} : CATEGORY TWO OF SATTVA

T_{38} : CATEGORY THREE OF SATTVA

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(8)Freewill-Destiny(Freewill is the indiscreet usage of discretionary powers vested be it in giving Credits or allowing mortgages, and Destiny is what follows, be it Governmental intervention or suspension of "fat cats" of wall street!-Please see Abstract

MODULE NUMBERED EIGHT

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$G_{40}: CATEGORY\ ONE\ OF\ FREE\ WILL$

$G_{41}: CATEGORY\ TWO\ OFFREEWIL\ L$(**Quantum mechanics and Free will is a -a wheedling in to will o the wisp .**On to quantum mechanics. Quantum mechanics is thought to restore the possibility of free will (also miracles, but that's another topic) **because it** is completely random and **therefore** non-

deterministic. But the more accurate description is that quantum mechanics is stochastic, not random. You cannot predict the outcome of a particular measurement, but you can predict the probabilities of different outcomes. In fact, in principle you can predict those probabilities exactly. If there were any way to **influence** the outcomes of the probabilities, there would, in principle, be an experiment that measures this s**kewing** of probabilities. Such an experiment would **contradict** the stochastic nature of quantum mechanics)

$$G_{42}: CATEGORY\ THREE\ OF\ FREEWILL$$

$$T_{40}: CATEGORY\ ONE\ DESTINY$$

T_{41}:CATEGORY TWO OF DESTINY (DESTINY IS TAKEN AS THE CONSEQUENCE OF ACTIONS-PLEASE SEE ABSTRACT)

$$T_{42}: CATEGORY\ THREE\ OF\ DESTINYRENORMALIZATION.$$

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$(a_{13})^{(1)}, (a_{14})^{(1)}, (a_{15})^{(1)}, (b_{13})^{(1)}, (b_{14})^{(1)}, (b_{15})^{(1)}\ (a_{16})^{(2)}, (a_{17})^{(2)}, (a_{18})^{(2)}$
$(b_{16})^{(2)}, (b_{17})^{(2)}, (b_{18})^{(2)}: (a_{20})^{(3)}, (a_{21})^{(3)}, (a_{22})^{(3)}\ , \ (b_{20})^{(3)}, (b_{21})^{(3)}, (b_{22})^{(3)}$
$(a_{24})^{(4)}, (a_{25})^{(4)}, (a_{26})^{(4)}, (b_{24})^{(4)}, (b_{25})^{(4)}, (b_{26})^{(4)}, (b_{28})^{(5)}, (b_{29})^{(5)}, (b_{30})^{(5)},$
$(a_{28})^{(5)}, (a_{29})^{(5)}, (a_{30})^{(5)}, (a_{32})^{(6)}, (a_{33})^{(6)}, (a_{34})^{(6)}, (b_{32})^{(6)}, (b_{33})^{(6)}, (b_{34})^{(6)}$

are Accentuation coefficients

$(a_{13}^{'})^{(1)}, (a_{14}^{'})^{(1)}, (a_{15}^{'})^{(1)}, (b_{13}^{'})^{(1)}, (b_{14}^{'})^{(1)}, (b_{15}^{'})^{(1)}, (a_{16}^{'})^{(2)}, (a_{17}^{'})^{(2)}, (a_{18}^{'})^{(2)},$
$(b_{16}^{'})^{(2)}, (b_{17}^{'})^{(2)}, (b_{18}^{'})^{(2)}\ , (a_{20}^{'})^{(3)}, (a_{21}^{'})^{(3)}, (a_{22}^{'})^{(3)}, (b_{20}^{'})^{(3)}, (b_{21}^{'})^{(3)}, (b_{22}^{'})^{(3)}$
$(a_{24}^{'})^{(4)}, (a_{25}^{'})^{(4)}, (a_{26}^{'})^{(4)}, (b_{24}^{'})^{(4)}, (b_{25}^{'})^{(4)}, (b_{26}^{'})^{(4)}, (b_{28}^{'})^{(5)}, (b_{29}^{'})^{(5)}, (b_{30}^{'})^{(5)}$
$(a_{28}^{'})^{(5)}, (a_{29}^{'})^{(5)}, (a_{30}^{'})^{(5)}\ , (a_{32}^{'})^{(6)}, (a_{33}^{'})^{(6)}, (a_{34}^{'})^{(6)}, (b_{32}^{'})^{(6)}, (b_{33}^{'})^{(6)}, (b_{34}^{'})^{(6)}$

are Dissipation coefficients

MODULE NUMBERED ONE

$$\frac{dG_{14}}{dt} = (a_{14})^{(1)}G_{13} - \left[(a_{14}^{'})^{(1)} + (a_{14}^{''})^{(1)}(T_{14}, t)\right]G_{14} \quad 3$$

$$\frac{dG_{15}}{dt} = (a_{15})^{(1)}G_{14} - \left[(a_{15}^{'})^{(1)} + (a_{15}^{''})^{(1)}(T_{14}, t)\right]G_{15} \quad 4$$

$$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G, t)\right]T_{13} \quad 5$$

$$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G, t)\right]T_{14} \quad 6$$

$$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G, t)\right]T_{15} \quad 7$$

$+(a_{13}^{''})^{(1)}(T_{14}, t) =$ First augmentation factor 8

$-(b_{13}^{''})^{(1)}(G,t) =$ First detritions factor

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MODULE NUMBERED TWO

The differential system of this model is now (Module numbered two)

$$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17},t)\right]G_{16} \quad 10$$

$$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17},t)\right]G_{17} \quad 11$$

$$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17},t)\right]G_{18} \quad 12$$

$$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}\big((G_{19}),t\big)\right]T_{16} \quad 13$$

$$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[(b_{17}^{'})^{(2)} - (b_{17}^{''})^{(2)}\big((G_{19}),t\big)\right]T_{17} \quad 14$$

$$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}\big((G_{19}),t\big)\right]T_{18} \quad 15$$

$+(a_{16}^{''})^{(2)}(T_{17},t) =$ First augmentation factor 16

$-(b_{16}^{''})^{(2)}\big((G_{19}),t\big) =$ First detritions factor 17

MODULE NUMBERED THREE 18

The differential system of this model is now (Module numbered three)

$$\frac{dG_{20}}{dt} = (a_{20})^{(3)}G_{21} - \left[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21},t)\right]G_{20} \quad 19$$

$$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[(a_{21}^{'})^{(3)} + (a_{21}^{''})^{(3)}(T_{21},t)\right]G_{21} \quad 20$$

$$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21},t)\right]G_{22} \quad 21$$

$$\frac{dT_{20}}{dt} = (b_{20})^{(3)}T_{21} - \left[(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23},t)\right]T_{20} \quad 22$$

$$\frac{dT_{21}}{dt} = (b_{21})^{(3)}T_{20} - \left[(b_{21}^{'})^{(3)} - (b_{21}^{''})^{(3)}(G_{23},t)\right]T_{21} \quad 23$$

$$\frac{dT_{22}}{dt} = (b_{22})^{(3)}T_{21} - \left[(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23},t)\right]T_{22} \quad 24$$

$+(a_{20}^{''})^{(3)}(T_{21},t) =$ First augmentation factor

$-(b_{20}^{''})^{(3)}(G_{23},t) =$ First detritions factor 25

) 26

: MODULE NUMBERED FOUR

The differential system of this model is now (Module numbered Four)

$$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25},t)\right]G_{24} \quad 27$$

$$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \left[(a_{25}^{'})^{(4)} + (a_{25}^{''})^{(4)}(T_{25},t)\right]G_{25} \quad 28$$

$$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \left[(a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25}, t)\right]G_{26} \quad 29$$

$$\frac{dT_{24}}{dt} = (b_{24})^{(4)}T_{25} - \left[(b'_{24})^{(4)} - (b''_{24})^{(4)}\big((G_{27}), t\big)\right]T_{24} \quad 30$$

$$\frac{dT_{25}}{dt} = (b_{25})^{(4)}T_{24} - \left[(b'_{25})^{(4)} - (b''_{25})^{(4)}\big((G_{27}), t\big)\right]T_{25} \quad 31$$

$$\frac{dT_{26}}{dt} = (b_{26})^{(4)}T_{25} - \left[(b'_{26})^{(4)} - (b''_{26})^{(4)}\big((G_{27}), t\big)\right]T_{26} \quad 32$$

$+(a''_{24})^{(4)}(T_{25}, t) =$ **First augmentation factor** 33

$-(b''_{24})^{(4)}\big((G_{27}), t\big) =$ **First detritions factor** 34

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MODULE NUMBERED FIVE:

The differential system of this model is now (Module number five)

$$\frac{dG_{28}}{dt} = (a_{28})^{(5)}G_{29} - \left[(a'_{28})^{(5)} + (a''_{28})^{(5)}(T_{29}, t)\right]G_{28} \quad 36$$

$$\frac{dG_{29}}{dt} = (a_{29})^{(5)}G_{28} - \left[(a'_{29})^{(5)} + (a''_{29})^{(5)}(T_{29}, t)\right]G_{29} \quad 37$$

$$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \left[(a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29}, t)\right]G_{30} \quad 38$$

$$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[(b'_{28})^{(5)} - (b''_{28})^{(5)}\big((G_{31}), t\big)\right]T_{28} \quad 39$$

$$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \left[(b'_{29})^{(5)} - (b''_{29})^{(5)}\big((G_{31}), t\big)\right]T_{29} \quad 40$$

$$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \left[(b'_{30})^{(5)} - (b''_{30})^{(5)}\big((G_{31}), t\big)\right]T_{30} \quad 41$$

$+(a''_{28})^{(5)}(T_{29}, t) =$ **First augmentation factor** 42

$-(b''_{28})^{(5)}\big((G_{31}), t\big) =$ **First detritions factor** 43

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MODULE NUMBERED SIX

The differential system of this model is now (Module numbered Six)

$$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} - \left[(a'_{32})^{(6)} + (a''_{32})^{(6)}(T_{33}, t)\right]G_{32} \quad 46$$

$$\frac{dG_{33}}{dt} = (a_{33})^{(6)}G_{32} - \left[(a'_{33})^{(6)} + (a''_{33})^{(6)}(T_{33}, t)\right]G_{33} \quad 47$$

$$\frac{dG_{34}}{dt} = (a_{34})^{(6)}G_{33} - \left[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T_{33}, t)\right]G_{34} \quad 48$$

$$\frac{dT_{32}}{dt} = (b_{32})^{(6)}T_{33} - \left[(b'_{32})^{(6)} - (b''_{32})^{(6)}\left((G_{35}),t\right)\right]T_{32} \quad 49$$

$$\frac{dT_{33}}{dt} = (b_{33})^{(6)}T_{32} - \left[(b'_{33})^{(6)} - (b''_{33})^{(6)}\left((G_{35}),t\right)\right]T_{33} \quad 50$$

$$\frac{dT_{34}}{dt} = (b_{34})^{(6)}T_{33} - \left[(b'_{34})^{(6)} - (b''_{34})^{(6)}\left((G_{35}),t\right)\right]T_{34} \quad 51$$

$+(a''_{32})^{(6)}(T_{33},t) =$ **First augmentation factor** 52

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MODULE NUMBERED SEVEN:

The differential system of this model is now (SEVENTH MODULE)

$$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \left[(a'_{36})^{(7)} + (a''_{36})^{(7)}(T_{37},t)\right]G_{36} \quad 54$$

$$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \left[(a'_{37})^{(7)} + (a''_{37})^{(7)}(T_{37},t)\right]G_{37} \quad 55$$

$$\frac{dG_{38}}{dt} = (a_{38})^{(7)}G_{37} - \left[(a'_{38})^{(7)} + (a''_{38})^{(7)}(T_{37},t)\right]G_{38} \quad 56$$

$$\frac{dT_{36}}{dt} = (b_{36})^{(7)}T_{37} - \left[(b'_{36})^{(7)} - (b''_{36})^{(7)}\left((G_{39}),t\right)\right]T_{36} \quad 57$$

$$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} - \left[(b'_{37})^{(7)} - (b''_{37})^{(7)}\left((G_{39}),t\right)\right]T_{37} \quad 58$$

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$$\frac{dT_{38}}{dt} = (b_{38})^{(7)}T_{37} - \left[(b'_{38})^{(7)} - (b''_{38})^{(7)}\left((G_{39}),t\right)\right]T_{38} \quad 60$$

$+(a''_{36})^{(7)}(T_{37},t) =$ **First augmentation factor** 61

MODULE NUMBERED EIGHT 62

GOVERNING EQUATIONS:

The differential system of this model is now

$$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41},t)\right]G_{40} \quad 63$$

$$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41},t)\right]G_{41} \quad 64$$

$$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41},t)\right]G_{42} \quad 65$$

$$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \left[(b'_{40})^{(8)} - (b''_{40})^{(8)}\left((G_{43}),t\right)\right]T_{40} \quad 66$$

$$\frac{dT_{41}}{dt} = (b_{41})^{(8)}T_{40} - \left[(b'_{41})^{(8)} - (b''_{41})^{(8)}\left((G_{43}),t\right)\right]T_{41} \quad 67$$

$$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \left[(b'_{42})^{(8)} - (b''_{42})^{(8)}\left((G_{43}),t\right)\right]T_{42} \quad 68$$

$-(b''_{36})^{(7)}\left((G_{39}),t\right) =$ **First detritions factor** 69

FIRST MODULE CONCATENATION:

$$\frac{dG_{13}}{dt} = (a_{13})^{(1)}G_{14} - \left[\begin{array}{c} (a_{13}^{'})^{(1)}\boxed{+(a_{13}^{''})^{(1)}(T_{14},t)}\boxed{+(a_{16}^{''})^{(2,2,)}(T_{17},t)}\boxed{+(a_{20}^{''})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a_{24}^{''})^{(4,4,4,4,)}(T_{25},t)}\boxed{+(a_{28}^{''})^{(5,5,5,5,)}(T_{29},t)}\boxed{+(a_{32}^{''})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a_{36}^{''})^{(7)}(T_{37},t)}\ \boxed{+(a_{40}^{''})^{(8)}(T_{41},t)} \end{array}\right]G_{13}$$

$$\frac{dG_{14}}{dt} = (a_{14})^{(1)}G_{13} - \left[\begin{array}{c} (a_{14}^{'})^{(1)}\boxed{+(a_{14}^{''})^{(1)}(T_{14},t)}\boxed{+(a_{17}^{''})^{(2,2,)}(T_{17},t)}\boxed{+(a_{21}^{''})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a_{25}^{''})^{(4,4,4,4,)}(T_{25},t)}\boxed{+(a_{29}^{''})^{(5,5,5,5,)}(T_{29},t)}\boxed{+(a_{33}^{''})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a_{37}^{''})^{(7)}(T_{37},t)}\boxed{+(a_{41}^{''})^{(8)}(T_{41},t)} \end{array}\right]G_{14} \qquad 70$$

$$\frac{dG_{15}}{dt} = (a_{15})^{(1)}G_{14} - \left[\begin{array}{c} (a_{15}^{'})^{(1)}\boxed{+(a_{15}^{''})^{(1)}(T_{14},t)}\boxed{+(a_{18}^{''})^{(2,2,)}(T_{17},t)}\boxed{+(a_{22}^{''})^{(3,3,)}(T_{21},t)} \\ \boxed{+(a_{26}^{''})^{(4,4,4,4,)}(T_{25},t)}\boxed{+(a_{30}^{''})^{(5,5,5,5,)}(T_{29},t)}\boxed{+(a_{34}^{''})^{(6,6,6,6,)}(T_{33},t)} \\ \boxed{+(a_{38}^{''})^{(7)}(T_{37},t)}\ \boxed{+(a_{42}^{''})^{(8)}(T_{41},t)} \end{array}\right]G_{15}$$

Where $\boxed{(a_{13}^{''})^{(1)}(T_{14},t)}$, $\boxed{(a_{14}^{''})^{(1)}(T_{14},t)}$, $\boxed{(a_{15}^{''})^{(1)}(T_{14},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{16}^{''})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a_{17}^{''})^{(2,2,)}(T_{17},t)}$, $\boxed{+(a_{18}^{''})^{(2,2,)}(T_{17},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{20}^{''})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a_{21}^{''})^{(3,3,)}(T_{21},t)}$, $\boxed{+(a_{22}^{''})^{(3,3,)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{24}^{''})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{25}^{''})^{(4,4,4,4,)}(T_{25},t)}$, $\boxed{+(a_{26}^{''})^{(4,4,4,4,)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{28}^{''})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a_{29}^{''})^{(5,5,5,5,)}(T_{29},t)}$, $\boxed{+(a_{30}^{''})^{(5,5,5,5,)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{32}^{''})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a_{33}^{''})^{(6,6,6,6,)}(T_{33},t)}$, $\boxed{+(a_{34}^{''})^{(6,6,6,6,)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{36}^{''})^{(7)}(T_{37},t)}\boxed{+(a_{37}^{''})^{(7)}(T_{37},t)}\boxed{+(a_{38}^{''})^{(7)}(T_{37},t)}$ ARESEVENTHAUGMENTATION COEFFICIENTS

$\boxed{+(a_{42}^{''})^{(8)}(T_{40},t)}\boxed{+(a_{42}^{''})^{(8)}(T_{41},t)}\boxed{+(a_{42}^{''})^{(8)}(T_{41},t)}$ ARE EIGHTH AUGMENTATION COEFFICIENTS

$$\frac{dT_{13}}{dt} = (b_{13})^{(1)}T_{14} - \left[\begin{array}{c} (b_{13}^{'})^{(1)}\boxed{-(b_{16}^{''})^{(1)}(G,t)}\ \boxed{-(b_{36}^{''})^{(7,)}(G_{39},t)}\boxed{-(b_{20}^{''})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b_{24}^{''})^{(4,4,4,4,)}(G_{27},t)}\boxed{-(b_{28}^{''})^{(5,5,5,5,)}(G_{31},t)}\boxed{-(b_{32}^{''})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b_{36}^{''})^{(7,)}(G_{39},t)}\ \boxed{-(b_{40}^{''})^{(8,)}(G_{43},t)} \end{array}\right]T_{13}$$

$$\frac{dT_{14}}{dt} = (b_{14})^{(1)}T_{13} - \left[\begin{array}{c} (b_{14}^{'})^{(1)}\boxed{-(b_{14}^{''})^{(1)}(G,t)}\ \boxed{-(b_{17}^{''})^{(2,2,)}(G_{19},t)}\ \boxed{-(b_{21}^{''})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b_{25}^{''})^{(4,4,4,4,)}(G_{27},t)}\ \boxed{-(b_{29}^{''})^{(5,5,5,5,)}(G_{31},t)}\ \boxed{-(b_{33}^{''})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b_{37}^{''})^{(7,)}(G_{39},t)}\quad \boxed{-(b_{41}^{''})^{(8,)}(G_{43},t)} \end{array}\right] T_{14}$$

$$\frac{dT_{15}}{dt} = (b_{15})^{(1)}T_{14} - \left[\begin{array}{c} (b_{15}^{'})^{(1)}\boxed{-(b_{15}^{''})^{(1)}(G,t)}\ \boxed{-(b_{18}^{''})^{(2,2,)}(G_{19},t)}\ \boxed{-(b_{22}^{''})^{(3,3,)}(G_{23},t)} \\ \boxed{-(b_{26}^{''})^{(4,4,4,4,)}(G_{27},t)}\ \boxed{-(b_{30}^{''})^{(5,5,5,5,)}(G_{31},t)}\ \boxed{-(b_{34}^{''})^{(6,6,6,6,)}(G_{35},t)} \\ \boxed{-(b_{38}^{''})^{(7,)}(G_{39},t)}\quad \boxed{-(b_{42}^{''})^{(8,)}(G_{41},t)} \end{array}\right] T_{15}$$

Where $\boxed{-(b_{13}^{''})^{(1)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1)}(G,t)}$, $\boxed{-(b_{15}^{''})^{(1)}(G,t)}$ are first detritions coefficients for category 1, 2 and 3

$\boxed{-(b_{16}^{''})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2,2,)}(G_{19},t)}$ are second detritions coefficients for category 1, 2 and 3

$\boxed{-(b_{20}^{''})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b_{21}^{''})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b_{22}^{''})^{(3,3,)}(G_{23},t)}$ are third detritions coefficients for category 1, 2 and 3

$\boxed{-(b_{24}^{''})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{25}^{''})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{26}^{''})^{(4,4,4,4,)}(G_{27},t)}$ are fourth detritions coefficients for category 1, 2 and 3

$\boxed{-(b_{28}^{''})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b_{29}^{''})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b_{30}^{''})^{(5,5,5,5,)}(G_{31},t)}$ are fifth detritions coefficients for category 1, 2 and 3

$\boxed{-(b_{32}^{''})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{33}^{''})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{34}^{''})^{(6,6,6,6,)}(G_{35},t)}$ are sixth detritions coefficients for category 1, 2 and 3

$\boxed{-(b_{36}^{''})^{(7,)}(G_{39},t)}$ $\boxed{-(b_{36}^{''})^{(7,)}(G_{39},t)}$ $\boxed{-(b_{36}^{''})^{(7,)}(G_{39},t)}$ ARE SEVENTH DETRITION COEFFICIENTS

$\boxed{-(b_{40}^{''})^{(8,)}(G_{41},t)}$ $\boxed{-(b_{41}^{''})^{(8,)}(G_{41},t)}$ $\boxed{-(b_{42}^{''})^{(8,)}(G_{41},t)}$ ARE EIGHTH DETRIONCOEFFICIENTS

SECOND MODULE CONCATENATION:

$$\frac{dG_{16}}{dt} = (a_{16})^{(2)}G_{17} - \left[\begin{array}{c} (a_{16}^{'})^{(2)}\boxed{+(a_{16}^{''})^{(2)}(T_{17},t)}\ \boxed{+(a_{13}^{''})^{(1,1,)}(T_{14},t)}\ \boxed{+(a_{20}^{''})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a_{24}^{''})^{(4,4,4,4,4)}(T_{25},t)}\ \boxed{+(a_{28}^{''})^{(5,5,5,5,5)}(T_{29},t)}\ \boxed{+(a_{32}^{''})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{36}^{''})^{(7,7,)}(T_{37},t)}\ \boxed{+(a_{40}^{''})^{(8,8)}(T_{41},t)} \end{array}\right] \quad 71$$

Where $\boxed{-(b_{13}^{''})^{(1)}(G,t)}$, $\boxed{-(b_{14}^{''})^{(1)}(G,t)}$, $\boxed{-(b_{15}^{''})^{(1)}(G,t)}$ are first detrition coefficients for category 1, 2 and 3 *72*

$\boxed{-(b_{16}^{''})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b_{17}^{''})^{(2,2,)}(G_{19},t)}$, $\boxed{-(b_{18}^{''})^{(2,2,)}(G_{19},t)}$ are second detritions coefficients for category 1, 2 and 3

$\boxed{-(b_{20}^{''})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b_{21}^{''})^{(3,3,)}(G_{23},t)}$, $\boxed{-(b_{22}^{''})^{(3,3,)}(G_{23},t)}$ are third detritions coefficients for category 1, 2 and 3

$\boxed{-(b_{24}^{''})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{25}^{''})^{(4,4,4,4,)}(G_{27},t)}$, $\boxed{-(b_{26}^{''})^{(4,4,4,4,)}(G_{27},t)}$ are fourth detritions

coefficients for category 1, 2 and 3

$\boxed{-(b_{28}^{''})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b_{29}^{''})^{(5,5,5,5,)}(G_{31},t)}$, $\boxed{-(b_{30}^{''})^{(5,5,5,5,)}(G_{31},t)}$ are fifth detritions coefficients for category 1, 2 and 3

$\boxed{-(b_{32}^{''})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{33}^{''})^{(6,6,6,6,)}(G_{35},t)}$, $\boxed{-(b_{34}^{''})^{(6,6,6,6,)}(G_{35},t)}$ are sixth detritions coefficients for category 1, 2 and 3

$$\frac{dG_{17}}{dt} = (a_{17})^{(2)}G_{16} - \left[\begin{array}{c}(a_{17}^{'})^{(2)}\boxed{+(a_{17}^{''})^{(2)}(T_{17},t)}\boxed{+(a_{14}^{''})^{(1,1,)}(T_{14},t)}\boxed{+(a_{21}^{''})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a_{25}^{''})^{(4,4,4,4,4)}(T_{25},t)}\boxed{+(a_{29}^{''})^{(5,5,5,5,5)}(T_{29},t)}\boxed{+(a_{33}^{''})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{37}^{''})^{(7,7,)}(T_{37},t)}\ \boxed{+(a_{41}^{''})^{(8,8)}(T_{41},t)}\end{array}\right]G_{17} \quad 73$$

$$\frac{dG_{18}}{dt} = (a_{18})^{(2)}G_{17} - \left[\begin{array}{c}(a_{18}^{'})^{(2)}\boxed{+(a_{18}^{''})^{(2)}(T_{17},t)}\boxed{+(a_{15}^{''})^{(1,1,)}(T_{14},t)}\boxed{+(a_{22}^{''})^{(3,3,3)}(T_{21},t)} \\ \boxed{+(a_{26}^{''})^{(4,4,4,4,4)}(T_{25},t)}\boxed{+(a_{30}^{''})^{(5,5,5,5,5)}(T_{29},t)}\boxed{+(a_{34}^{''})^{(6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{38}^{''})^{(7,7,)}(T_{37},t)}\ \boxed{+(a_{42}^{''})^{(8,8)}(T_{41},t)}\end{array}\right]G_{18} \quad 74$$

Where $\boxed{+(a_{16}^{''})^{(2)}(T_{17},t)}$, $\boxed{+(a_{17}^{''})^{(2)}(T_{17},t)}$, $\boxed{+(a_{18}^{''})^{(2)}(T_{17},t)}$ are first augmentation coefficients for category 1, 2 and 3 *75*

$\boxed{+(a_{13}^{''})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a_{14}^{''})^{(1,1,)}(T_{14},t)}$, $\boxed{+(a_{15}^{''})^{(1,1,)}(T_{14},t)}$ are second augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{20}^{''})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}^{''})^{(3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}^{''})^{(3,3,3)}(T_{21},t)}$ are third augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{24}^{''})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{25}^{''})^{(4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{26}^{''})^{(4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{28}^{''})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}^{''})^{(5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}^{''})^{(5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{32}^{''})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}^{''})^{(6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}^{''})^{(6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficient for category 1, 2 and 3

$\boxed{+(a_{36}^{''})^{(7,7,)}(T_{37},t)}\boxed{+(a_{37}^{''})^{(7,7,)}(T_{37},t)}\boxed{+(a_{38}^{''})^{(7,7,)}(T_{37},t)}$ ARE SEVENTH DETRITION *76*

COEFFICIENTS

$\boxed{+(a_{40}^{''})^{(8)}(T_{41},t)}\boxed{+(a_{41}^{''})^{(8)}(T_{41},t)}\boxed{+(a_{42}^{''})^{(8)}(T_{41},t)}$ ARE EIGHT AUGMENTATION COEFFICIENTS

$$\frac{dT_{16}}{dt} = (b_{16})^{(2)}T_{17} - \left[\begin{array}{c}(b_{16}^{'})^{(2)}\boxed{-(b_{16}^{''})^{(2)}(G_{19},t)}\ \boxed{-(b_{13}^{''})^{(1,1,)}(G,t)}\boxed{-(b_{20}^{''})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b_{24}^{''})^{(4,4,4,4,4)}(G_{27},t)}\boxed{-(b_{28}^{''})^{(5,5,5,5,5)}(G_{31},t)}\boxed{-(b_{32}^{''})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{36}^{''})^{(7,7)}(G_{39},t)}\ \boxed{-(b_{40}^{''})^{(8,8,)}(G_{43},t)}\end{array}\right]T_{16} \quad 77$$

$$\frac{dT_{17}}{dt} = (b_{17})^{(2)}T_{16} - \left[\begin{array}{c} (b_{17}^{'})^{(2)}\boxed{-(b_{17}^{''})^{(2)}(G_{19},t)}\ \boxed{-(b_{14}^{''})^{(1,1,)}(G,t)}\ \boxed{-(b_{21}^{''})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b_{25}^{''})^{(4,4,4,4,4)}(G_{27},t)}\ \boxed{-(b_{29}^{''})^{(5,5,5,5,5)}(G_{31},t)}\ \boxed{-(b_{33}^{''})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{37}^{''})^{(7,7)}(G_{39},t)}\ \boxed{-(b_{41}^{''})^{(8,8,)}(G_{43},t)} \end{array}\right] T_{17} \quad 78$$

$$\frac{dT_{18}}{dt} = (b_{18})^{(2)}T_{17} - \left[\begin{array}{c} (b_{18}^{'})^{(2)}\boxed{-(b_{18}^{''})^{(2)}(G_{19},t)}\ \boxed{-(b_{15}^{''})^{(1,1,)}(G,t)}\ \boxed{-(b_{22}^{''})^{(3,3,3,)}(G_{23},t)} \\ \boxed{-(b_{26}^{''})^{(4,4,4,4,4)}(G_{27},t)}\ \boxed{-(b_{30}^{''})^{(5,5,5,5,5)}(G_{31},t)}\ \boxed{-(b_{34}^{''})^{(6,6,6,6,6)}(G_{35},t)} \\ \boxed{-(b_{38}^{''})^{(7,7)}(G_{39},t)}\ \boxed{-(b_{42}^{''})^{(8,8,)}(G_{43},t)} \end{array}\right] T_{18} \quad 79$$

THIRD MODULE CONCATENATION:

80

$$\frac{dG_{20}}{dt} = \quad 81$$

$$(a_{20})^{(3)}G_{21} - \left[\begin{array}{c} (a_{20}^{'})^{(3)}\boxed{+(a_{20}^{''})^{(3)}(T_{21},t)}\ \boxed{+(a_{16}^{''})^{(2,2,2)}(T_{17},t)}\ \boxed{+(a_{13}^{''})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a_{24}^{''})^{(4,4,4,4,4,4)}(T_{25},t)}\ \boxed{+(a_{28}^{''})^{(5,5,5,5,5,5)}(T_{29},t)}\ \boxed{+(a_{32}^{''})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{36}^{''})^{(7.7.7.)}(T_{37},t)}\ \boxed{+(a_{40}^{''})^{(8,8,8)}(T_{41},t)} \end{array}\right] G_{20}$$

$$\frac{dG_{21}}{dt} = (a_{21})^{(3)}G_{20} - \left[\begin{array}{c} (a_{21}^{'})^{(3)}\boxed{+(a_{21}^{''})^{(3)}(T_{21},t)}\ \boxed{+(a_{17}^{''})^{(2,2,2)}(T_{17},t)}\ \boxed{+(a_{14}^{''})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a_{25}^{''})^{(4,4,4,4,4,4)}(T_{25},t)}\ \boxed{+(a_{29}^{''})^{(5,5,5,5,5,5)}(T_{29},t)}\ \boxed{+(a_{33}^{''})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{37}^{''})^{(7.7.7.)}(T_{37},t)}\ \boxed{+(a_{41}^{''})^{(8,8,8)}(T_{41},t)} \end{array}\right] G_{21} \quad 82$$

$$\frac{dG_{22}}{dt} = (a_{22})^{(3)}G_{21} - \left[\begin{array}{c} (a_{22}^{'})^{(3)}\boxed{+(a_{22}^{''})^{(3)}(T_{21},t)}\ \boxed{+(a_{18}^{''})^{(2,2,2)}(T_{17},t)}\ \boxed{+(a_{15}^{''})^{(1,1,1,)}(T_{14},t)} \\ \boxed{+(a_{26}^{''})^{(4,4,4,4,4,4)}(T_{25},t)}\ \boxed{+(a_{30}^{''})^{(5,5,5,5,5,5)}(T_{29},t)}\ \boxed{+(a_{34}^{''})^{(6,6,6,6,6,6)}(T_{33},t)} \\ \boxed{+(a_{38}^{''})^{(7.7.7.)}(T_{37},t)}\ \boxed{+(a_{42}^{''})^{(8,8,8)}(T_{41},t)} \end{array}\right] G_{22} \quad 83$$

84

$\boxed{+(a_{20}^{''})^{(3)}(T_{21},t)}$, $\boxed{+(a_{21}^{''})^{(3)}(T_{21},t)}$, $\boxed{+(a_{22}^{''})^{(3)}(T_{21},t)}$ are first augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{16}^{''})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}^{''})^{(2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}^{''})^{(2,2,2)}(T_{17},t)}$ are second augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{13}^{''})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a_{14}^{''})^{(1,1,1,)}(T_{14},t)}$, $\boxed{+(a_{15}^{''})^{(1,1,1,)}(T_{14},t)}$ are third augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{24}^{''})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{25}^{''})^{(4,4,4,4,4,4)}(T_{25},t)}$, $\boxed{+(a_{26}^{''})^{(4,4,4,4,4,4)}(T_{25},t)}$ are fourth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{28}^{''})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{29}^{''})^{(5,5,5,5,5,5)}(T_{29},t)}$, $\boxed{+(a_{30}^{''})^{(5,5,5,5,5,5)}(T_{29},t)}$ are fifth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{32}^{''})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a^{''}_{33})^{(6,6,6,6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}^{''})^{(6,6,6,6,6,6)}(T_{33},t)}$ are sixth augmentation coefficients for category 1, 2 and 3

$\boxed{+(a_{36}^{''})^{(7.7.7.)}(T_{37},t)}$ $\boxed{+(a_{37}^{''})^{(7.7.7.)}(T_{37},t)}$ $\boxed{+(a_{38}^{''})^{(7.7.7.)}(T_{37},t)}$ are seventh augmentation coefficient *85*

$+(a_{40}^{''})^{(8)}(T_{41},t)$ $+(a_{41}^{''})^{(8)}(T_{41},t)$ $+(a_{42}^{''})^{(8)}(T_{41},t)$ ARE EIGHTH AUGMENTATION COEFFICIENT

$$\frac{dT_{20}}{dt} = \qquad (86)$$

$$(b_{20})^{(3)}T_{21} - \begin{bmatrix} (b_{20}^{'})^{(3)} & -(b_{20}^{''})^{(3)}(G_{23},t) & -(b_{36}^{''})^{(7,7,7)}(G_{19},t) & -(b_{13}^{''})^{(1,1,1,)}(G,t) \\ -(b_{24}^{''})^{(4,4,4,4,4,4)}(G_{27},t) & -(b_{28}^{''})^{(5,5,5,5,5,5)}(G_{31},t) & -(b_{32}^{''})^{(6,6,6,6,6,6)}(G_{35},t) & \\ -(b_{36}^{''})^{(7,7,7)}(G_{39},t) & -(b_{40}^{''})^{(8,8,)}(G_{43},t) & -(b_{40}^{''})^{(8,8,8,)}(G_{43},t) & \end{bmatrix} T_{20}$$

$$\frac{dT_{21}}{dt} = \qquad (87)$$

$$(b_{21})^{(3)}T_{20} - \begin{bmatrix} (b_{21}^{'})^{(3)} & -(b_{21}^{''})^{(3)}(G_{23},t) & -(b_{17}^{''})^{(2,2,2)}(G_{19},t) & -(b_{14}^{''})^{(1,1,1,)}(G,t) \\ -(b_{25}^{''})^{(4,4,4,4,4,4)}(G_{27},t) & -(b_{29}^{''})^{(5,5,5,5,5,5)}(G_{31},t) & -(b_{33}^{''})^{(6,6,6,6,6,6)}(G_{35},t) & \\ -(b_{37}^{''})^{(7,7,7)}(G_{39},t) & -(b_{40}^{''})^{(8,8,8,)}(G_{43},t) & & \end{bmatrix} T_{21}$$

$$\frac{dT_{22}}{dt} = \qquad (88)$$

$$(b_{22})^{(3)}T_{21} - \begin{bmatrix} (b_{22}^{'})^{(3)} & -(b_{22}^{''})^{(3)}(G_{23},t) & -(b_{18}^{''})^{(2,2,2)}(G_{19},t) & -(b_{15}^{''})^{(1,1,1,)}(G,t) \\ -(b_{26}^{''})^{(4,4,4,4,4,4)}(G_{27},t) & -(b_{30}^{''})^{(5,5,5,5,5,5)}(G_{31},t) & -(b_{34}^{''})^{(6,6,6,6,6,6)}(G_{35},t) & \\ -(b_{38}^{''})^{(7,7,7)}(G_{39},t) & -(b_{40}^{''})^{(8,8,8,)}(G_{43},t) & & \end{bmatrix} T_{22}$$

$-(b_{20}^{''})^{(3)}(G_{23},t)$, $-(b_{21}^{''})^{(3)}(G_{23},t)$, $-(b_{22}^{''})^{(3)}(G_{23},t)$ *are first detritions coefficients for category 1, 2 and 3* (89)

$-(b_{16}^{''})^{(2,2,2)}(G_{19},t)$, $-(b_{17}^{''})^{(2,2,2)}(G_{19},t)$, $-(b_{18}^{''})^{(2,2,2)}(G_{19},t)$ *are second detritions coefficients for category 1, 2 and 3*

$-(b_{13}^{''})^{(1,1,1,)}(G,t)$, $-(b_{14}^{''})^{(1,1,1,)}(G,t)$, $-(b_{15}^{''})^{(1,1,1,)}(G,t)$ *are third detrition coefficients for category 1,2 and 3*

$-(b_{24}^{''})^{(4,4,4,4,4,4)}(G_{27},t)$, $-(b_{25}^{''})^{(4,4,4,4,4,4)}(G_{27},t)$, $-(b_{26}^{''})^{(4,4,4,4,4,4)}(G_{27},t)$ *are fourth detritions coefficients for category 1, 2 and 3*

$-(b_{28}^{''})^{(5,5,5,5,5,5)}(G_{31},t)$, $-(b_{29}^{''})^{(5,5,5,5,5,5)}(G_{31},t)$, $-(b_{30}^{''})^{(5,5,5,5,5,5)}(G_{31},t)$ *are fifth detritions coefficients for category 1, 2 and 3*

$-(b_{32}^{''})^{(6,6,6,6,6,6)}(G_{35},t)$, $-(b_{33}^{''})^{(6,6,6,6,6,6)}(G_{35},t)$, $-(b_{34}^{''})^{(6,6,6,6,6,6)}(G_{35},t)$ *are sixth detritions coefficients for category 1, 2 and 3*

(90)

Where $(a_{24}^{''})^{(4)}(T_{25},t)$, $(a_{25}^{''})^{(4)}(T_{25},t)$, $(a_{26}^{''})^{(4)}(T_{25},t)$ *are first augmentation coefficients fo*

(91)

$+(a_{28}^{''})^{(5,5,)}(T_{29},t)$, $+(a_{29}^{''})^{(5,5,)}(T_{29},t)$, $+(a_{30}^{''})^{(5,5,)}(T_{29},t)$ *are second augmentation coefficien*

$+(a_{32}^{''})^{(6,6,)}(T_{33},t)$, $+(a_{33}^{''})^{(6,6,)}(T_{33},t)$, $+(a_{34}^{''})^{(6,6,)}(T_{33},t)$ *are third augmentation coefficient*

$+(a_{13}^{''})^{(1,1,1,1)}(T_{14},t)$, $+(a_{14}^{''})^{(1,1,1,1)}(T_{14},t)$, $+(a_{15}^{''})^{(1,1,1,1)}(T_{14},t)$ are fourth augmentation coefficients for category 1, 2,and 3

$+(a_{16}^{''})^{(2,2,2,2)}(T_{17},t)$, $+(a_{17}^{''})^{(2,2,2,2)}(T_{17},t)$, $+(a_{18}^{''})^{(2,2,2,2)}(T_{17},t)$ are fifth augmentation

coefficients for category 1, 2,and 3

$+(a_{20}^{''})^{(3,3,3,3)}(T_{21},t)$, $+(a_{21}^{''})^{(3,3,3,3)}(T_{21},t)$, $+(a_{22}^{''})^{(3,3,3,3)}(T_{21},t)$ are sixth augmentation coefficients for category 1, 2,and 3

$+(a_{36}^{''})^{(7,7,7,7,)}(T_{37},t)$ $+(a_{36}^{''})^{(7,7,7,7,)}(T_{37},t)$ $+(a_{36}^{''})^{(7,7,7,7,)}(T_{37},t)$ ARE SEVENTH augmentation coefficients

FOURTH MODULE CONCATENATION:

$$\frac{dG_{24}}{dt} = (a_{24})^{(4)}G_{25} - \left[\begin{array}{c}(a_{24}^{'})^{(4)}\,+(a_{24}^{''})^{(4)}(T_{25},t)\;\;+(a_{28}^{''})^{(5,5,)}(T_{29},t)\;\;+(a_{32}^{''})^{(6,6,)}(T_{33},t)\\ +(a_{13}^{''})^{(1,1,1,1)}(T_{14},t)\;\;+(a_{16}^{''})^{(2,2,2,2)}(T_{17},t)\;\;+(a_{20}^{''})^{(3,3,3,3)}(T_{21},t)\\ +(a_{36}^{''})^{(7,7,7,7,)}(T_{37},t)\;\;+(a_{40}^{''})^{(8,8,8,8,)}(T_{41},t)\end{array}\right]G_{24} \quad 92$$

$$\frac{dG_{25}}{dt} = (a_{25})^{(4)}G_{24} - \left[\begin{array}{c}(a_{25}^{'})^{(4)}\,+(a_{25}^{''})^{(4)}(T_{25},t)\;\;+(a_{29}^{''})^{(5,5,)}(T_{29},t)\;\;+(a_{33}^{''})^{(6,6)}(T_{33},t)\\ +(a_{14}^{''})^{(1,1,1,1)}(T_{14},t)\;\;+(a_{17}^{''})^{(2,2,2,2)}(T_{17},t)\;\;+(a_{21}^{''})^{(3,3,3,3)}(T_{21},t)\\ +(a_{37}^{''})^{(7,7,7,7,)}(T_{37},t)\;\;+(a_{41}^{''})^{(8,8,8,8)}(T_{41},t)\end{array}\right]G_{25} \quad 93$$

$$\frac{dG_{26}}{dt} = (a_{26})^{(4)}G_{25} - \left[\begin{array}{c}(a_{26}^{'})^{(4)}\,+(a_{26}^{''})^{(4)}(T_{25},t)\;\;+(a_{30}^{''})^{(5,5,)}(T_{29},t)\;\;+(a_{34}^{''})^{(6,6,)}(T_{33},t)\\ +(a_{15}^{''})^{(1,1,1,1)}(T_{14},t)\;\;+(a_{18}^{''})^{(2,2,2,2)}(T_{17},t)\;\;+(a_{22}^{''})^{(3,3,3,3)}(T_{21},t)\\ +(a_{38}^{''})^{(7,7,7,7,)}(T_{37},t)\;\;+(a_{42}^{''})^{(8.8,8,8)}(T_{41},t)\end{array}\right]G_{26} \quad 94$$

95

Where $(a_{24}^{''})^{(4)}(T_{25},t)$, $(a_{25}^{''})^{(4)}(T_{25},t)$, $(a_{26}^{''})^{(4)}(T_{25},t)$ *are first augmentation coefficients fo*

$+(a_{28}^{''})^{(5,5,)}(T_{29},t)$, $+(a_{29}^{''})^{(5,5,)}(T_{29},t)$, $+(a_{30}^{''})^{(5,5,)}(T_{29},t)$ *are second augmentation coefficien*

$+(a_{32}^{''})^{(6,6,)}(T_{33},t)$, $+(a_{33}^{''})^{(6,6,)}(T_{33},t)$, $+(a_{34}^{''})^{(6,6,)}(T_{33},t)$ *are third augmentation coefficient*

$+(a_{13}^{''})^{(1,1,1,1)}(T_{14},t)$, $+(a_{14}^{''})^{(1,1,1,1)}(T_{14},t)$, $+(a_{15}^{''})^{(1,1,1,1)}(T_{14},t)$ are fourth augmentation coefficients for category 1, 2,and 3

$+(a_{16}^{''})^{(2,2,2,2)}(T_{17},t)$, $+(a_{17}^{''})^{(2,2,2,2)}(T_{17},t)$, $+(a_{18}^{''})^{(2,2,2,2)}(T_{17},t)$ are fifth augmentation coefficients for category 1, 2,and 3

$+(a_{20}^{''})^{(3,3,3,3)}(T_{21},t)$, $+(a_{21}^{''})^{(3,3,3,3)}(T_{21},t)$, $+(a_{22}^{''})^{(3,3,3,3)}(T_{21},t)$ are sixth augmentation coefficients for category 1, 2,and 3

$+(a_{36}^{''})^{(7,7,7,7,)}(T_{37},t)$ $+(a_{36}^{''})^{(7,7,7,7,)}(T_{37},t)$ $+(a_{36}^{''})^{(7,7,7,7,)}(T_{37},t)$ ARE SEVENTH augmentation coefficients

$+(a_{41}^{''})^{(8,8,8,8)}(T_{41},t)$

$\boxed{+(a_{41}^{''})^{(8,8,8,8,)}(T_{41},t)}\boxed{+(a_{41}^{''})^{(8,8,8,8,)}(T_{41},t)}$ ARE EIGHTH AUGMENTATION COEFFICIENTS

$$\frac{dT_{24}}{dt}=(b_{24})^{(4)}T_{25}-\left[\begin{matrix}(b_{24}^{'})^{(4)}\boxed{-(b_{24}^{''})^{(4)}(G_{27},t)}\ \boxed{-(b_{28}^{''})^{(5,5,)}(G_{31},t)}\ \boxed{-(b_{32}^{''})^{(6,6,)}(G_{35},t)}\\ \boxed{-(b_{13}^{''})^{(1,1,1,1)}(G,t)}\ \boxed{-(b_{16}^{''})^{(2,2,2,2)}(G_{19},t)}\ \boxed{-(b_{20}^{''})^{(3,3,3,3)}(G_{23},t)}\\ \boxed{-(b_{36}^{''})^{(7,7,7,7,,,)}(G_{39},t)}\boxed{-(b_{40}^{''})^{(8,,8,8,8,)}(G_{43},t)}\end{matrix}\right]T_{24} \quad 96$$

$$\frac{dT_{25}}{dt}=(b_{25})^{(4)}T_{24}-\left[\begin{matrix}(b_{25}^{'})^{(4)}\boxed{-(b_{25}^{''})^{(4)}(G_{27},t)}\ \boxed{-(b_{29}^{''})^{(5,5,)}(G_{31},t)}\ \boxed{-(b_{33}^{''})^{(6,6,)}(G_{35},t)}\\ \boxed{-(b_{14}^{''})^{(1,1,1,1)}(G,t)}\ \boxed{-(b_{17}^{''})^{(2,2,2,2)}(G_{19},t)}\ \boxed{-(b_{21}^{''})^{(3,3,3,3)}(G_{23},t)}\\ \boxed{-(b_{37}^{''})^{(7,7,7,77,,)}(G_{39},t)}\ \boxed{-(b_{41}^{''})^{(8,8,8,8,)}(G_{43},t)}\end{matrix}\right]T_{25} \quad 97$$

98

$Where\ \boxed{-(b_{24}^{''})^{(4)}(G_{27},t)},\boxed{-(b_{25}^{''})^{(4)}(G_{27},t)},\boxed{-(b_{26}^{''})^{(4)}(G_{27},t)}\ are\ first\ detrition\ coefficients\ fo$ 99

$\boxed{-(b_{28}^{''})^{(5,5,)}(G_{31},t)},\boxed{-(b_{29}^{''})^{(5,5,)}(G_{31},t)},\boxed{-(b_{30}^{''})^{(5,5,)}(G_{31},t)}\ are\ second\ detrition\ coefficients\ fo$

$\boxed{-(b_{32}^{''})^{(6,6,)}(G_{35},t)},\boxed{-(b_{33}^{''})^{(6,6,)}(G_{35},t)},\boxed{-(b_{34}^{''})^{(6,6,)}(G_{35},t)}\ are\ third\ detrition\ coefficients\ for\ c$

$\boxed{-(b_{13}^{''})^{(1,1,1,1)}(G,t)},\boxed{-(b_{14}^{''})^{(1,1,1,1)}(G,t)},\boxed{-(b_{15}^{''})^{(1,1,1,1)}(G,t)}$
$are\ fourth\ \ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{-(b_{16}^{''})^{(2,2,2,2)}(G_{19},t)},\boxed{-(b_{17}^{''})^{(2,2,2,2)}(G_{19},t)},\boxed{-(b_{18}^{''})^{(2,2,2,2)}(G_{19},t)}$
$are\ fifth\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{-(b_{20}^{''})^{(3,3,3,3)}(G_{23},t)},\boxed{-(b_{21}^{''})^{(3,3,3,3)}(G_{23},t)},\boxed{-(b_{22}^{''})^{(3,3,3,3)}(G_{23},t)}$
$are\ sixth\ detrition\ coefficients\ for\ category\ 1,2\ and\ 3$

$\boxed{-(b_{36}^{''})^{(7,7,7,7,7,,)}(G_{39},t)}\boxed{-(b_{37}^{''})^{(7,7,7,7,7,,)}(G_{39},t)}\boxed{-(b_{38}^{''})^{(7,7,7,7,7,,)}(G_{39},t)}\ ARE$ SEVENTH DETRITION

COEFFICIENTS

$\boxed{-(b_{40}^{''})^{(8,,88,,8,)}(G_{43},t)}\boxed{-(b_{41}^{''})^{(8,,8,8,8,)}(G_{43},t)}\boxed{-(b_{42}^{''})^{(8,,8,8,8,)}(G_{43},t)}$ ARE EIGHTH DETRITION COEFFICIENTS.

FIFTH MODULE CONCATENATION: 100

$$\frac{dG_{28}}{dt}=(a_{28})^{(5)}G_{29}-\left[\begin{matrix}(a_{28}^{'})^{(5)}\boxed{+(a_{28}^{''})^{(5)}(T_{29},t)}\ \boxed{+(a_{24}^{''})^{(4,4,)}(T_{25},t)}\ \boxed{+(a_{32}^{''})^{(6,6,6)}(T_{33},t)}\\ \boxed{+(a_{13}^{''})^{(1,1,1,1,1)}(T_{14},t)}\ \boxed{+(a_{16}^{''})^{(2,2,2,2,2)}(T_{17},t)}\ \boxed{+(a_{20}^{''})^{(3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a_{36}^{''})^{(7,7,,7,,7,7)}(T_{37},t)}\ \ \boxed{+(a_{40}^{''})^{(8,8,8,8,8)}(T_{41},t)}\end{matrix}\right]G_{28} \quad 101$$

$$\frac{dG_{29}}{dt}=(a_{29})^{(5)}G_{28}-\left[\begin{matrix}(a_{29}^{'})^{(5)}\boxed{+(a_{29}^{''})^{(5)}(T_{29},t)}\ \boxed{+(a_{25}^{''})^{(4,4,)}(T_{25},t)}\ \boxed{+(a_{33}^{''})^{(6,6,6)}(T_{33},t)}\\ \boxed{+(a_{14}^{''})^{(1,1,1,1,1)}(T_{14},t)}\ \boxed{+(a_{17}^{''})^{(2,2,2,2,2)}(T_{17},t)}\ \boxed{+(a_{21}^{''})^{(3,3,3,3,3)}(T_{21},t)}\\ \boxed{+(a_{37}^{''})^{(7,7,,,7,,7,7)}(T_{37},t)}\ \ \boxed{+(a_{41}^{''})^{(8,8,8,8,8)}(T_{41},t)}\end{matrix}\right]G_{29} \quad 102$$

$$\frac{dG_{30}}{dt} = (a_{30})^{(5)}G_{29} - \left[\begin{array}{ccc} (a_{30}^{'})^{(5)}\boxed{+(a_{30}^{''})^{(5)}(T_{29},t)} & \boxed{+(a_{26}^{''})^{(4,4,)}(T_{25},t)} & \boxed{+(a_{34}^{''})^{(6,6,6)}(T_{33},t)} \\ \boxed{+(a_{15}^{''})^{(1,1,1,1,1)}(T_{14},t)} & \boxed{+(a_{18}^{''})^{(2,2,2,2,2)}(T_{17},t)} & \boxed{+(a_{22}^{''})^{(3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{38}^{''})^{(7,7,,7,,7,7)}(T_{37},t)} & \boxed{+(a_{41}^{''})^{(8,8,8,8,8)}(T_{41},t)} & \end{array}\right] G_{30} \quad 103$$

$Where$ $\boxed{+(a_{28}^{''})^{(5)}(T_{29},t)}$, $\boxed{+(a_{29}^{''})^{(5)}(T_{29},t)}$, $\boxed{+(a_{30}^{''})^{(5)}(T_{29},t)}$ $are\ first\ augmentation\ coefficient$ *104*

And $\boxed{+(a_{24}^{''})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a_{25}^{''})^{(4,4,)}(T_{25},t)}$, $\boxed{+(a_{26}^{''})^{(4,4,)}(T_{25},t)}$ $are\ second\ augmentation\ coeffi$

$\boxed{+(a_{32}^{''})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a_{33}^{''})^{(6,6,6)}(T_{33},t)}$, $\boxed{+(a_{34}^{''})^{(6,6,6)}(T_{33},t)}$ $are\ third\ \ augmentation\ coefficier$

$\boxed{+(a_{13}^{''})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{14}^{''})^{(1,1,1,1,1)}(T_{14},t)}$, $\boxed{+(a_{15}^{''})^{(1,1,1,1,1)}(T_{14},t)}$ are fourth augmentation coefficients for category 1,2, and 3

$\boxed{+(a_{16}^{''})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{17}^{''})^{(2,2,2,2,2)}(T_{17},t)}$, $\boxed{+(a_{18}^{''})^{(2,2,2,2,2)}(T_{17},t)}$ are fifth augmentation coefficients for category 1,2,and 3

$\boxed{+(a_{20}^{''})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{21}^{''})^{(3,3,3,3,3)}(T_{21},t)}$, $\boxed{+(a_{22}^{''})^{(3,3,3,3,3)}(T_{21},t)}$ are sixth augmentation coefficients for category 1,2, 3

$\boxed{+(a_{40}^{''})^{(8,8,8,8,8)}(T_{41},t)}$ $\boxed{+(a_{41}^{''})^{(8,8,8,8,8)}(T_{41},t)}$ $\boxed{+(a_{42}^{''})^{(8,8,8,8,8)}(T_{41},t)}$ ARE EIGHTH AUMENTATION COEFFICIENTS

$$\frac{dT_{28}}{dt} = (b_{28})^{(5)}T_{29} - \left[\begin{array}{ccc} (b_{28}^{'})^{(5)}\boxed{-(b_{28}^{''})^{(5)}(G_{31},t)} & \boxed{-(b_{24}^{''})^{(4,4,)}(G_{23},t)} & \boxed{-(b_{32}^{''})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b_{13}^{''})^{(1,1,1,1,1)}(G,t)} & \boxed{-(b_{16}^{''})^{(2,2,2,2,2)}(G_{19},t)} & \boxed{-(b_{20}^{''})^{(3,3,3,3,3)}(G_{23},t)} \\ & \boxed{-(b_{36}^{''})^{(7,7,,7,7,7,)}(G_{38},t)} & \end{array}\right] T_{28} \quad 105$$

$$\frac{dT_{29}}{dt} = (b_{29})^{(5)}T_{28} - \left[\begin{array}{ccc} (b_{29}^{'})^{(5)}\boxed{-(b_{29}^{''})^{(5)}(G_{31},t)} & \boxed{-(b_{25}^{''})^{(4,4,)}(G_{27},t)} & \boxed{-(b_{33}^{''})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b_{14}^{''})^{(1,1,1,1,1)}(G,t)} & \boxed{-(b_{17}^{''})^{(2,2,2,2,2)}(G_{19},t)} & \boxed{-(b_{21}^{''})^{(3,3,3,3,3)}(G_{23},t)} \\ & \boxed{-(b_{37}^{''})^{(7,7,7,7,7,)}(G_{38},t)} & \end{array}\right] T_{29} \quad 106$$

$$\frac{dT_{30}}{dt} = (b_{30})^{(5)}T_{29} - \left[\begin{array}{ccc} (b_{30}^{'})^{(5)}\boxed{-(b_{30}^{''})^{(5)}(G_{31},t)} & \boxed{-(b_{26}^{''})^{(4,4,)}(G_{27},t)} & \boxed{-(b_{34}^{''})^{(6,6,6)}(G_{35},t)} \\ \boxed{-(b_{15}^{''})^{(1,1,1,1,1,)}(G,t)} & \boxed{-(b_{18}^{''})^{(2,2,2,2,2)}(G_{19},t)} & \boxed{-(b_{22}^{''})^{(3,3,3,3,3)}(G_{23},t)} \\ & \boxed{-(b_{38}^{''})^{(7,7,7,7,7,)}(G_{38},t)} & \end{array}\right] T_{30} \quad 107$$

SIXTH MODULE CONCATENATION *108*

$$\frac{dG_{32}}{dt} = (a_{32})^{(6)}G_{33} \quad 109$$
$$- \left[\begin{array}{ccc} (a_{32}^{'})^{(6)}\boxed{+(a_{32}^{''})^{(6)}(T_{33},t)} & \boxed{+(a_{28}^{''})^{(5,5,5)}(T_{29},t)} & \boxed{+(a_{24}^{''})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a_{13}^{''})^{(1,1,1,1,1,1)}(T_{14},t)} & \boxed{+(a_{16}^{''})^{(2,2,2,2,2,2)}(T_{17},t)} & \boxed{+(a_{20}^{''})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a_{36}^{''})^{(7,7,7,7,7,7,)}(T_{37},t)} & \boxed{+(a_{40}^{''})^{(8,8,8,8,8,,8)}(T_{41},t)} & \end{array}\right] G_{32}$$

$$\frac{dG_{33}}{dt} = (a_{33})^{(6)} G_{32} - \left[\begin{array}{c} (a'_{33})^{(6)} \boxed{+(a''_{33})^{(6)}(T_{33},t)} \boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{37})^{(7,7,7,,7,7,7,)}(T_{37},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,,8)}(T_{41},t)} \end{array} \right] G_{33} \quad (110)$$

$$\frac{dG_{34}}{dt} = (a_{34})^{(6)} G_{33} - \left[\begin{array}{c} (a'_{34})^{(6)} \boxed{+(a''_{34})^{(6)}(T_{33},t)} \boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)} \boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)} \\ \boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)} \boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)} \boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)} \\ \boxed{+(a''_{38})^{(7,7,7,7,7,7,)}(T_{37},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,,8)}(T_{41},t)} \end{array} \right] G_{34} \quad (111)$$

$\boxed{+(a''_{32})^{(6)}(T_{33},t)}, \boxed{+(a''_{33})^{(6)}(T_{33},t)}, \boxed{+(a''_{34})^{(6)}(T_{33},t)}$ *are first augmentation coefficients for c* (112)

$\boxed{+(a''_{28})^{(5,5,5)}(T_{29},t)}, \boxed{+(a''_{29})^{(5,5,5)}(T_{29},t)}, \boxed{+(a''_{30})^{(5,5,5)}(T_{29},t)}$ *are second augmentation coefficie*

$\boxed{+(a''_{24})^{(4,4,4,)}(T_{25},t)}, \boxed{+(a''_{25})^{(4,4,4,)}(T_{25},t)}, \boxed{+(a''_{26})^{(4,4,4,)}(T_{25},t)}$ *are third augmentation coeffici*

$\boxed{+(a''_{13})^{(1,1,1,1,1,1)}(T_{14},t)}, \boxed{+(a''_{14})^{(1,1,1,1,1,1)}(T_{14},t)}, \boxed{+(a''_{15})^{(1,1,1,1,1,1)}(T_{14},t)}$ - are fourth augmentation coefficients

$\boxed{+(a''_{16})^{(2,2,2,2,2,2)}(T_{17},t)}, \boxed{+(a''_{17})^{(2,2,2,2,2,2)}(T_{17},t)}, \boxed{+(a''_{18})^{(2,2,2,2,2,2)}(T_{17},t)}$ - fifth augmentation coefficients

$\boxed{+(a''_{20})^{(3,3,3,3,3,3)}(T_{21},t)}, \boxed{+(a''_{21})^{(3,3,3,3,3,3)}(T_{21},t)}, \boxed{+(a''_{22})^{(3,3,3,3,3,3)}(T_{21},t)}$ sixth augmentation coefficients

$\boxed{+(a''_{36})^{(7,7,7,7,7,7,)}(T_{37},t)} \boxed{+(a''_{36})^{(7,7,,77,7,,7,)}(T_{37},t)} \boxed{+(a''_{36})^{(7,7,7,,7,7,7,)}(T_{37},t)}$ ARE SEVENTH AUGMENTATION COEFFICIENTS

$\boxed{+(a''_{40})^{(8,8,8,8,8,,8)}(T_{41},t)} \boxed{+(a''_{41})^{(8,8,8,8,8,,8)}(T_{41},t)} \boxed{+(a''_{42})^{(8,8,8,8,8,,8)}(T_{41},t)}$ ARE EIGHT AUGMENTATION COEFFICIENTS

(113)

$$\frac{dT_{32}}{dt} = (b_{32})^{(6)} T_{33} - \left[\begin{array}{c} (b'_{32})^{(6)} \boxed{-(b''_{32})^{(6)}(G_{35},t)} \boxed{-(b''_{28})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{24})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{13})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{16})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{20})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{36})^{(7,7,7,,7,7,7)}(G_{39},t)} \quad \boxed{-(b''_{40})^{(8,,8,8,8,8,8,)}(G_{43},t)} \end{array} \right] T_{32} \quad (114)$$

$$\frac{dT_{33}}{dt} = (b_{33})^{(6)} T_{32} - \left[\begin{array}{c} (b'_{33})^{(6)} \boxed{-(b''_{33})^{(6)}(G_{35},t)} \boxed{-(b''_{29})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{25})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{14})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{17})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{21})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{37})^{(7,7,7,,7,7,7)}(G_{39},t)} \quad \boxed{-(b''_{41})^{(8,,8,8,8,8,8,)}(G_{43},t)} \end{array} \right] T_{33} \quad (115)$$

$$\frac{dT_{34}}{dt} = (b_{34})^{(6)} T_{33} - \left[\begin{array}{c} (b'_{34})^{(6)} \boxed{-(b''_{34})^{(6)}(G_{35},t)} \boxed{-(b''_{30})^{(5,5,5)}(G_{31},t)} \boxed{-(b''_{26})^{(4,4,4,)}(G_{27},t)} \\ \boxed{-(b''_{15})^{(1,1,1,1,1,1)}(G,t)} \boxed{-(b''_{18})^{(2,2,2,2,2,2)}(G_{19},t)} \boxed{-(b''_{22})^{(3,3,3,3,3,3)}(G_{23},t)} \\ \boxed{-(b''_{38})^{(7,7,7,,7,7,7)}(G_{39},t)} \quad \boxed{-(b''_{42})^{(8,,8,8,8,8,8,)}(G_{43},t)} \end{array} \right] T_{34} \quad (116)$$

$\boxed{-(b''_{32})^{(6)}(G_{35},t)}, \boxed{-(b''_{33})^{(6)}(G_{35},t)}, \boxed{-(b''_{34})^{(6)}(G_{35},t)}$ *are first detrition coefficients for cate* (117)

$-(b_{28}^{''})^{(5,5,5)}(G_{31},t)$, $-(b_{29}^{''})^{(5,5,5)}(G_{31},t)$, $-(b_{30}^{''})^{(5,5,5)}(G_{31},t)$ *are second detrition coefficients*

$-(b_{24}^{''})^{(4,4,4,)}(G_{27},t)$, $-(b_{25}^{''})^{(4,4,4,)}(G_{27},t)$, $-(b_{26}^{''})^{(4,4,4,)}(G_{27},t)$ *are third detrition coefficients f*

$-(b_{13}^{''})^{(1,1,1,1,1,1)}(G,t)$, $-(b_{14}^{''})^{(1,1,1,1,1,1)}(G,t)$, $-(b_{15}^{''})^{(1,1,1,1,1,1)}(G,t)$ are fourth detrition coefficients for category 1, 2, and 3

$-(b_{16}^{''})^{(2,2,2,2,2,2)}(G_{19},t)$, $-(b_{17}^{''})^{(2,2,2,2,2,2)}(G_{19},t)$, $-(b_{18}^{''})^{(2,2,2,2,2,2)}(G_{19},t)$ are fifth detrition coefficients for category 1, 2, and 3

$-(b_{20}^{''})^{(3,3,3,3,3,3)}(G_{23},t)$, $-(b_{21}^{''})^{(3,3,3,3,3,3)}(G_{23},t)$, $-(b_{22}^{''})^{(3,3,3,3,3,3)}(G_{23},t)$ are sixth detritions coefficients for category 1, 2, and 3

$-(b_{36}^{''})^{(7,7,7,7,7,7)}(G_{39},t)$ $-(b_{36}^{''})^{(7,7,7,7,7,7)}(G_{39},t)$ $-(b_{36}^{''})^{(7,7,7,7,7,7)}(G_{39},t)$ ARE SEVENTH DETRITION COEFFICIENTS

$-(b_{40}^{''})^{(8,,8,8,8,8,8,)}(G_{43},t)$ $-(b_{41}^{''})^{(8,,8,8,8,8,8,)}(G_{43},t)$ $-(b_{42}^{''})^{(8,,8,8,8,8,8,)}(G_{43},t)$ ARE EIGHTH DETRITION COPEFFICIENTS.

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SEVENTH MODULE CONCATENATION*:* *119*

120

$$\frac{dG_{36}}{dt} = (a_{36})^{(7)}G_{37} - \Big[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37},t) + (a_{16}^{''})^{(7)}(T_{17},t) + (a_{20}^{''})^{(7)}(T_{21},t) + (a_{24}^{''})^{(7)}(T_{23},t)G_{36} + (a_{28}^{''})^{(7)}(T_{29},t) + (a_{32}^{''})^{(7)}(T_{33},t) + (a_{13}^{''})^{(7)}(T_{14},t) + (a_{40}^{''})^{(8,8,8,8,8,,8,8)}(T_{41},t)\Big]G_{36}$$

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122

$$\frac{dG_{37}}{dt} = (a_{37})^{(7)}G_{36} - \Big[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37},t) + (a_{14}^{''})^{(7)}(T_{14},t) + (a_{21}^{''})^{(7)}(T_{21},t) + (a_{17}^{''})^{(7)}(T_{17},t) + (a_{25}^{''})^{(7)}(T_{25},t) + (a_{33}^{''})^{(7)}(T_{33},t) + (a_{29}^{''})^{(7)}(T_{29},t) + (a_{41}^{''})^{(8,8,8,8,8,,8,8)}(T_{41},t)\Big]G_{37}$$

123

$$\frac{dG_{38}}{dt} =$$

124

$$(a_{38})^{(7)}G_{37} -$$

125

$$\Big[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37},t) + \underbrace{(a_{15}^{''})^{(7)}(T_{14},t)} + (a_{22}^{''})^{(7)}(T_{21},t) + (a_{18}^{''})^{(7)}(T_{17},t) + (a_{26}^{''})^{(7)}(T_{25},t) + (a_{34}^{''})^{(7)}(T_{33},t) + (a_{30}^{''})^{(7)}(T_{29},t) + (a_{42}^{''})^{(8,8,8,8,8,,8,8)}(T_{41},t)\Big]G_{38}$$

126

$$\frac{dT_{36}}{dt} =$$

$$(b_{36})^{(7)}T_{37} - \Big[(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}((G_{39}),t) - (b_{16}^{''})^{(7)}((G_{19}),t) - (b_{13}^{''})^{(7)}((G_{14}),t) - (b_{20}^{''})^{(7)}((G_{231}),t) - (b_{24}^{''})^{(7)}((G_{27}),t) - (b_{28}^{''})^{(7)}((G_{31}),t) -$$

$\boxed{(b_{32}^{''})^{(7)}((G_{35}),t)}\ \Big]T_{36}$

$\frac{dT_{37}}{dt} = (b_{37})^{(7)}T_{36} -$ 127
$\Big[(b_{36}^{'})^{(7)} - \boxed{(b_{37}^{''})^{(7)}((G_{39}),t)} - \boxed{(b_{17}^{''})^{(7)}((G_{19}),t)} - \boxed{(b_{19}^{''})^{(7)}((G_{14}),t)} -$
$\boxed{(b_{21}^{''})^{(7)}((G_{231}),t)} - \boxed{(b_{25}^{''})^{(7)}((G_{27}),t)} - \boxed{(b_{29}^{''})^{(7)}((G_{31}),t)} -$
$\boxed{(b_{33}^{''})^{(7)}((G_{35}),t)}\ \Big]T_{37}$

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EIGHTH MODULE CONCATENATION:

$$\frac{dG_{40}}{dt} = (a_{40})^{(8)}G_{41} - \left[\begin{array}{c}(a_{40}^{'})^{(8)} + \boxed{(a_{40}^{''})^{(8)}(T_{41},t)} + \boxed{(a_{13}^{''})^{(8)}(T_{14},t)} + \boxed{(a_{16}^{''})^{(8)}(T_{17},t)} + \\ \boxed{(a_{20}^{''})^{(7)}(T_{21},t)} + \boxed{(a_{24}^{''})^{(8)}(T_{23},t)} + \boxed{(a_{28}^{''})^{(8)}(T_{29},t)} + \boxed{(a_{32}^{''})^{(8)}(T_{33},t)} \\ \boxed{+(a_{36}^{''})^{(8)}\vdots(T_{37},t)}\end{array}\right]G_{40}$$

$\frac{dG_{41}}{dt} = (a_{41})^{(8)}G_{40} - \Big[(a_{41}^{'})^{(8)} + \boxed{(a_{41}^{''})^{(8)}(T_{41},t)} + \boxed{(a_{14}^{''})^{(8)}(T_{14},t)} + \boxed{(a_{17}^{''})^{(8)}(T_{17},t)} +$
$\boxed{(a_{21}^{''})^{(8)}(T_{21},t)} + \boxed{(a_{25}^{''})^{(8)}(T_{23},t)} + \boxed{(a_{29}^{''})^{(8)}(T_{29},t)} + \boxed{(a_{33}^{''})^{(8)}(T_{33},t)} +$
$\boxed{+(a_{37}^{''})^{(8)}\vdots(T_{37},t)}\ \Big]G_{41}$

$\frac{dG_{42}}{dt} = (a_{42})^{(8)}G_{41} - \Big[(a_{42}^{'})^{(8)} + \boxed{(a_{42}^{''})^{(8)}(T_{41},t)} + \boxed{(a_{15}^{''})^{(8)}(T_{14},t)} + \boxed{(a_{18}^{''})^{(8)}(T_{17},t)} +$
$\boxed{(a_{22}^{''})^{(8)}(T_{21},t)} + \boxed{(a_{26}^{''})^{(8)}(T_{23},t)} + \boxed{(a_{30}^{''})^{(8)}(T_{29},t)} + \boxed{(a_{34}^{''})^{(8)}(T_{33},t)} +$
$\boxed{+(a_{38}^{''})^{(8)}\vdots(T_{37},t)}\ \Big]G_{42}$

$\frac{dT_{40}}{dt} = (b_{40})^{(8)}T_{41} - \Big[(b_{40}^{'})^{(8)} - \boxed{(b_{40}^{''})^{(8)}((G_{43}),t)} - \boxed{(b_{13}^{''})^{(8)}((G_{14}),t)} - \boxed{(b_{16}^{''})^{(8)}((G_{19}),t)} -$
$\boxed{(b_{20}^{''})^{(8)}((G_{23}),t)} - \boxed{(b_{24}^{''})^{(8)}((G_{27}),t)} - \boxed{(b_{28}^{''})^{(8)}((G_{31}),t)} - \boxed{(b_{32}^{''})^{(8)}((G_{35}),t)} -$
$\boxed{(b_{36}^{''})^{(8)}((G_{39}),t)}\ \Big]T_{40}$

$\frac{dT_{41}}{dt} =$
$(b_{41})^{(8)}T_{40} -$

$$\left[(b_{41}^{'})^{(8)} - \boxed{(b_{41}^{''})^{(8)}((G_{43}),t)} - \boxed{(b_{14}^{''})^{(8)}((G_{14}),t)} - \boxed{(b_{17}^{''})^{(8)}((G_{19}),t)} - \boxed{(b_{21}^{''})^{(8)}((G_{23}),t)} - \boxed{(b_{25}^{''})^{(8)}((G_{27}),t)} - \boxed{(b_{29}^{''})^{(8)}((G_{31}),t)} - \boxed{(b_{33}^{''})^{(8)}((G_{35}),t)} - \boxed{(b_{37}^{''})^{(8)}((G_{39}),t)}\right] T_{41}$$

$$\frac{dT_{42}}{dt} = (b_{42})^{(8)}T_{41} - \left[(b_{42}^{'})^{(8)} - \boxed{(b_{42}^{''})^{(8)}((G_{43}),t)} - \boxed{(b_{15}^{''})^{(7)}((G_{14}),t)} - \boxed{(b_{18}^{''})^{(8)}((G_{19}),t)} - \boxed{(b_{22}^{''})^{(8)}((G_{23}),t)} - \boxed{(b_{26}^{''})^{(8)}((G_{27}),t)} - \boxed{(b_{30}^{''})^{(8)}((G_{31}),t)} - \boxed{(b_{34}^{''})^{(8)}((G_{35}),t)} - \boxed{(b_{38}^{''})^{(8)}((G_{39}),t)}\right] T_{42}$$

$+(a_{40}^{''})^{(8)}(T_{41},t) =$ **First augmentation factor**

$-(b_{40}^{''})^{(8)}((G_{43}),t) =$ **First detritions factor**

Where we suppose

(A) $(a_i)^{(1)}, (a_i^{'})^{(1)}, (a_i^{''})^{(1)}, (b_i)^{(1)}, (b_i^{'})^{(1)}, (b_i^{''})^{(1)} > 0,$
$i, j = 13,14,15$

(B) The functions $(a_i^{''})^{(1)}, (b_i^{''})^{(1)}$ are positive continuous increasing and bounded.
Definition of $(p_i)^{(1)}$, $(r_i)^{(1)}$:

$$(a_i^{''})^{(1)}(T_{14},t) \leq (p_i)^{(1)} \leq (\hat{A}_{13})^{(1)}$$

$$(b_i^{''})^{(1)}(G,t) \leq (r_i)^{(1)} \leq (b_i^{'})^{(1)} \leq (\hat{B}_{13})^{(1)}$$

(C) $lim_{T_2 \to \infty}(a_i^{''})^{(1)}(T_{14},t) = (p_i)^{(1)}$
$\lim_{G \to \infty}(b_i^{''})^{(1)}(G,t) = (r_i)^{(1)}$

Definition of $(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}$:

Where $\boxed{(\hat{A}_{13})^{(1)}, (\hat{B}_{13})^{(1)}, (p_i)^{(1)}, (r_i)^{(1)}}$ are positive constants
and $\boxed{i = 13,14,15}$

They satisfy Lipschitz condition:
$$|(a_i^{''})^{(1)}(T_{14}^{'},t) - (a_i^{''})^{(1)}(T_{14},t)| \leq (\hat{k}_{13})^{(1)}|T_{14} - T_{14}^{'}|e^{-(\hat{M}_{13})^{(1)}t}$$

$$|(b_i^{''})^{(1)}(G^{'},t) - (b_i^{''})^{(1)}(G,T)| < (\hat{k}_{13})^{(1)}||G - G^{'}||e^{-(\hat{M}_{13})^{(1)}t}$$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(1)}(T_{14}^{'},t)$ and$(a_i^{''})^{(1)}(T_{14},t)$. $(T_{14}^{'},t)$ and (T_{14},t) are points belonging to the interval $\left[(\hat{k}_{13})^{(1)}, (\hat{M}_{13})^{(1)}\right]$. It is to be noted that $(a_i^{''})^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{13})^{(1)} = 1$ then the function $(a_i^{''})^{(1)}(T_{14},t)$, the **first augmentation coefficient** attributable to terrestrial organisms, would be absolutely continuous.

Definition of $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$:

(D) $(\hat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}$, are positive constants

$$\frac{(a_i)^{(1)}}{(\hat{M}_{13})^{(1)}}, \frac{(b_i)^{(1)}}{(\hat{M}_{13})^{(1)}} < 1$$

Definition of $(\hat{P}_{13})^{(1)}, (\hat{Q}_{13})^{(1)}$:

(E) There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ which together with $(\widehat{M}_{13})^{(1)}, (\hat{k}_{13})^{(1)}, (\hat{A}_{13})^{(1)} and\ (\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)}, (a_i')^{(1)}, (b_i)^{(1)}, (b_i')^{(1)}, (p_i)^{(1)}, (r_i)^{(1)}, i = 13,14,15,$ satisfy the inequalities

$$\frac{1}{(\widehat{M}_{13})^{(1)}}[(a_i)^{(1)} + (a_i')^{(1)} + (\hat{A}_{13})^{(1)} + (\hat{P}_{13})^{(1)} (\hat{k}_{13})^{(1)}] < 1$$

$$\frac{1}{(\widehat{M}_{13})^{(1)}}[(b_i)^{(1)} + (b_i')^{(1)} + (\hat{B}_{13})^{(1)} + (\hat{Q}_{13})^{(1)} (\hat{k}_{13})^{(1)}] < 1$$

$\frac{dT_{38}}{dt} =$ 128

$(b_{38})^{(7)}T_{37} - \left[(b_{38}')^{(7)} - \boxed{(b_{38}'')^{(7)}((G_{39}),t)} - \boxed{(b_{18}'')^{(7)}((G_{19}),t)} - \boxed{(b_{22}'')^{(7)}((G_{14}),t)} -$ 129

$\boxed{(b_{15}'')^{(7)}((G_{23}),t)} - \boxed{(b_{26}'')^{(7)}((G_{27}),t)} - \boxed{(b_{30}'')^{(7)}((G_{31}),t)} -$ 130

$\boxed{(b_{34}'')^{(7)}((G_{35}),t)} - \Big]T_{38}$ 131

132

$+(a_{36}'')^{(7)}(T_{37},t) =$ **First augmentation factor** 134

$(1)(a_i)^{(2)}, (a_i')^{(2)}, (a_i'')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (b_i'')^{(2)} > 0, \quad i,j = 16,17,18$ 135

(F) (2) The functions $(a_i'')^{(2)}, (b_i'')^{(2)}$ are positive continuous increasing and bounded. 136

Definition of $(\mathrm{p_i})^{(2)}$, $(\mathrm{r_i})^{(2)}$: 137

$(a_i'')^{(2)}(T_{17},t) \le (p_i)^{(2)} \le (\hat{A}_{16})^{(2)}$ 138

$(b_i'')^{(2)}(G_{19},t) \le (r_i)^{(2)} \le (b_i')^{(2)} \le (\hat{B}_{16})^{(2)}$ 139

(G) (3) $\lim_{T_2\to\infty}(a_i'')^{(2)}(T_{17},t) = (p_i)^{(2)}$ 140

$\lim_{G\to\infty}(b_i'')^{(2)}\big((G_{19}),t\big) = (r_i)^{(2)}$ 141

Definition of $(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}$: 142

Where $\boxed{(\hat{A}_{16})^{(2)}, (\hat{B}_{16})^{(2)}, (p_i)^{(2)}, (r_i)^{(2)}}$ are positive constants and $\boxed{i = 16,17,18}$

They satisfy Lipschitz condition: 143

$|(a_i'')^{(2)}(T_{17}',t) - (a_i'')^{(2)}(T_{17},t)| \le (\hat{k}_{16})^{(2)}|T_{17} - T_{17}'|e^{-(\hat{M}_{16})^{(2)}t}$ 144

$|(b_i'')^{(2)}((G_{19})',t) - (b_i'')^{(2)}\big((G_{19}),t\big)| < (\hat{k}_{16})^{(2)}||(G_{19}) - (G_{19})'||e^{-(\hat{M}_{16})^{(2)}t}$ 145

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(2)}(T_{17}',t)$ and$(a_i'')^{(2)}(T_{17},t)$. (T_{17}',t) And (T_{17},t) are points belonging to the interval $\left[(\hat{k}_{16})^{(2)}, (\hat{M}_{16})^{(2)}\right]$. It is to be noted that $(a_i'')^{(2)}(T_{17},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{16})^{(2)} = 1$ then the function $(a_i'')^{(2)}(T_{17},t)$, the SECOND augmentation coefficient would be absolutely continuous. 146

Definition of $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$: 147

(H) (4) $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}$, are positive constants 148

$\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}}, \frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}} < 1$

Definition of $(\hat{P}_{13})^{(2)}, (\hat{Q}_{13})^{(2)}$: 149

There exists two constants $(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ which together with $(\hat{M}_{16})^{(2)}, (\hat{k}_{16})^{(2)}, (\hat{A}_{16})^{(2)} and\ (\hat{B}_{16})^{(2)}$ and the constants $(a_i)^{(2)}, (a_i')^{(2)}, (b_i)^{(2)}, (b_i')^{(2)}, (p_i)^{(2)}, (r_i)^{(2)}, i = 16,17,18,$

satisfy the inequalities

$$\frac{1}{(\widehat{M}_{16})^{(2)}}[(a_i)^{(2)} + (a_i')^{(2)} + (\widehat{A}_{16})^{(2)} + (\widehat{P}_{16})^{(2)}(\hat{k}_{16})^{(2)}] < 1 \quad 150$$

$$\frac{1}{(\widehat{M}_{16})^{(2)}}[(b_i)^{(2)} + (b_i')^{(2)} + (\hat{B}_{16})^{(2)} + (\hat{Q}_{16})^{(2)}(\hat{k}_{16})^{(2)}] < 1 \quad 151$$

Where we suppose 152

(I) $(a_i)^{(3)}, (a_i')^{(3)}, (a_i'')^{(3)}, (b_i)^{(3)}, (b_i')^{(3)}, (b_i'')^{(3)} > 0, \quad i,j = 20,21,22$ 153

The functions $(a_i'')^{(3)}, (b_i'')^{(3)}$ are positive continuous increasing and bounded.

Definition of $(p_i)^{(3)}$, $(r_i)^{(3)}$:

$$(a_i'')^{(3)}(T_{21},t) \le (p_i)^{(3)} \le (\hat{A}_{20})^{(3)}$$

$$(b_i'')^{(3)}(G_{23},t) \le (r_i)^{(3)} \le (b_i')^{(3)} \le (\hat{B}_{20})^{(3)}$$

$$lim_{T_2\to\infty}(a_i'')^{(3)}(T_{21},t) = (p_i)^{(3)} \quad 154$$

$$\lim_{G\to\infty}(b_i'')^{(3)}(G_{23},t) = (r_i)^{(3)} \quad 155$$

Definition of $(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}$: 156

Where $\boxed{(\hat{A}_{20})^{(3)}, (\hat{B}_{20})^{(3)}, (p_i)^{(3)}, (r_i)^{(3)}}$ are positive constants and $\boxed{i = 20,21,22}$

They satisfy Lipschitz condition: 157

$$|(a_i'')^{(3)}(T_{21}',t) - (a_i'')^{(3)}(T_{21},t)| \le (\hat{k}_{20})^{(3)}|T_{21} - T_{21}'|e^{-(\widehat{M}_{20})^{(3)}t} \quad 158$$

$$|(b_i'')^{(3)}(G_{23}',t) - (b_i'')^{(3)}(G_{23},t)| < (\hat{k}_{20})^{(3)}||G_{23} - G_{23}'||e^{-(\widehat{M}_{20})^{(3)}t} \quad 159$$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i'')^{(3)}(T_{21}',t)$ and$(a_i'')^{(3)}(T_{21},t)$. (T_{21}',t) And (T_{21},t) are points belonging to the interval $\left[(\hat{k}_{20})^{(3)}, (\widehat{M}_{20})^{(3)}\right]$. It is to be noted that $(a_i'')^{(3)}(T_{21},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\widehat{M}_{20})^{(3)} = 1$ then the function $(a_i'')^{(3)}(T_{21},t)$, the THIRD augmentation coefficient, would be absolutely continuous. 160

Definition of $(\widehat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$: 161

$(\widehat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}$, are positive constants

$$\frac{(a_i)^{(3)}}{(\widehat{M}_{20})^{(3)}}, \frac{(b_i)^{(3)}}{(\widehat{M}_{20})^{(3)}} < 1$$

There exists two constants There exists two constants $(\hat{P}_{20})^{(3)}$ and $(\hat{Q}_{20})^{(3)}$ which together with $(\widehat{M}_{20})^{(3)}, (\hat{k}_{20})^{(3)}, (\hat{A}_{20})^{(3)} and (\hat{B}_{20})^{(3)}$ and the constants 162
$(a_i)^{(3)}, (a_i')^{(3)}, (b_i)^{(3)}, (b_i')^{(3)}, (p_i)^{(3)}, (r_i)^{(3)}, i = 20,21,22,$ 163
satisfy the inequalities 164

$$\frac{1}{(\widehat{M}_{20})^{(3)}}[(a_i)^{(3)} + (a_i')^{(3)} + (\hat{A}_{20})^{(3)} + (\hat{P}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1 \quad 165$$

$$\frac{1}{(\widehat{M}_{20})^{(3)}}[(b_i)^{(3)} + (b_i')^{(3)} + (\hat{B}_{20})^{(3)} + (\hat{Q}_{20})^{(3)}(\hat{k}_{20})^{(3)}] < 1 \quad 166$$

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Where we suppose 168

$$(a_i)^{(4)}, (a_i')^{(4)}, (a_i'')^{(4)}, (b_i)^{(4)}, (b_i')^{(4)}, (b_i'')^{(4)} > 0, \quad i,j = 24,25,26 \quad 169$$

The functions $(a_i'')^{(4)}, (b_i'')^{(4)}$ are positive continuous increasing and bounded.

Definition of $(p_i)^{(4)}$, $(r_i)^{(4)}$:

$$(a_i^{''})^{(4)}(T_{25},t) \le (p_i)^{(4)} \le (\hat{A}_{24})^{(4)}$$

$$(b_i^{''})^{(4)}\big((G_{27}),t\big) \le (r_i)^{(4)} \le (b_i^{'})^{(4)} \le (\hat{B}_{24})^{(4)}$$

170

$$lim_{T_2\to\infty}(a_i^{''})^{(4)}(T_{25},t) = (p_i)^{(4)}$$
$$\lim_{G\to\infty}(b_i^{''})^{(4)}\big((G_{27}),t\big) = (r_i)^{(4)}$$

Definition of $(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}$:

Where $\boxed{(\hat{A}_{24})^{(4)}, (\hat{B}_{24})^{(4)}, (p_i)^{(4)}, (r_i)^{(4)}}$ are positive constants and $\boxed{i = 24,25,26}$

They satisfy Lipschitz condition: 171

$$|(a_i^{''})^{(4)}(T_{25}^{'},t) - (a_i^{''})^{(4)}(T_{25},t)| \le (\hat{k}_{24})^{(4)}|T_{25} - T_{25}^{'}|e^{-(\hat{M}_{24})^{(4)}t}$$

$$|(b_i^{''})^{(4)}((G_{27})^{'},t) - (b_i^{''})^{(4)}\big((G_{27}),t\big)| < (\hat{k}_{24})^{(4)}||(G_{27}) - (G_{27})^{'}||e^{-(\hat{M}_{24})^{(4)}t}$$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(4)}(T_{25}^{'},t)$ 172
and$(a_i^{''})^{(4)}(T_{25},t)$. $(T_{25}^{'},t)$ And (T_{25},t) are points belonging to the interval $\big[(\hat{k}_{24})^{(4)}, (\hat{M}_{24})^{(4)}\big]$. It is to be noted that $(a_i^{''})^{(4)}(T_{25},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{24})^{(4)} = 4$ then the function $(a_i^{''})^{(4)}(T_{25},t)$, the FOURTH **augmentation coefficient WOULD** be absolutely continuous.

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Definition of $(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}$: 174

$(\hat{M}_{24})176^{175(4)}, (\hat{k}_{24})^{(4)}$, are positive constants

$$\frac{(a_i)^{(4)}}{(\hat{M}_{24})^{(4)}}, \frac{(b_i)^{(4)}}{(\hat{M}_{24})^{(4)}} < 1$$

Definition of $(\hat{P}_{24})^{(4)}, (\hat{Q}_{24})^{(4)}$: 175

There exists two constants $(\hat{P}_{24})^{(4)}$ and $(\hat{Q}_{24})^{(4)}$ which together with
$(\hat{M}_{24})^{(4)}, (\hat{k}_{24})^{(4)}, (\hat{A}_{24})^{(4)} and\ (\hat{B}_{24})^{(4)}$ and the constants
$(a_i)^{(4)}, (a_i^{'})^{(4)}, (b_i)^{(4)}, (b_i^{'})^{(4)}, (p_i)^{(4)}, (r_i)^{(4)}, i = 24,25,26,$
satisfy the inequalities

$$\frac{1}{(\hat{M}_{24})^{(4)}}[(a_i)^{(4)} + (a_i^{'})^{(4)} + (\hat{A}_{24})^{(4)} + (\hat{P}_{24})^{(4)}(\hat{k}_{24})^{(4)}] < 1$$

$$\frac{1}{(\hat{M}_{24})^{(4)}}[(b_i)^{(4)} + (b_i^{'})^{(4)} + (\hat{B}_{24})^{(4)} + (\hat{Q}_{24})^{(4)}(\hat{k}_{24})^{(4)}] < 1$$

Where we suppose 176

$$(a_i)^{(5)}, (a_i^{'})^{(5)}, (a_i^{''})^{(5)}, (b_i)^{(5)}, (b_i^{'})^{(5)}, (b_i^{''})^{(5)} > 0, \quad i,j = 28,29,30$$ 177

The functions $(a_i^{''})^{(5)}, (b_i^{''})^{(5)}$ are positive continuous increasing and bounded.

Definition of $(p_i)^{(5)}$, $(r_i)^{(5)}$:

$$(a_i^{''})^{(5)}(T_{29},t) \le (p_i)^{(5)} \le (\hat{A}_{28})^{(5)}$$

$$(b_i^{''})^{(5)}\big((G_{31}),t\big) \leq \ (r_i)^{(5)} \leq (b_i^{'})^{(5)} \leq (\hat{B}_{28})^{(5)}$$

178

$$lim_{T_2\to\infty}(a_i^{''})^{(5)}(T_{29},t) = (p_i)^{(5)}$$
$$\lim_{G\to\infty}(b_i^{''})^{(5)}(G_{31},t) = \ (r_i)^{(5)}$$

Definition of $(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}$:

Where $\boxed{(\hat{A}_{28})^{(5)}, (\hat{B}_{28})^{(5)}, (p_i)^{(5)}, \ (r_i)^{(5)}}$ are positive constants and $\boxed{i = 28{,}29{,}30}$

They satisfy Lipschitz condition: 179

$$|(a_i^{''})^{(5)}(T_{29}^{'},t) - (a_i^{''})^{(5)}(T_{29},t)| \leq (\hat{k}_{28})^{(5)}|T_{29} - T_{29}^{'}|e^{-(\hat{M}_{28})^{(5)}t}$$

$$|(b_i^{''})^{(5)}((G_{31})^{'},t) - (b_i^{''})^{(5)}\big((G_{31}),t\big)| < (\hat{k}_{28})^{(5)}||(G_{31}) - (G_{31})^{'}||e^{-(\hat{M}_{28})^{(5)}t}$$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(5)}(T_{29}^{'},t)$ 180
and$(a_i^{''})^{(5)}(T_{29},t)$. $(T_{29}^{'},t)$ and (T_{29},t) are points belonging to the interval $\big[(\hat{k}_{28})^{(5)}, (\hat{M}_{28})^{(5)}\big]$. It is to be noted that $(a_i^{''})^{(5)}(T_{29},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{28})^{(5)} = 5$ then the function $(a_i^{''})^{(5)}(T_{29},t)$, theFIFTH **augmentation coefficient** attributable would be absolutely continuous.

Definition of $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$: 181

) $(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}$, are positive constants
$\frac{(a_i)^{(5)}}{(\hat{M}_{28})^{(5)}}, \frac{(b_i)^{(5)}}{(\hat{M}_{28})^{(5)}} < 1$

Definition of $(\hat{P}_{28})^{(5)}, (\hat{Q}_{28})^{(5)}$: 182

) There exists two constants $(\hat{P}_{28})^{(5)}$ and $(\hat{Q}_{28})^{(5)}$ which together with
$(\hat{M}_{28})^{(5)}, (\hat{k}_{28})^{(5)}, (\hat{A}_{28})^{(5)} and\ (\hat{B}_{28})^{(5)}$ and the constants
$(a_i)^{(5)}, (a_i^{'})^{(5)}, (b_i)^{(5)}, (b_i^{'})^{(5)}, (p_i)^{(5)}, \ (r_i)^{(5)}, i = 28{,}29{,}30,$ satisfy the inequalities

$$\frac{1}{(\hat{M}_{28})^{(5)}}[\,(a_i)^{(5)} + (a_i^{'})^{(5)} + \ (\hat{A}_{28})^{(5)} + \ (\hat{P}_{28})^{(5)}\,(\hat{k}_{28})^{(5)}] < 1$$

$$\frac{1}{(\hat{M}_{28})^{(5)}}[\ (b_i)^{(5)} + (b_i^{'})^{(5)} + \ (\hat{B}_{28})^{(5)} + \ (\hat{Q}_{28})^{(5)}\ (\hat{k}_{28})^{(5)}] < 1$$

Where we suppose 183

$(a_i)^{(6)}, (a_i^{'})^{(6)}, (a_i^{''})^{(6)}, (b_i)^{(6)}, (b_i^{'})^{(6)}, (b_i^{''})^{(6)} > 0, \quad i,j = 32{,}33{,}34$ 184
The functions $(a_i^{''})^{(6)}, (b_i^{''})^{(6)}$ are positive continuous increasing and bounded.

Definition of $(p_i)^{(6)}, \ (r_i)^{(6)}$:

$$(a_i^{''})^{(6)}(T_{33},t) \leq (p_i)^{(6)} \leq (\hat{A}_{32})^{(6)}$$

$$(b_i^{''})^{(6)}((G_{35}),t) \leq \ (r_i)^{(6)} \leq (b_i^{'})^{(6)} \leq (\hat{B}_{32})^{(6)}$$

185

$$lim_{T_2\to\infty}(a_i^{''})^{(6)}(T_{33},t) = (p_i)^{(6)}$$
$$\lim_{G\to\infty}(b_i^{''})^{(6)}\big((G_{35}),t\big) = \ (r_i)^{(6)}$$

Definition of $(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}$:

Where $\boxed{(\hat{A}_{32})^{(6)}, (\hat{B}_{32})^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}}$ are positive constants and $\boxed{i = 32,33,34}$

They satisfy Lipschitz condition: 186

$$|(a_i^{''})^{(6)}(T_{33}', t) - (a_i^{''})^{(6)}(T_{33}, t)| \leq (\hat{k}_{32})^{(6)}|T_{33} - T_{33}'|e^{-(\hat{M}_{32})^{(6)}t}$$

$$|(b_i^{''})^{(6)}((G_{35})', t) - (b_i^{''})^{(6)}\big((G_{35}), t\big)| < (\hat{k}_{32})^{(6)}||(G_{35}) - (G_{35})'||e^{-(\hat{M}_{32})^{(6)}t}$$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(6)}(T_{33}', t)$ and$(a_i^{''})^{(6)}(T_{33}, t)$. (T_{33}', t) and (T_{33}, t) are points belonging to the interval $\big[(\hat{k}_{32})^{(6)}, (\widehat{M}_{32})^{(6)}\big]$. It is to be noted that $(a_i^{''})^{(6)}(T_{33}, t)$ is uniformly continuous. In the eventuality of the fact, that if $(\widehat{M}_{32})^{(6)} = 6$ then the function $(a_i^{''})^{(6)}(T_{33}, t)$, the SIXTH **augmentation coefficient** would be absolutely continuous. 187

Definition of $(\widehat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$: 188

$(\widehat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}$, are positive constants

$\frac{(a_i)^{(6)}}{(\widehat{M}_{32})^{(6)}}$, $\frac{(b_i)^{(6)}}{(\widehat{M}_{32})^{(6)}} < 1$

Definition of $(\hat{P}_{32})^{(6)}, (\hat{Q}_{32})^{(6)}$: 189

There exists two constants $(\hat{P}_{32})^{(6)}$ and $(\hat{Q}_{32})^{(6)}$ which together with $(\widehat{M}_{32})^{(6)}, (\hat{k}_{32})^{(6)}, (\hat{A}_{32})^{(6)} and \ (\hat{B}_{32})^{(6)}$ and the constants $(a_i)^{(6)}, (a_i')^{(6)}, (b_i)^{(6)}, (b_i')^{(6)}, (p_i)^{(6)}, \ (r_i)^{(6)}, i = 32,33,34,$ satisfy the inequalities

$$\frac{1}{(\widehat{M}_{32})^{(6)}}[(a_i)^{(6)} + (a_i')^{(6)} + (\hat{A}_{32})^{(6)} + (\hat{P}_{32})^{(6)}(\hat{k}_{32})^{(6)}] < 1$$

$$\frac{1}{(\widehat{M}_{32})^{(6)}}[(b_i)^{(6)} + (b_i')^{(6)} + (\hat{B}_{32})^{(6)} + (\hat{Q}_{32})^{(6)}(\hat{k}_{32})^{(6)}] < 1$$

Where we suppose 190

$$(a_i)^{(7)}, (a_i')^{(7)}, (a_i^{''})^{(7)}, (b_i)^{(7)}, (b_i')^{(7)}, (b_i^{''})^{(7)} > 0, \quad 191$$

$i, j = 36,37,38$

The functions $(a_i^{''})^{(7)}, (b_i^{''})^{(7)}$ are positive continuous increasing and bounded.

Definition of $(p_i)^{(7)}, \ (r_i)^{(7)}$:

$$(a_i^{''})^{(7)}(T_{37}, t) \leq (p_i)^{(7)} \leq (\hat{A}_{36})^{(7)}$$

$$(b_i^{''})^{(7)}(G, t) \leq \ (r_i)^{(7)} \leq (b_i')^{(7)} \leq (\hat{B}_{36})^{(7)}$$

192

$$\lim_{T_2\to\infty} (a_i^{''})^{(7)}(T_{37},t) = (p_i)^{(7)}$$

$$\lim_{G\to\infty} (b_i^{''})^{(7)}\big((G_{39}),t\big) = (r_i)^{(7)}$$

Definition of $(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}$:

Where $\boxed{(\hat{A}_{36})^{(7)}, (\hat{B}_{36})^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}}$ are positive constants
and $\boxed{i = 36,37,38}$

They satisfy Lipschitz condition: 193

$$|(a_i^{''})^{(7)}(T_{37}^{'},t) - (a_i^{''})^{(7)}(T_{37},t)| \le (\hat{k}_{36})^{(7)}|T_{37} - T_{37}^{'}|e^{-(\hat{M}_{36})^{(7)}t}$$

$$|(b_i^{''})^{(7)}((G_{39})^{'},t) - (b_i^{''})^{(7)}\big((G_{39}),(T_{39})\big)| < (\hat{k}_{36})^{(7)}||(G_{39}) - (G_{39})^{'}||e^{-(\hat{M}_{36})^{(7)}t}$$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(7)}(T_{37}^{'},t)$ 194
and$(a_i^{''})^{(7)}(T_{37},t)$. $(T_{37}^{'},t)$ and (T_{37},t) are points belonging to the interval $\big[(\hat{k}_{36})^{(7)}, (\hat{M}_{36})^{(7)}\big]$.
It is to be noted that $(a_i^{''})^{(7)}(T_{37},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{36})^{(7)} = 7$ then the function $(a_i^{''})^{(7)}(T_{37},t)$, the **first augmentation coefficient** attributable to terrestrial organisms, would be absolutely continuous.

Definition of $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$: 195

(O) $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}$, are positive constants

$$\frac{(a_i)^{(7)}}{(\hat{M}_{36})^{(7)}}, \frac{(b_i)^{(7)}}{(\hat{M}_{36})^{(7)}} < 1$$

Definition of $(\hat{P}_{36})^{(7)}, (\hat{Q}_{36})^{(7)}$: 196

There exists two constants $(\hat{P}_{36})^{(7)}$ and $(\hat{Q}_{36})^{(7)}$ which together with $(\hat{M}_{36})^{(7)}, (\hat{k}_{36})^{(7)}, (\hat{A}_{36})^{(7)} and\ (\hat{B}_{36})^{(7)}$ and the constants $(a_i)^{(7)}, (a_i^{'})^{(7)}, (b_i)^{(7)}, (b_i^{'})^{(7)}, (p_i)^{(7)}, (r_i)^{(7)}, i = 36,37,38,$
satisfy the inequalities

$$\frac{1}{(\hat{M}_{36})^{(7)}}[(a_i)^{(7)} + (a_i')^{(7)} + (\hat{A}_{36})^{(7)} + (\hat{P}_{36})^{(7)}(\hat{k}_{36})^{(7)}] < 1$$

$$\frac{1}{(\hat{M}_{36})^{(7)}}[(b_i)^{(7)} + (b_i')^{(7)} + (\hat{B}_{36})^{(7)} + (\hat{Q}_{36})^{(7)}(\hat{k}_{36})^{(7)}] < 1$$

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Definition of $G_i(0), T_i(0)$:

$G_i(t) \leq (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)}t}$, $\boxed{G_i(0) = G_i^0 > 0}$

$T_i(t) \leq (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)}t}$, $\boxed{T_i(0) = T_i^0 > 0}$

198

Where we suppose 199

(P) $(a_i)^{(8)}, (a_i')^{(8)}, (a_i'')^{(8)}, (b_i)^{(8)}, (b_i')^{(8)}, (b_i'')^{(8)} > 0,$ 200
$i, j = 40,41,42$

(Q) The functions $(a_i'')^{(8)}, (b_i'')^{(8)}$ are positive continuous increasing and bounded.
Definition of $(p_i)^{(8)}$, $(r_i)^{(8)}$:

$$(a_i'')^{(8)}(T_{41}, t) \leq (p_i)^{(8)} \leq (\hat{A}_{40})^{(8)}$$

$$(b_i'')^{(8)}((G_{43}), t) \leq (r_i)^{(8)} \leq (b_i')^{(8)} \leq (\hat{B}_{40})^{(8)}$$

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(R) $\lim_{T_2 \to \infty} (a_i'')^{(8)}(T_{41}, t) = (p_i)^{(8)}$
$\lim_{G \to \infty} (b_i'')^{(8)}((G_{43}), t) = (r_i)^{(8)}$

Definition of $(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}$:

Where $\boxed{(\hat{A}_{40})^{(8)}, (\hat{B}_{40})^{(8)}, (p_i)^{(8)}, (r_i)^{(8)}}$ are positive constants
and $\boxed{i = 40,41,42}$

They satisfy Lipschitz condition: 202

$$|(a_i^{''})^{(8)}(T_{41}^{'},t)-(a_i^{''})^{(8)}(T_{41},t)|\leq(\hat{k}_{40})^{(8)}|T_{41}-T_{41}^{'}|e^{-(\hat{M}_{40})^{(8)}t}$$

$$|(b_i^{''})^{(8)}((G_{43})^{'},t)-(b_i^{''})^{(8)}\big((G_{43}),(T_{43})\big)|<(\hat{k}_{40})^{(8)}||(G_{43})-(G_{43})^{'}||e^{-(\hat{M}_{40})^{(8)}t}$$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(8)}(T_{41}^{'},t)$ and$(a_i^{''})^{(8)}(T_{41},t)$. $(T_{41}^{'},t)$ and (T_{41},t) are points belonging to the interval $\left[(\hat{k}_{40})^{(8)},(\hat{M}_{40})^{(8)}\right]$. It is to be noted that $(a_i^{''})^{(8)}(T_{41},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\hat{M}_{40})^{(8)}=8$ then the function $(a_i^{''})^{(8)}(T_{41},t)$, the EIGHT **augmentation coefficient** would be absolutely continuous. 203

Definition of $(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)}$: 204

(S) $(\hat{M}_{40})^{(8)},(\hat{k}_{40})^{(8)}$, are positive constants

204A

$$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}},\frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}}<1$$

==========

$$\bar{G}_{15}(t)=G_{15}^{0}+\int_0^t\left[(a_{15})^{(1)}G_{14}\big(s_{(13)}\big)-\Big((a_{15}^{'})^{(1)}+(a_{15}^{''})^{(1)}\big(T_{14}\big(s_{(13)}\big),s_{(13)}\big)\Big)G_{15}\big(s_{(13)}\big)\right]ds_{(13)}$$ 204B

By 205

$$\bar{G}_{13}(t)=G_{13}^{0}+\int_0^t\left[(a_{13})^{(1)}G_{14}\big(s_{(13)}\big)-\Big((a_{13}^{'})^{(1)}+a_{13}^{''})^{(1)}\big(T_{14}\big(s_{(13)}\big),s_{(13)}\big)\Big)G_{13}\big(s_{(13)}\big)\right]ds_{(13)}$$

$$\bar{G}_{14}(t)=G_{14}^{0}+\int_0^t\left[(a_{14})^{(1)}G_{13}\big(s_{(13)}\big)-\Big((a_{14}^{'})^{(1)}+(a_{14}^{''})^{(1)}\big(T_{14}\big(s_{(13)}\big),s_{(13)}\big)\Big)G_{14}\big(s_{(13)}\big)\right]ds_{(13)}$$ 206

$$\bar{T}_{13}(t)=T_{13}^{0}+\int_0^t\left[(b_{13})^{(1)}T_{14}\big(s_{(13)}\big)-\Big((b_{13}^{'})^{(1)}-(b_{13}^{''})^{(1)}\big(G\big(s_{(13)}\big),s_{(13)}\big)\Big)T_{13}\big(s_{(13)}\big)\right]ds_{(13)}$$ 207

$$\bar{T}_{14}(t)=T_{14}^{0}+\int_0^t\left[(b_{14})^{(1)}T_{13}\big(s_{(13)}\big)-\Big((b_{14}^{'})^{(1)}-(b_{14}^{''})^{(1)}\big(G\big(s_{(13)}\big),s_{(13)}\big)\Big)T_{14}\big(s_{(13)}\big)\right]ds_{(13)}$$ 208

$$\bar{\mathrm{T}}_{15}(\mathrm{t})=\mathrm{T}_{15}^{0}+\int_0^t\left[(b_{15})^{(1)}T_{14}\big(s_{(13)}\big)-\Big((b_{15}^{'})^{(1)}-(b_{15}^{''})^{(1)}\big(G\big(s_{(13)}\big),s_{(13)}\big)\Big)T_{15}\big(s_{(13)}\big)\right]ds_{(13)}$$ 209

Where $s_{(13)}$ is the integrand that is integrated over an interval $(0,t)$

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if the conditions IN THE FOREGOING above are fulfilled, there exists a solution satisfying the conditions

Definition of $G_i(0)\,,T_i(0)$:

$G_i(t) \leq \left(\hat{P}_{36}\right)^{(7)} e^{\left(\hat{M}_{36}\right)^{(7)} t}$, $\boxed{G_i(0) = G_i^0 > 0}$

$T_i(t) \leq \left(\hat{Q}_{36}\right)^{(7)} e^{\left(\hat{M}_{36}\right)^{(7)} t}$, $\boxed{T_i(0) = T_i^0 > 0}$

Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions G_i , $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy

$G_i(0) = G_i^0$, $T_i(0) = T_i^0$, $G_i^0 \leq \left(\hat{P}_{36}\right)^{(7)}$, $T_i^0 \leq \left(\hat{Q}_{36}\right)^{(7)}$,

$$0 \leq G_i(t) - G_i^0 \leq \left(\hat{P}_{36}\right)^{(7)} e^{\left(\hat{M}_{36}\right)^{(7)} t}$$

$$0 \leq T_i(t) - T_i^0 \leq \left(\hat{Q}_{36}\right)^{(7)} e^{\left(\hat{M}_{36}\right)^{(7)} t}$$

By

$$\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}\left(s_{(36)}\right) - \left((a'_{36})^{(7)} + a''^{(7)}_{36}\left(T_{37}\left(s_{(36)}\right), s_{(36)}\right)\right) G_{36}\left(s_{(36)}\right)\right] ds_{(36)}$$

$$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}\left(s_{(36)}\right) - \left((a'_{37})^{(7)} + (a''_{37})^{(7)}\left(T_{37}\left(s_{(36)}\right), s_{(36)}\right)\right) G_{37}\left(s_{(36)}\right)\right] ds_{(36)}$$

$$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}\left(s_{(36)}\right) - \left((a'_{38})^{(7)} + (a''_{38})^{(7)}\left(T_{37}\left(s_{(36)}\right), s_{(36)}\right)\right) G_{38}\left(s_{(36)}\right)\right] ds_{(36)}$$

$$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}\left(s_{(36)}\right) - \left((b'_{36})^{(7)} - (b''_{36})^{(7)}\left(G\left(s_{(36)}\right), s_{(36)}\right)\right) T_{36}\left(s_{(36)}\right)\right] ds_{(36)}$$

$$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}\left(s_{(36)}\right) - \left((b'_{37})^{(7)} - (b''_{37})^{(7)}\left(G\left(s_{(36)}\right), s_{(36)}\right)\right) T_{37}\left(s_{(36)}\right)\right] ds_{(36)}$$

$$\bar{\mathrm{T}}_{38}(\mathrm{t}) = \mathrm{T}_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}\left(s_{(36)}\right) - \left((b'_{38})^{(7)} - (b''_{38})^{(7)}\left(G\left(s_{(36)}\right), s_{(36)}\right)\right) T_{38}\left(s_{(36)}\right)\right] ds_{(36)}$$

Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$

211

Consider operator $\mathcal{A}^{(2)}$ defined on the space of sextuples of continuous functions G_i , T_i: $\mathbb{R}_+ \to \mathbb{R}_+$ which satisfy

$$G_i(0) = G_i^0 \text{ , } T_i(0) = T_i^0 \text{ , } G_i^0 \le (\hat{P}_{16})^{(2)} \text{ , } T_i^0 \le (\hat{Q}_{16})^{(2)}, \quad 212$$

$$0 \le G_i(t) - G_i^0 \le (\hat{P}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t} \quad 213$$

$$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{16})^{(2)} e^{(\hat{M}_{16})^{(2)} t} \quad 214$$

By 215

$$\bar{G}_{16}(t) = G_{16}^0 + \int_0^t \left[(a_{16})^{(2)} G_{17}(s_{(16)}) - \left((a_{16}')^{(2)} + a_{16}'')^{(2)} (T_{17}(s_{(16)}), s_{(16)})\right) G_{16}(s_{(16)})\right] ds_{(16)}$$

$$\bar{G}_{17}(t) = G_{17}^0 + \int_0^t \left[(a_{17})^{(2)} G_{16}(s_{(16)}) - \left((a_{17}')^{(2)} + (a_{17}'')^{(2)} (T_{17}(s_{(16)}), s_{(17)})\right) G_{17}(s_{(16)})\right] ds_{(16)} \quad 216$$

$$\bar{G}_{18}(t) = G_{18}^0 + \int_0^t \left[(a_{18})^{(2)} G_{17}(s_{(16)}) - \left((a_{18}')^{(2)} + (a_{18}'')^{(2)} (T_{17}(s_{(16)}), s_{(16)})\right) G_{18}(s_{(16)})\right] ds_{(16)} \quad 217$$

$$\bar{T}_{16}(t) = T_{16}^0 + \int_0^t \left[(b_{16})^{(2)} T_{17}(s_{(16)}) - \left((b_{16}')^{(2)} - (b_{16}'')^{(2)} (G(s_{(16)}), s_{(16)})\right) T_{16}(s_{(16)})\right] ds_{(16)} \quad 218$$

$$\bar{T}_{17}(t) = T_{17}^0 + \int_0^t \left[(b_{17})^{(2)} T_{16}(s_{(16)}) - \left((b_{17}')^{(2)} - (b_{17}'')^{(2)} (G(s_{(16)}), s_{(16)})\right) T_{17}(s_{(16)})\right] ds_{(16)} \quad 219$$

$$\bar{T}_{18}(t) = T_{18}^0 + \int_0^t \left[(b_{18})^{(2)} T_{17}(s_{(16)}) - \left((b_{18}')^{(2)} - (b_{18}'')^{(2)} (G(s_{(16)}), s_{(16)})\right) T_{18}(s_{(16)})\right] ds_{(16)} \quad 220$$

Where $s_{(16)}$ is the integrand that is integrated over an interval $(0, t)$

221

Consider operator $\mathcal{A}^{(3)}$ defined on the space of sextuples of continuous functions G_i , T_i: $\mathbb{R}_+ \to \mathbb{R}_+$ which satisfy

$$G_i(0) = G_i^0 \text{ , } T_i(0) = T_i^0 \text{ , } G_i^0 \le (\hat{P}_{20})^{(3)} \text{ , } T_i^0 \le (\hat{Q}_{20})^{(3)}, \quad 222$$

$$0 \le G_i(t) - G_i^0 \le (\hat{P}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t} \quad 223$$

$$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{20})^{(3)} e^{(\hat{M}_{20})^{(3)} t} \quad 224$$

By 225

$$\bar{G}_{20}(t) = G_{20}^0 + \int_0^t \left[(a_{20})^{(3)} G_{21}(s_{(20)}) - \left((a_{20}')^{(3)} + a_{20}'')^{(3)} (T_{21}(s_{(20)}), s_{(20)})\right) G_{20}(s_{(20)})\right] ds_{(20)}$$

$$\bar{G}_{21}(t) = G_{21}^0 + \int_0^t \left[(a_{21})^{(3)} G_{20}(s_{(20)}) - \left((a_{21}')^{(3)} + (a_{21}'')^{(3)} (T_{21}(s_{(20)}), s_{(20)})\right) G_{21}(s_{(20)})\right] ds_{(20)} \quad 226$$

$$\bar{G}_{22}(t) = G_{22}^0 + \int_0^t \left[(a_{22})^{(3)} G_{21}(s_{(20)}) - \left((a_{22}')^{(3)} + (a_{22}'')^{(3)} (T_{21}(s_{(20)}), s_{(20)})\right) G_{22}(s_{(20)})\right] ds_{(20)} \quad 227$$

$$\bar{T}_{20}(t) = T_{20}^0 + \int_0^t \left[(b_{20})^{(3)} T_{21}(s_{(20)}) - \left((b_{20}')^{(3)} - (b_{20}'')^{(3)} (G(s_{(20)}), s_{(20)})\right) T_{20}(s_{(20)})\right] ds_{(20)} \quad 228$$

$$\bar{T}_{21}(t) = T_{21}^0 + \int_0^t \left[(b_{21})^{(3)} T_{20}(s_{(20)}) - \left((b_{21}')^{(3)} - (b_{21}'')^{(3)} (G(s_{(20)}), s_{(20)})\right) T_{21}(s_{(20)})\right] ds_{(20)} \quad 229$$

$$\overline{\mathrm{T}}_{22}(\mathrm{t}) = \mathrm{T}_{22}^{0} + \int_0^t \left[(b_{22})^{(3)} T_{21}\left(s_{(20)}\right) - \left((b_{22}')^{(3)} - (b_{22}'')^{(3)}\left(G\left(s_{(20)}\right), s_{(20)}\right)\right) T_{22}\left(s_{(20)}\right)\right] ds_{(20)} \quad 230$$

Where $s_{(20)}$ is the integrand that is integrated over an interval $(0, t)$

Consider operator $\mathcal{A}^{(4)}$ defined on the space of sextuples of continuous functions G_i , $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ 231
which satisfy

$$G_i(0) = G_i^0 \text{ , } T_i(0) = T_i^0 \text{ , } G_i^0 \le (\hat{P}_{24})^{(4)} \text{ , } T_i^0 \le (\hat{Q}_{24})^{(4)}, \quad 232$$

$$0 \le G_i(t) - G_i^0 \le (\hat{P}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t} \quad 233$$

$$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{24})^{(4)} e^{(\hat{M}_{24})^{(4)} t} \quad 234$$

By 235

$$\bar{G}_{24}(t) = G_{24}^0 + \int_0^t \left[(a_{24})^{(4)} G_{25}\left(s_{(24)}\right) - \left((a_{24}')^{(4)} + a_{24}'')^{(4)}\left(T_{25}\left(s_{(24)}\right), s_{(24)}\right)\right) G_{24}\left(s_{(24)}\right)\right] ds_{(24)}$$

$$\bar{G}_{25}(t) = G_{25}^0 + \int_0^t \left[(a_{25})^{(4)} G_{24}\left(s_{(24)}\right) - \left((a_{25}')^{(4)} + (a_{25}'')^{(4)}\left(T_{25}\left(s_{(24)}\right), s_{(24)}\right)\right) G_{25}\left(s_{(24)}\right)\right] ds_{(24)} \quad 236$$

$$\bar{G}_{26}(t) = G_{26}^0 + \int_0^t \left[(a_{26})^{(4)} G_{25}\left(s_{(24)}\right) - \left((a_{26}')^{(4)} + (a_{26}'')^{(4)}\left(T_{25}\left(s_{(24)}\right), s_{(24)}\right)\right) G_{26}\left(s_{(24)}\right)\right] ds_{(24)} \quad 237$$

$$\bar{T}_{24}(t) = T_{24}^0 + \int_0^t \left[(b_{24})^{(4)} T_{25}\left(s_{(24)}\right) - \left((b_{24}')^{(4)} - (b_{24}'')^{(4)}\left(G\left(s_{(24)}\right), s_{(24)}\right)\right) T_{24}\left(s_{(24)}\right)\right] ds_{(24)} \quad 238$$

$$\bar{T}_{25}(t) = T_{25}^0 + \int_0^t \left[(b_{25})^{(4)} T_{24}\left(s_{(24)}\right) - \left((b_{25}')^{(4)} - (b_{25}'')^{(4)}\left(G\left(s_{(24)}\right), s_{(24)}\right)\right) T_{25}\left(s_{(24)}\right)\right] ds_{(24)} \quad 239$$

$$\overline{\mathrm{T}}_{26}(\mathrm{t}) = \mathrm{T}_{26}^{0} + \int_0^t \left[(b_{26})^{(4)} T_{25}\left(s_{(24)}\right) - \left((b_{26}')^{(4)} - (b_{26}'')^{(4)}\left(G\left(s_{(24)}\right), s_{(24)}\right)\right) T_{26}\left(s_{(24)}\right)\right] ds_{(24)} \quad 240$$

Where $s_{(24)}$ is the integrand that is integrated over an interval $(0, t)$

Consider operator $\mathcal{A}^{(5)}$ defined on the space of sextuples of continuous functions G_i , $T_i: \mathbb{R}_+ \to \mathbb{R}_+$ 241
which satisfy

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$$G_i(0) = G_i^0 \text{ , } T_i(0) = T_i^0 \text{ , } G_i^0 \le (\hat{P}_{28})^{(5)} \text{ , } T_i^0 \le (\hat{Q}_{28})^{(5)}, \quad 243$$

$$0 \le G_i(t) - G_i^0 \le (\hat{P}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t} \quad 244$$

$$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{28})^{(5)} e^{(\hat{M}_{28})^{(5)} t} \quad 245$$

By 246

$$\bar{G}_{28}(t) = G_{28}^0 + \int_0^t \left[(a_{28})^{(5)} G_{29}\left(s_{(28)}\right) - \left((a_{28}')^{(5)} + a_{28}'')^{(5)}\left(T_{29}\left(s_{(28)}\right), s_{(28)}\right)\right) G_{28}\left(s_{(28)}\right)\right] ds_{(28)}$$

$$\bar{G}_{29}(t) = G_{29}^0 + \int_0^t \left[(a_{29})^{(5)} G_{28}\left(s_{(28)}\right) - \left((a_{29}')^{(5)} + (a_{29}'')^{(5)}\left(T_{29}\left(s_{(28)}\right), s_{(28)}\right)\right) G_{29}\left(s_{(28)}\right)\right] ds_{(28)} \quad 247$$

$$\bar{G}_{30}(t) = G_{30}^0 + \int_0^t \left[(a_{30})^{(5)} G_{29}\left(s_{(28)}\right) - \left((a_{30}')^{(5)} + (a_{30}'')^{(5)}\left(T_{29}\left(s_{(28)}\right), s_{(28)}\right)\right) G_{30}\left(s_{(28)}\right)\right] ds_{(28)} \quad 248$$

$$\bar{T}_{28}(t) = T_{28}^0 + \int_0^t \left[(b_{28})^{(5)} T_{29}\left(s_{(28)}\right) - \left((b_{28}')^{(5)} - (b_{28}'')^{(5)}\left(G\left(s_{(28)}\right), s_{(28)}\right)\right) T_{28}\left(s_{(28)}\right)\right] ds_{(28)} \quad 249$$

$$\bar{T}_{29}(t) = T_{29}^0 + \int_0^t \left[(b_{29})^{(5)} T_{28}\left(s_{(28)}\right) - \left((b_{29}')^{(5)} - (b_{29}'')^{(5)}\left(G\left(s_{(28)}\right), s_{(28)}\right)\right) T_{29}\left(s_{(28)}\right)\right] ds_{(28)} \quad 250$$

$$\overline{\mathrm{T}}_{30}(\mathrm{t}) = \mathrm{T}_{30}^{0} + \int_0^t \left[(b_{30})^{(5)} T_{29}(s_{(28)}) - \left((b_{30}')^{(5)} - (b_{30}'')^{(5)}(G(s_{(28)}), s_{(28)})\right) T_{30}(s_{(28)})\right] ds_{(28)} \quad 251$$

Where $s_{(28)}$ is the integrand that is integrated over an interval $(0, t)$

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Consider operator $\mathcal{A}^{(6)}$ defined on the space of sextuples of continuous functions G_i , $T_i : \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy

$$G_i(0) = G_i^0 \text{ , } T_i(0) = T_i^0 \text{ , } G_i^0 \le (\hat{P}_{32})^{(6)} \text{ , } T_i^0 \le (\hat{Q}_{32})^{(6)}, \quad 253$$

$$0 \le G_i(t) - G_i^0 \le (\hat{P}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t} \quad 254$$

$$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{32})^{(6)} e^{(\hat{M}_{32})^{(6)} t} \quad 255$$

By 256

$$\bar{G}_{32}(t) = G_{32}^0 + \int_0^t \left[(a_{32})^{(6)} G_{33}(s_{(32)}) - \left((a_{32}')^{(6)} + a_{32}'')^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{32}(s_{(32)})\right] ds_{(32)}$$

$$\bar{G}_{33}(t) = G_{33}^0 + \int_0^t \left[(a_{33})^{(6)} G_{32}(s_{(32)}) - \left((a_{33}')^{(6)} + (a_{33}'')^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{33}(s_{(32)})\right] ds_{(32)} \quad 257$$

$$\bar{G}_{34}(t) = G_{34}^0 + \int_0^t \left[(a_{34})^{(6)} G_{33}(s_{(32)}) - \left((a_{34}')^{(6)} + (a_{34}'')^{(6)}(T_{33}(s_{(32)}), s_{(32)})\right) G_{34}(s_{(32)})\right] ds_{(32)} \quad 258$$

$$\bar{T}_{32}(t) = T_{32}^0 + \int_0^t \left[(b_{32})^{(6)} T_{33}(s_{(32)}) - \left((b_{32}')^{(6)} - (b_{32}'')^{(6)}(G(s_{(32)}), s_{(32)})\right) T_{32}(s_{(32)})\right] ds_{(32)} \quad 259$$

$$\bar{T}_{33}(t) = T_{33}^0 + \int_0^t \left[(b_{33})^{(6)} T_{32}(s_{(32)}) - \left((b_{33}')^{(6)} - (b_{33}'')^{(6)}(G(s_{(32)}), s_{(32)})\right) T_{33}(s_{(32)})\right] ds_{(32)} \quad 260$$

$$\overline{\mathrm{T}}_{34}(\mathrm{t}) = \mathrm{T}_{34}^{0} + \int_0^t \left[(b_{34})^{(6)} T_{33}(s_{(32)}) - \left((b_{34}')^{(6)} - (b_{34}'')^{(6)}(G(s_{(32)}), s_{(32)})\right) T_{34}(s_{(32)})\right] ds_{(32)} \quad 261$$

Where $s_{(32)}$ is the integrand that is integrated over an interval $(0, t)$

: if the conditions IN THE FOREGOING are fulfilled, there exists a solution satisfying the conditions 262

Definition of $G_i(0)$, $T_i(0)$:

$$G_i(t) \le \left(\hat{P}_{36}\right)^{(7)} e^{(\hat{M}_{36})^{(7)} t} \quad , \quad \boxed{G_i(0) = G_i^0 > 0}$$

$$T_i(t) \le (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t} \quad , \quad \boxed{T_i(0) = T_i^0 > 0}$$

Proof:

Consider operator $\mathcal{A}^{(7)}$ defined on the space of sextuples of continuous functions G_i , $T_i : \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy

$$G_i(0) = G_i^0 \text{ , } T_i(0) = T_i^0 \text{ , } G_i^0 \le (\hat{P}_{36})^{(7)} \text{ , } T_i^0 \le (\hat{Q}_{36})^{(7)}, \quad 263$$

$$0 \le G_i(t) - G_i^0 \le (\hat{P}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t} \quad 264$$

$$0 \le T_i(t) - T_i^0 \le (\hat{Q}_{36})^{(7)} e^{(\hat{M}_{36})^{(7)} t} \quad 265$$

By 266

$$\bar{G}_{36}(t) = G_{36}^0 + \int_0^t \left[(a_{36})^{(7)} G_{37}(s_{(36)}) - \left((a'_{36})^{(7)} + a''_{36})^{(7)} (T_{37}(s_{(36)}), s_{(36)})\right) G_{36}(s_{(36)})\right] ds_{(36)} \quad 267$$

$$\bar{G}_{37}(t) = G_{37}^0 + \int_0^t \left[(a_{37})^{(7)} G_{36}(s_{(36)}) - \left((a'_{37})^{(7)} + (a''_{37})^{(7)} (T_{37}(s_{(36)}), s_{(36)})\right) G_{37}(s_{(36)})\right] ds_{(36)}$$

$$\bar{G}_{38}(t) = G_{38}^0 + \int_0^t \left[(a_{38})^{(7)} G_{37}(s_{(36)}) - \left((a'_{38})^{(7)} + (a''_{38})^{(7)} (T_{37}(s_{(36)}), s_{(36)})\right) G_{38}(s_{(36)})\right] ds_{(36)} \quad 268$$

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$$\bar{T}_{36}(t) = T_{36}^0 + \int_0^t \left[(b_{36})^{(7)} T_{37}(s_{(36)}) - \left((b'_{36})^{(7)} - (b''_{36})^{(7)} (G(s_{(36)}), s_{(36)})\right) T_{36}(s_{(36)})\right] ds_{(36)}$$

$$\bar{T}_{37}(t) = T_{37}^0 + \int_0^t \left[(b_{37})^{(7)} T_{36}(s_{(36)}) - \left((b'_{37})^{(7)} - (b''_{37})^{(7)} (G(s_{(36)}), s_{(36)})\right) T_{37}(s_{(36)})\right] ds_{(36)} \quad 270$$

$$\bar{\mathrm{T}}_{38}(\mathrm{t}) = \mathrm{T}_{38}^0 + \int_0^t \left[(b_{38})^{(7)} T_{37}(s_{(36)}) - \left((b'_{38})^{(7)} - (b''_{38})^{(7)} (G(s_{(36)}), s_{(36)})\right) T_{38}(s_{(36)})\right] ds_{(36)} \quad 271$$

Where $s_{(36)}$ is the integrand that is integrated over an interval $(0, t)$

if the conditions above are fulfilled, there exists a solution satisfying the conditions 272

Definition of $G_i(0)\,, T_i(0)$:

$$G_i(t) \le \left(\hat{P}_{40}\right)^{(8)} e^{(\hat{M}_{40})^{(8)}t} \quad , \quad \boxed{G_i(0) = G_i^0 > 0}$$

$$T_i(t) \le \left(\hat{Q}_{40}\right)^{(8)} e^{(\hat{M}_{40})^{(8)}t} \quad , \quad \boxed{T_i(0) = T_i^0 > 0}$$

Proof:

Consider operator $\mathcal{A}^{(8)}$ defined on the space of sextuples of continuous functions $G_i\,,\ T_i\colon \mathbb{R}_+ \to \mathbb{R}_+$ which satisfy

$$G_i(0) = G_i^0\,,\ T_i(0) = T_i^0\,,\ G_i^0 \le \left(\hat{P}_{40}\right)^{(8)}, T_i^0 \le \left(\hat{Q}_{40}\right)^{(8)}, \tag{273}$$

$$0 \le G_i(t) - G_i^0 \le \left(\hat{P}_{40}\right)^{(8)} e^{(\hat{M}_{40})^{(8)}t} \tag{274}$$

$$0 \le T_i(t) - T_i^0 \le \left(\hat{Q}_{40}\right)^{(8)} e^{(\hat{M}_{40})^{(8)}t} \tag{275}$$

By (276)

$$\bar{G}_{40}(t) = G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} G_{41}\left(s_{(40)}\right) - \left((a'_{40})^{(8)} + a''^{(8)}_{40}\left(T_{41}\left(s_{(40)}\right), s_{(40)}\right)\right) G_{40}\left(s_{(40)}\right)\right] ds_{(40)} \tag{277}$$

$$\bar{G}_{41}(t) = G_{41}^0 + \int_0^t \left[(a_{41})^{(8)} G_{40}\left(s_{(40)}\right) - \left((a'_{41})^{(8)} + (a''_{41})^{(8)}\left(T_{41}\left(s_{(40)}\right), s_{(40)}\right)\right) G_{41}\left(s_{(40)}\right)\right] ds_{(40)}$$

$$\bar{G}_{42}(t) = G_{42}^0 + \int_0^t \left[(a_{42})^{(8)} G_{41}\left(s_{(40)}\right) - \left((a'_{42})^{(8)} + (a''_{42})^{(8)}\left(T_{41}\left(s_{(40)}\right), s_{(40)}\right)\right) G_{42}\left(s_{(40)}\right)\right] ds_{(40)} \tag{278}$$

(279)

$$\bar{T}_{40}(t) = T_{40}^0 + \int_0^t \left[(b_{40})^{(8)} T_{41}\left(s_{(40)}\right) - \left((b'_{40})^{(8)} - (b''_{40})^{(8)}\left(G\left(s_{(40)}\right), s_{(40)}\right)\right) T_{40}\left(s_{(40)}\right)\right] ds_{(40)}$$

$$\bar{T}_{41}(t) = T_{41}^0 + \tag{280}$$

$$\int_0^t \left[(b_{41})^{(8)} T_{40}(s_{(40)}) - \left((b'_{41})^{(8)} - (b''_{41})^{(8)}\left(G(s_{(40)}), s_{(40)}\right)\right) T_{41}(s_{(40)})\right] ds_{(40)}$$

$$\overline{\mathrm{T}}_{42}(\mathrm{t}) = \mathrm{T}_{42}^0 + \qquad 281$$

$$\int_0^t \left[(b_{42})^{(8)} T_{41}(s_{(40)}) - \left((b'_{42})^{(8)} - (b''_{42})^{(8)}\left(G(s_{(40)}), s_{(40)}\right)\right) T_{42}(s_{(40)})\right] ds_{(40)} \qquad 282$$

Where $s_{(40)}$ is the integrand that is integrated over an interval $(0, t)$

The operator $\mathcal{A}^{(8)}$ maps the space of functions satisfying global equations into itself .Indeed it is obvious that 283

$$G_{40}(t) \le G_{40}^0 + \int_0^t \left[(a_{40})^{(8)} \left(G_{41}^0 + (\hat{P}_{40})^{(8)} e^{(\hat{M}_{40})^{(8)} s_{(40)}}\right)\right] ds_{(40)} =$$

$$\left(1 + (a_{40})^{(8)} t\right) G_{41}^0 + \frac{(a_{40})^{(8)} (\hat{P}_{40})^{(8)}}{(\hat{M}_{40})^{(8)}} \left(e^{(\hat{M}_{40})^{(8)} t} - 1\right) \qquad 284$$

From which it follows that

$$(G_{40}(t) - G_{40}^0) e^{-(\hat{M}_{40})^{(8)} t} \le \frac{(a_{40})^{(8)}}{(\hat{M}_{40})^{(8)}} \left[\left((\hat{P}_{40})^{(8)} + G_{41}^0\right) e^{\left(-\frac{(\hat{P}_{40})^{(8)} + G_{41}^0}{G_{41}^0}\right)} + (\hat{P}_{40})^{(8)}\right]$$

(G_i^0) is as defined in the statement of theorem 1

In order that the operator $\mathcal{A}^{(1)}$ transforms the space of sextuples of functions G_i , T_i satisfying GLOBAL EQUATIONS into itself 285

The operator $\mathcal{A}^{(1)}$ is a contraction with respect to the metric 286

$$d\left(\left(G^{(1)}, T^{(1)}\right), \left(G^{(2)}, T^{(2)}\right)\right) =$$

$$\sup_i \{\max_{t \in \mathbb{R}_+} \left|G_i^{(1)}(t) - G_i^{(2)}(t)\right| e^{-(\hat{M}_{13})^{(1)} t}, \max_{t \in \mathbb{R}_+} \left|T_i^{(1)}(t) - T_i^{(2)}(t)\right| e^{-(\hat{M}_{13})^{(1)} t}\}$$

Indeed if we denote 287

Definition of $\tilde{G}, \tilde{T}$:

$$\left(\tilde{G}, \tilde{T}\right) = \mathcal{A}^{(1)}(G, T)$$

It results

$$\left|\tilde{G}_{13}^{(1)} - \tilde{G}_i^{(2)}\right| \le \int_0^t (a_{13})^{(1)} \left|G_{14}^{(1)} - G_{14}^{(2)}\right| e^{-(\hat{M}_{13})^{(1)} s_{(13)}} e^{(\hat{M}_{13})^{(1)} s_{(13)}} ds_{(13)} +$$

$\int_0^t\{(a_{13}^{'})^{(1)}\left|G_{13}^{(1)}-G_{13}^{(2)}\right|e^{-(\widehat{M}_{13})^{(1)}s_{(13)}}e^{-(\widehat{M}_{13})^{(1)}s_{(13)}}+$

$(a_{13}^{''})^{(1)}\left(T_{14}^{(1)},s_{(13)}\right)\left|G_{13}^{(1)}-G_{13}^{(2)}\right|e^{-(\widehat{M}_{13})^{(1)}s_{(13)}}e^{(\widehat{M}_{13})^{(1)}s_{(13)}}+$

$G_{13}^{(2)}|(a_{13}^{''})^{(1)}\left(T_{14}^{(1)},s_{(13)}\right)-(a_{13}^{''})^{(1)}\left(T_{14}^{(2)},s_{(13)}\right)|\ e^{-(\widehat{M}_{13})^{(1)}s_{(13)}}e^{(\widehat{M}_{13})^{(1)}s_{(13)}}\}ds_{(13)}$

Where $s_{(13)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$

From the hypotheses it follows

$\left|G^{(1)}-G^{(2)}\right|e^{-(\widehat{M}_{13})^{(1)}t}\leq$ 288
$\frac{1}{(\widehat{M}_{13})^{(1)}}\left((a_{13})^{(1)}+(a_{13}^{'})^{(1)}+(\widehat{A}_{13})^{(1)}+(\widehat{P}_{13})^{(1)}(\widehat{k}_{13})^{(1)}\right)d\left(\left(G^{(1)},T^{(1)};\ G^{(2)},T^{(2)}\right)\right)$

And analogous inequalities for $G_i\ and\ T_i$. Taking into account the hypothesis the result follows

Remark 1: The fact that we supposed $(a_{13}^{''})^{(1)}$ and $(b_{13}^{''})^{(1)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{13})^{(1)}e^{(\widehat{M}_{13})^{(1)}t}\ and\ (\widehat{Q}_{13})^{(1)}e^{(\widehat{M}_{13})^{(1)}t}$ respectively of $\mathbb{R}_+$. 289

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i^{''})^{(1)}$ and $(b_i^{''})^{(1)}, i=13{,}14{,}15$ depend only on T_{14} and respectively on $G(and\ not\ on\ t)$ and hypothesis can replaced by a usual Lipschitz condition.

Remark 2: There does not exist any t where $G_i\ (t)=0\ and\ T_i\ (t)=0$ 290

From 19 to 24 it results

$G_i\ (t)\geq G_i^0e^{\left[-\int_0^t\{(a_i^{'})^{(1)}-(a_i^{''})^{(1)}(T_{14}(s_{(13)}),s_{(13)})\}ds_{(13)}\right]}\geq 0$ 291

$T_i\ (t)\geq T_i^0e^{\left(-(b_i^{'})^{(1)}t\right)}>0\quad \text{for t} > 0$

Definition of $\left((\widehat{M}_{13})^{(1)}\right)_1, and\ \left((\widehat{M}_{13})^{(1)}\right)_3$: 292

Remark 3: if G_{13} is bounded, the same property have also $G_{14}\ and\ G_{15}$. indeed if

$G_{13}<(\widehat{M}_{13})^{(1)}$ it follows $\frac{dG_{14}}{dt}\leq\left((\widehat{M}_{13})^{(1)}\right)_1-(a_{14}^{'})^{(1)}G_{14}$ and by integrating

$G_{14}\leq\left((\widehat{M}_{13})^{(1)}\right)_2=G_{14}^0+2(a_{14})^{(1)}\left((\widehat{M}_{13})^{(1)}\right)_1/(a_{14}^{'})^{(1)}$

In the same way , one can obtain

$G_{15}\leq\left((\widehat{M}_{13})^{(1)}\right)_3=G_{15}^0+2(a_{15})^{(1)}\left((\widehat{M}_{13})^{(1)}\right)_2/(a_{15}^{'})^{(1)}$

If $G_{14}\ or\ G_{15}$ is bounded, the same property follows for G_{13} , G_{15} and G_{13} , G_{14} respectively.

Remark 4: If $G_{13}\ is$ bounded, from below, the same property holds for $G_{14}\ and\ G_{15}$. The proof is analogous with the preceding one. An analogous property is true if G_{14} is bounded from below. 293

Remark 5: If T_{13} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(1)}\ (G(t),t))=(b_{14}^{'})^{(1)}$ then $T_{14}\ \to\infty$. 294

Definition of $(m)^{(1)}$ and ε_1 :

Indeed let t_1 be so that for $t\ >t_1$

$(b_{14})^{(1)}-(b_i^{''})^{(1)}(G(t),t)<\varepsilon_1, T_{13}\ (t)>(m)^{(1)}$

Then $\frac{dT_{14}}{dt} \geq (a_{14})^{(1)}(m)^{(1)} - \varepsilon_1 T_{14}$ which leads to 295

$T_{14} \geq \left(\frac{(a_{14})^{(1)}(m)^{(1)}}{\varepsilon_1}\right)(1 - e^{-\varepsilon_1 t}) + T_{14}^0 e^{-\varepsilon_1 t}$ If we take t such that $e^{-\varepsilon_1 t} = \frac{1}{2}$ it results

$T_{14} \geq \left(\frac{(a_{14})^{(1)}(m)^{(1)}}{2}\right), \quad t = log\frac{2}{\varepsilon_1}$ By taking now ε_1 sufficiently small one sees that T_{14} is unbounded. The same property holds for T_{15} if $\lim_{t\to\infty}(b_{15}^{''})^{(1)}(G(t), t) = (b_{15}^{'})^{(1)}$

We now state a more precise theorem about the behaviors at infinity of the solutions

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It is now sufficient to take $\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}}, \frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}} < 1$ and to choose 297

$(\hat{P}_{16})^{(2)}$ and $(\hat{Q}_{16})^{(2)}$ large to have

$$\frac{(a_i)^{(2)}}{(\hat{M}_{16})^{(2)}}\left[(\hat{P}_{16})^{(2)} + \left((\hat{P}_{16})^{(2)} + G_j^0\right)e^{-\left(\frac{(\hat{P}_{16})^{(2)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{16})^{(2)} \quad 298$$

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$$\frac{(b_i)^{(2)}}{(\hat{M}_{16})^{(2)}}\left[\left((\hat{Q}_{16})^{(2)} + T_j^0\right)e^{-\left(\frac{(\hat{Q}_{16})^{(2)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{16})^{(2)}\right] \leq (\hat{Q}_{16})^{(2)}$$

In order that the operator $\mathcal{A}^{(2)}$ transforms the space of sextuples of functions G_i, T_i satisfying 300

The operator $\mathcal{A}^{(2)}$ is a contraction with respect to the metric 301

$$d\left(((G_{19})^{(1)}, (T_{19})^{(1)}), ((G_{19})^{(2)}, (T_{19})^{(2)})\right) =$$

$$\sup_i\{\max_{t\in\mathbb{R}_+}\left|G_i^{(1)}(t) - G_i^{(2)}(t)\right|e^{-(\hat{M}_{16})^{(2)}t}, \max_{t\in\mathbb{R}_+}\left|T_i^{(1)}(t) - T_i^{(2)}(t)\right|e^{-(\hat{M}_{16})^{(2)}t}\}$$

Indeed if we denote 302

Definition of $\widetilde{G_{19}}, \widetilde{T_{19}}$: $(\widetilde{G_{19}}, \widetilde{T_{19}}) = \mathcal{A}^{(2)}(G_{19}, T_{19})$

It results 303

$$\left|\tilde{G}_{16}^{(1)} - \tilde{G}_i^{(2)}\right| \leq \int_0^t (a_{16})^{(2)}\left|G_{17}^{(1)} - G_{17}^{(2)}\right|e^{-(\widehat{M}_{16})^{(2)}s_{(16)}}e^{(\widehat{M}_{16})^{(2)}s_{(16)}}\,ds_{(16)} +$$

$$\int_0^t\{(a_{16}^{'})^{(2)}\left|G_{16}^{(1)} - G_{16}^{(2)}\right|e^{-(\widehat{M}_{16})^{(2)}s_{(16)}}e^{-(\widehat{M}_{16})^{(2)}s_{(16)}} +$$

$$(a_{16}^{''})^{(2)}\left(T_{17}^{(1)}, s_{(16)}\right)\left|G_{16}^{(1)} - G_{16}^{(2)}\right|e^{-(\widehat{M}_{16})^{(2)}s_{(16)}}e^{(\widehat{M}_{16})^{(2)}s_{(16)}} +$$

$$G_{16}^{(2)}\left|(a_{16}^{''})^{(2)}\left(T_{17}^{(1)}, s_{(16)}\right) - (a_{16}^{''})^{(2)}\left(T_{17}^{(2)}, s_{(16)}\right)\right|\ e^{-(\widehat{M}_{16})^{(2)}s_{(16)}}e^{(\widehat{M}_{16})^{(2)}s_{(16)}}\}ds_{(16)}$$

Where $s_{(16)}$ represents integrand that is integrated over the interval $[0, t]$ 304

From the hypotheses it follows

$$\left|(G_{19})^{(1)} - (G_{19})^{(2)}\right|e^{-(\widehat{M}_{16})^{(2)}t} \leq \quad 305$$
$$\frac{1}{(\widehat{M}_{16})^{(2)}}\left((a_{16})^{(2)} + (a_{16}^{'})^{(2)} + (\widehat{A}_{16})^{(2)} +\right.$$

$(\widehat{\mathrm{P}}_{16})^{(2)}(\widehat{k}_{16})^{(2)}\mathrm{d}\left(((G_{19})^{(1)},(T_{19})^{(1)};\ (G_{19})^{(2)},(T_{19})^{(2)})\right)$

And analogous inequalities for G_i and T_i. Taking into account the hypothesis the result follows 306

Remark 1: The fact that we supposed $(a_{16}^{''})^{(2)}$ and $(b_{16}^{''})^{(2)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{\mathrm{P}}_{16})^{(2)}\mathrm{e}^{(\widehat{\mathrm{M}}_{16})^{(2)}\mathrm{t}}$ and $(\widehat{\mathrm{Q}}_{16})^{(2)}\mathrm{e}^{(\widehat{\mathrm{M}}_{16})^{(2)}\mathrm{t}}$ respectively of $\mathbb{R}_+$. 307

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i^{''})^{(2)}$ and $(b_i^{''})^{(2)}, i = 16{,}17{,}18$ depend only on T_{17} and respectively on (G_{19})(and not on t) and hypothesis can replaced by a usual Lipschitz condition.

Remark 2: There does not exist any t where $\mathrm{G}_i(\mathrm{t}) = 0$ and $\mathrm{T}_i(\mathrm{t}) = 0$ 308

From 19 to 24 it results

$\mathrm{G}_i(\mathrm{t}) \geq \mathrm{G}_i^0\mathrm{e}^{\left[-\int_0^{\mathrm{t}}\{(a_i^{'})^{(2)}-(a_i^{''})^{(2)}(\mathrm{T}_{17}(s_{(16)}),s_{(16)})\}\mathrm{d}s_{(16)}\right]} \geq 0$

$\mathrm{T}_i(\mathrm{t}) \geq \mathrm{T}_i^0\mathrm{e}^{(-(b_i^{'})^{(2)}\mathrm{t})} > 0 \quad \text{for } \mathrm{t} > 0$

Definition of $\left((\widehat{\mathrm{M}}_{16})^{(2)}\right)_1$, $\left((\widehat{\mathrm{M}}_{16})^{(2)}\right)_2$ and $\left((\widehat{\mathrm{M}}_{16})^{(2)}\right)_3$: 309

Remark 3: if G_{16} is bounded, the same property have also G_{17} and G_{18} . indeed if

$\mathrm{G}_{16} < (\widehat{\mathrm{M}}_{16})^{(2)}$ it follows $\frac{\mathrm{dG}_{17}}{\mathrm{dt}} \leq \left((\widehat{\mathrm{M}}_{16})^{(2)}\right)_1 - (a_{17}^{'})^{(2)}\mathrm{G}_{17}$ and by integrating

$\mathrm{G}_{17} \leq \left((\widehat{\mathrm{M}}_{16})^{(2)}\right)_2 = \mathrm{G}_{17}^0 + 2(a_{17})^{(2)}\left((\widehat{\mathrm{M}}_{16})^{(2)}\right)_1/(a_{17}^{'})^{(2)}$

In the same way , one can obtain

$\mathrm{G}_{18} \leq \left((\widehat{\mathrm{M}}_{16})^{(2)}\right)_3 = \mathrm{G}_{18}^0 + 2(a_{18})^{(2)}\left((\widehat{\mathrm{M}}_{16})^{(2)}\right)_2/(a_{18}^{'})^{(2)}$ 310

If G_{17} or G_{18} is bounded, the same property follows for G_{16} , G_{18} and G_{16} , G_{17} respectively.

Remark 4: If G_{16} is bounded, from below, the same property holds for G_{17} and G_{18} . The proof is analogous with the preceding one. An analogous property is true if G_{17} is bounded from below. 311

Remark 5: If T_{16} is bounded from below and $\lim_{\mathrm{t}\to\infty}((b_i^{''})^{(2)}((G_{19})(\mathrm{t}),\mathrm{t})) = (b_{17}^{'})^{(2)}$ then $\mathrm{T}_{17} \to \infty$. 312

Definition of $(m)^{(2)}$ and ε_2 :

Indeed let t_2 be so that for $\mathrm{t} > \mathrm{t}_2$

$(b_{17})^{(2)} - (b_i^{''})^{(2)}((G_{19})(\mathrm{t}),\mathrm{t}) < \varepsilon_2, \mathrm{T}_{16}(\mathrm{t}) > (m)^{(2)}$

Then $\frac{\mathrm{dT}_{17}}{\mathrm{dt}} \geq (a_{17})^{(2)}(m)^{(2)} - \varepsilon_2\mathrm{T}_{17}$ which leads to 313

$\mathrm{T}_{17} \geq \left(\frac{(a_{17})^{(2)}(m)^{(2)}}{\varepsilon_2}\right)(1-\mathrm{e}^{-\varepsilon_2\mathrm{t}}) + \mathrm{T}_{17}^0\mathrm{e}^{-\varepsilon_2\mathrm{t}}$ If we take t such that $\mathrm{e}^{-\varepsilon_2\mathrm{t}} = \frac{1}{2}$ it results

$\mathrm{T}_{17} \geq \left(\frac{(a_{17})^{(2)}(m)^{(2)}}{2}\right), \quad t = \log\frac{2}{\varepsilon_2}$ By taking now ε_2 sufficiently small one sees that T_{17} is unbounded. The same property holds for T_{18} if $\lim_{t\to\infty}(b_{18}^{''})^{(2)}\left((G_{19})(\mathrm{t}),\mathrm{t}\right) = (b_{18}^{'})^{(2)}$ 314

We now state a more precise theorem about the behaviors at infinity of the solutions

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It is now sufficient to take $\frac{(a_i)^{(3)}}{(\widehat{M}_{20})^{(3)}}$, $\frac{(b_i)^{(3)}}{(\widehat{M}_{20})^{(3)}} < 1$ and to choose 316

$(\widehat{P}_{20})^{(3)}$ and $(\widehat{Q}_{20})^{(3)}$ large to have

$$\frac{(a_i)^{(3)}}{(\widehat{M}_{20})^{(3)}}\left[(\widehat{P}_{20})^{(3)} + \left((\widehat{P}_{20})^{(3)} + G_j^0\right)e^{-\left(\frac{(\widehat{P}_{20})^{(3)}+G_j^0}{G_j^0}\right)}\right] \leq (\widehat{P}_{20})^{(3)} \quad 317$$

$$\frac{(b_i)^{(3)}}{(\widehat{M}_{20})^{(3)}}\left[\left((\widehat{Q}_{20})^{(3)} + T_j^0\right)e^{-\left(\frac{(\widehat{Q}_{20})^{(3)}+T_j^0}{T_j^0}\right)} + (\widehat{Q}_{20})^{(3)}\right] \leq (\widehat{Q}_{20})^{(3)} \quad 318$$

In order that the operator $\mathcal{A}^{(3)}$ transforms the space of sextuples of functions G_i , T_i into itself 319

The operator $\mathcal{A}^{(3)}$ is a contraction with respect to the metric 320

$$d\left(((G_{23})^{(1)}, (T_{23})^{(1)}), ((G_{23})^{(2)}, (T_{23})^{(2)})\right) =$$

$$\sup_i\{\max_{t\in\mathbb{R}_+}\left|G_i^{(1)}(t) - G_i^{(2)}(t)\right|e^{-(\widehat{M}_{20})^{(3)}t}, \max_{t\in\mathbb{R}_+}\left|T_i^{(1)}(t) - T_i^{(2)}(t)\right|e^{-(\widehat{M}_{20})^{(3)}t}\}$$

Indeed if we denote 321

Definition of $\widetilde{G_{23}}, \widetilde{T_{23}}$:$\left(\widetilde{(G_{23})}, \widetilde{(T_{23})}\right) = \mathcal{A}^{(3)}((G_{23}), (T_{23}))$

It results 322

$$\left|\tilde{G}_{20}^{(1)} - \tilde{G}_i^{(2)}\right| \leq \int_0^t (a_{20})^{(3)}\left|G_{21}^{(1)} - G_{21}^{(2)}\right|e^{-(\widehat{M}_{20})^{(3)}s_{(20)}}e^{(\widehat{M}_{20})^{(3)}s_{(20)}}\,ds_{(20)} +$$

$$\int_0^t\{(a_{20}^{'})^{(3)}\left|G_{20}^{(1)} - G_{20}^{(2)}\right|e^{-(\widehat{M}_{20})^{(3)}s_{(20)}}e^{-(\widehat{M}_{20})^{(3)}s_{(20)}} + \quad 323$$

$$(a_{20}^{''})^{(3)}\left(T_{21}^{(1)}, s_{(20)}\right)\left|G_{20}^{(1)} - G_{20}^{(2)}\right|e^{-(\widehat{M}_{20})^{(3)}s_{(20)}}e^{(\widehat{M}_{20})^{(3)}s_{(20)}} +$$

$$G_{20}^{(2)}\left|(a_{20}^{''})^{(3)}\left(T_{21}^{(1)}, s_{(20)}\right) - (a_{20}^{''})^{(3)}\left(T_{21}^{(2)}, s_{(20)}\right)\right|\ e^{-(\widehat{M}_{20})^{(3)}s_{(20)}}e^{(\widehat{M}_{20})^{(3)}s_{(20)}}\}ds_{(20)}$$

Where $s_{(20)}$ represents integrand that is integrated over the interval $[0, t]$

From the hypotheses it follows

$$\left|G^{(1)} - G^{(2)}\right|e^{-(\widehat{M}_{20})^{(3)}t} \leq \quad 324$$
$$\frac{1}{(\widehat{M}_{20})^{(3)}}\left((a_{20})^{(3)} + (a_{20}^{'})^{(3)} + (\widehat{A}_{20})^{(3)} +\right.$$
$$\left.(\widehat{P}_{20})^{(3)}(\widehat{k}_{20})^{(3)}\right)d\left(((G_{23})^{(1)}, (T_{23})^{(1)};\ (G_{23})^{(2)}, (T_{23})^{(2)})\right)$$

And analogous inequalities for $G_i\ and\ T_i$. Taking into account the hypothesis the result follows

Remark 1: The fact that we supposed $(a_{20}^{''})^{(3)}$ and $(b_{20}^{''})^{(3)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{20})^{(3)}e^{(\widehat{M}_{20})^{(3)}t}\ and\ (\widehat{Q}_{20})^{(3)}e^{(\widehat{M}_{20})^{(3)}t}$ respectively of $\mathbb{R}_+$. 325

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i^{''})^{(3)}$ and $(b_i^{''})^{(3)}, i = 20,21,22$ depend only on T_{21} and respectively on $(G_{23})(and\ not\ on\ t)$ and hypothesis can replaced by a usual Lipschitz condition.

Remark 2: There does not exist any t where $G_i\,(t) = 0\ and\ T_i\,(t) = 0$ 326

From 19 to 24 it results

$G_i\,(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(3)} - (a_i'')^{(3)}(T_{21}(s_{(20)}), s_{(20)})\} ds_{(20)}\right]} \geq 0$

$T_i\,(t) \geq T_i^0 e^{\left(-(b_i')^{(3)} t\right)} > 0$ for t > 0

Definition of $\left((\widehat{M}_{20})^{(3)}\right)_1, \left((\widehat{M}_{20})^{(3)}\right)_2\ and\ \left((\widehat{M}_{20})^{(3)}\right)_3$: 327

Remark 3: if G_{20} is bounded, the same property have also $G_{21}\ and\ G_{22}$. indeed if

$G_{20} < (\widehat{M}_{20})^{(3)}$ it follows $\frac{dG_{21}}{dt} \leq \left((\widehat{M}_{20})^{(3)}\right)_1 - (a_{21}')^{(3)} G_{21}$ and by integrating

$G_{21} \leq \left((\widehat{M}_{20})^{(3)}\right)_2 = G_{21}^0 + 2(a_{21})^{(3)}\left((\widehat{M}_{20})^{(3)}\right)_1 / (a_{21}')^{(3)}$

In the same way , one can obtain

$G_{22} \leq \left((\widehat{M}_{20})^{(3)}\right)_3 = G_{22}^0 + 2(a_{22})^{(3)}\left((\widehat{M}_{20})^{(3)}\right)_2 / (a_{22}')^{(3)}$

If $G_{21}\ or\ G_{22}$ is bounded, the same property follows for G_{20} , G_{22} and G_{20} , G_{21} respectively.

Remark 4: If $G_{20}\ \ is$ bounded, from below, the same property holds for $G_{21}\ and\ G_{22}$. The proof is analogous with the preceding one. An analogous property is true if G_{21} is bounded from below. 328

Remark 5: If T_{20} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(3)}\left((G_{23})(t), t\right)) = (b_{21}')^{(3)}$ then $T_{21} \to \infty$. 329

Definition of $(m)^{(3)}$ and ε_3 : 330

Indeed let t_3 be so that for $t > t_3$

$(b_{21})^{(3)} - (b_i'')^{(3)}\left((G_{23})(t), t\right) < \varepsilon_3, T_{20}\,(t) > (m)^{(3)}$

Then $\frac{dT_{21}}{dt} \geq (a_{21})^{(3)}(m)^{(3)} - \varepsilon_3 T_{21}$ which leads to 331

$T_{21} \geq \left(\frac{(a_{21})^{(3)}(m)^{(3)}}{\varepsilon_3}\right)(1 - e^{-\varepsilon_3 t}) + T_{21}^0 e^{-\varepsilon_3 t}$ If we take t such that $e^{-\varepsilon_3 t} = \frac{1}{2}$ it results

$T_{21} \geq \left(\frac{(a_{21})^{(3)}(m)^{(3)}}{2}\right),\quad t = log\,\frac{2}{\varepsilon_3}$ By taking now ε_3 sufficiently small one sees that T_{21} is unbounded. The same property holds for T_{22} if $\lim_{t\to\infty}(b_{22}'')^{(3)}\left((G_{23})(t), t\right) = (b_{22}')^{(3)}$

We now state a more precise theorem about the behaviors at infinity of the solutions

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It is now sufficient to take $\frac{(a_i)^{(4)}}{(\widehat{M}_{24})^{(4)}}$, $\frac{(b_i)^{(4)}}{(\widehat{M}_{24})^{(4)}} < 1$ and to choose 333

$(\widehat{P}_{24})^{(4)}$ and $(\widehat{Q}_{24})^{(4)}$ large to have

$$\frac{(a_i)^{(4)}}{(\widehat{M}_{24})^{(4)}}\left[(\widehat{P}_{24})^{(4)} + \left((\widehat{P}_{24})^{(4)} + G_j^0\right) e^{-\left(\frac{(\widehat{P}_{24})^{(4)} + G_j^0}{G_j^0}\right)}\right] \leq (\widehat{P}_{24})^{(4)} \quad 334$$

$$\frac{(b_i)^{(4)}}{(\widehat{M}_{24})^{(4)}}\left[\left((\hat{Q}_{24})^{(4)}+T_j^0\right)e^{-\left(\frac{(\hat{Q}_{24})^{(4)}+T_j^0}{T_j^0}\right)}+(\hat{Q}_{24})^{(4)}\right]\leq(\hat{Q}_{24})^{(4)} \quad 335$$

In order that the operator $\mathcal{A}^{(4)}$ transforms the space of sextuples of functions G_i , T_i satisfying IN to itself 336

The operator $\mathcal{A}^{(4)}$ is a contraction with respect to the metric 337

$$d\left(((G_{27})^{(1)},(T_{27})^{(1)}),((G_{27})^{(2)},(T_{27})^{(2)})\right)=$$

$$\sup_i\{\max_{t\in\mathbb{R}_+}\left|G_i^{(1)}(t)-G_i^{(2)}(t)\right|e^{-(\widehat{M}_{24})^{(4)}t},\max_{t\in\mathbb{R}_+}\left|T_i^{(1)}(t)-T_i^{(2)}(t)\right|e^{-(\widehat{M}_{24})^{(4)}t}\}$$

Indeed if we denote

Definition of $(\widetilde{G_{27}}),(\widetilde{T_{27}})$: $\left((\widetilde{G_{27}}),(\widetilde{T_{27}})\right)=\mathcal{A}^{(4)}((G_{27}),(T_{27}))$

It results

$$\left|\tilde{G}_{24}^{(1)}-\tilde{G}_i^{(2)}\right|\leq\int_0^t(a_{24})^{(4)}\left|G_{25}^{(1)}-G_{25}^{(2)}\right|e^{-(\widehat{M}_{24})^{(4)}s_{(24)}}e^{(\widehat{M}_{24})^{(4)}s_{(24)}}\,ds_{(24)}+$$

$$\int_0^t\{(a_{24}')^{(4)}\left|G_{24}^{(1)}-G_{24}^{(2)}\right|e^{-(\widehat{M}_{24})^{(4)}s_{(24)}}e^{-(\widehat{M}_{24})^{(4)}s_{(24)}}+$$

$$(a_{24}'')^{(4)}\left(T_{25}^{(1)},s_{(24)}\right)\left|G_{24}^{(1)}-G_{24}^{(2)}\right|e^{-(\widehat{M}_{24})^{(4)}s_{(24)}}e^{(\widehat{M}_{24})^{(4)}s_{(24)}}+$$

$$G_{24}^{(2)}\left|(a_{24}'')^{(4)}\left(T_{25}^{(1)},s_{(24)}\right)-(a_{24}'')^{(4)}\left(T_{25}^{(2)},s_{(24)}\right)\right|\;e^{-(\widehat{M}_{24})^{(4)}s_{(24)}}e^{(\widehat{M}_{24})^{(4)}s_{(24)}}\}ds_{(24)}$$

Where $s_{(24)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$

From the hypotheses it follows

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$$\left|(G_{27})^{(1)}-(G_{27})^{(2)}\right|e^{-(\widehat{M}_{24})^{(4)}t}\leq \quad 339$$
$$\frac{1}{(\widehat{M}_{24})^{(4)}}\left((a_{24})^{(4)}+(a_{24}')^{(4)}+(\widehat{A}_{24})^{(4)}+\right.$$
$$\left.(\widehat{P}_{24})^{(4)}(\hat{k}_{24})^{(4)}\right)d\left(((G_{27})^{(1)},(T_{27})^{(1)};\;(G_{27})^{(2)},(T_{27})^{(2)})\right)$$

And analogous inequalities for $G_i\ and\ T_i$. Taking into account the hypothesis the result follows

Remark 1: The fact that we supposed $(a_{24}'')^{(4)}$ and $(b_{24}'')^{(4)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{24})^{(4)}e^{(\widehat{M}_{24})^{(4)}t}\ and\ (\widehat{Q}_{24})^{(4)}e^{(\widehat{M}_{24})^{(4)}t}$ respectively of $\mathbb{R}_+$. 340

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i'')^{(4)}$ and $(b_i'')^{(4)}, i=24{,}25{,}26$ depend only on T_{25} and respectively on $(G_{27})(and\ not\ on\ t)$ and hypothesis can replaced by a usual Lipschitz condition.

Remark 2: There does not exist any t where $G_i\,(t)=0\ and\ T_i\,(t)=0$ 341

From GLOBAL EQUATIONS it results

$G_i\,(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(4)} - (a_i^{''})^{(4)}(T_{25}(s_{(24)}),s_{(24)})\}ds_{(24)}\right]} \geq 0$

$T_i\,(t) \geq T_i^0 e^{(-(b_i^{'})^{(4)}t)} > 0$ for t > 0

Definition of $\left((\widehat{M}_{24})^{(4)}\right)_1, \left((\widehat{M}_{24})^{(4)}\right)_2 \; and \; \left((\widehat{M}_{24})^{(4)}\right)_3$: 342

Remark 3: if G_{24} is bounded, the same property have also $G_{25} \; and \; G_{26}$. indeed if

$G_{24} < (\widehat{M}_{24})^{(4)}$ it follows $\frac{dG_{25}}{dt} \leq \left((\widehat{M}_{24})^{(4)}\right)_1 - (a_{25}^{'})^{(4)} G_{25}$ and by integrating

$G_{25} \leq \left((\widehat{M}_{24})^{(4)}\right)_2 = G_{25}^0 + 2(a_{25})^{(4)}\left((\widehat{M}_{24})^{(4)}\right)_1/(a_{25}^{'})^{(4)}$

In the same way , one can obtain

$G_{26} \leq \left((\widehat{M}_{24})^{(4)}\right)_3 = G_{26}^0 + 2(a_{26})^{(4)}\left((\widehat{M}_{24})^{(4)}\right)_2/(a_{26}^{'})^{(4)}$

If $G_{25} \; or \; G_{26}$ is bounded, the same property follows for G_{24} , G_{26} and G_{24} , G_{25} respectively.

Remark 4: If $G_{24} \; is$ bounded, from below, the same property holds for $G_{25} \; and \; G_{26}$. The proof is analogous with the preceding one. An analogous property is true if G_{25} is bounded from below. 343

Remark 5: If T_{24} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(4)}\,((G_{27})(t),t)) = (b_{25}^{'})^{(4)}$ then $T_{25} \to \infty$. 344

Definition of $(m)^{(4)}$ and ε_4 :

Indeed let t_4 be so that for $t > t_4$

$(b_{25})^{(4)} - (b_i^{''})^{(4)}((G_{27})(t),t) < \varepsilon_4, T_{24}\,(t) > (m)^{(4)}$

Then $\frac{dT_{25}}{dt} \geq (a_{25})^{(4)}(m)^{(4)} - \varepsilon_4 T_{25}$ which leads to 345

$T_{25} \geq \left(\frac{(a_{25})^{(4)}(m)^{(4)}}{\varepsilon_4}\right)(1 - e^{-\varepsilon_4 t}) + T_{25}^0 e^{-\varepsilon_4 t}$ If we take t such that $e^{-\varepsilon_4 t} = \frac{1}{2}$ it results

$T_{25} \geq \left(\frac{(a_{25})^{(4)}(m)^{(4)}}{2}\right), \quad t = log\,\frac{2}{\varepsilon_4}$ By taking now ε_4 sufficiently small one sees that T_{25} is unbounded. The same property holds for T_{26} if $\lim_{t\to\infty}(b_{26}^{''})^{(4)}\left((G_{27})(t),t\right) = (b_{26}^{'})^{(4)}$

We now state a more precise theorem about the behaviors at infinity of the solutions ANALOGOUS inequalities hold also for $G_{29}\,, G_{30}, T_{28}, T_{29}, T_{30}$

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It is now sufficient to take $\frac{(a_i)^{(5)}}{(\widehat{M}_{28})^{(5)}}$, $\frac{(b_i)^{(5)}}{(\widehat{M}_{28})^{(5)}} < 1$ and to choose 347

$(\widehat{P}_{28})^{(5)}$ and $(\widehat{Q}_{28})^{(5)}$ large to have

$$\frac{(a_i)^{(5)}}{(\widehat{M}_{28})^{(5)}}\left[(\widehat{P}_{28})^{(5)} + \left((\widehat{P}_{28})^{(5)} + G_j^0\right)e^{-\left(\frac{(\widehat{P}_{28})^{(5)} + G_j^0}{G_j^0}\right)}\right] \leq (\widehat{P}_{28})^{(5)} \qquad 348$$

$$\frac{(b_i)^{(5)}}{(\widehat{M}_{28})^{(5)}}\left[\left((\hat{Q}_{28})^{(5)}+T_j^0\right)e^{-\left(\frac{(\hat{Q}_{28})^{(5)}+T_j^0}{T_j^0}\right)}+(\hat{Q}_{28})^{(5)}\right]\leq(\hat{Q}_{28})^{(5)} \quad 349$$

In order that the operator $\mathcal{A}^{(5)}$ transforms the space of sextuples of functions G_i, T_i into itself 350

The operator $\mathcal{A}^{(5)}$ is a contraction with respect to the metric 351

$$d\left(((G_{31})^{(1)},(T_{31})^{(1)}),((G_{31})^{(2)},(T_{31})^{(2)})\right)=$$

$$\sup_i\{\max_{t\in\mathbb{R}_+}\left|G_i^{(1)}(t)-G_i^{(2)}(t)\right|e^{-(\widehat{M}_{28})^{(5)}t},\max_{t\in\mathbb{R}_+}\left|T_i^{(1)}(t)-T_i^{(2)}(t)\right|e^{-(\widehat{M}_{28})^{(5)}t}\}$$

Indeed if we denote

Definition of $(\widetilde{G_{31}}),(\widetilde{T_{31}})$: $\left((\widetilde{G_{31}}),(\widetilde{T_{31}})\right)=\mathcal{A}^{(5)}\left((G_{31}),(T_{31})\right)$

It results

$$\left|\tilde{G}_{28}^{(1)}-\tilde{G}_i^{(2)}\right|\leq\int_0^t(a_{28})^{(5)}\left|G_{29}^{(1)}-G_{29}^{(2)}\right|e^{-(\widehat{M}_{28})^{(5)}s_{(28)}}e^{(\widehat{M}_{28})^{(5)}s_{(28)}}\,ds_{(28)}+$$

$$\int_0^t\{(a_{28}^{'})^{(5)}\left|G_{28}^{(1)}-G_{28}^{(2)}\right|e^{-(\widehat{M}_{28})^{(5)}s_{(28)}}e^{-(\widehat{M}_{28})^{(5)}s_{(28)}}+$$

$$(a_{28}^{''})^{(5)}\left(T_{29}^{(1)},s_{(28)}\right)\left|G_{28}^{(1)}-G_{28}^{(2)}\right|e^{-(\widehat{M}_{28})^{(5)}s_{(28)}}e^{(\widehat{M}_{28})^{(5)}s_{(28)}}+$$

$$G_{28}^{(2)}\left|(a_{28}^{''})^{(5)}\left(T_{29}^{(1)},s_{(28)}\right)-(a_{28}^{''})^{(5)}\left(T_{29}^{(2)},s_{(28)}\right)\right|\;e^{-(\widehat{M}_{28})^{(5)}s_{(28)}}e^{(\widehat{M}_{28})^{(5)}s_{(28)}}\}ds_{(28)}$$

Where $s_{(28)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$

From the hypotheses it follows

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$$\left|(G_{31})^{(1)}-(G_{31})^{(2)}\right|e^{-(\widehat{M}_{28})^{(5)}t}\leq \quad 353$$
$$\frac{1}{(\widehat{M}_{28})^{(5)}}\left((a_{28})^{(5)}+(a_{28}^{'})^{(5)}+(\widehat{A}_{28})^{(5)}+\right.$$
$$\left.(\widehat{P}_{28})^{(5)}(\widehat{k}_{28})^{(5)}\right)d\left(((G_{31})^{(1)},(T_{31})^{(1)};\;(G_{31})^{(2)},(T_{31})^{(2)})\right)$$

And analogous inequalities for $G_i\ and\ T_i$. Taking into account the hypothesis (35,35,36) the result follows

Remark 1: The fact that we supposed $(a_{28}^{''})^{(5)}$ and $(b_{28}^{''})^{(5)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{28})^{(5)}e^{(\widehat{M}_{28})^{(5)}t}\ and\ (\widehat{Q}_{28})^{(5)}e^{(\widehat{M}_{28})^{(5)}t}$ respectively of $\mathbb{R}_+$. 354

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i^{''})^{(5)}$ and $(b_i^{''})^{(5)}, i=28,29,30$ depend only on T_{29} and respectively on $(G_{31})(and\ not\ on\ t)$ and hypothesis can replaced by a usual Lipschitz condition.

Remark 2: There does not exist any t where $G_i(t)=0\ and\ T_i(t)=0$ 355

From GLOBAL EQUATIONS it results

$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i')^{(5)} - (a_i'')^{(5)}(T_{29}(s_{(28)}), s_{(28)})\} ds_{(28)}\right]} \geq 0$

$T_i(t) \geq T_i^0 e^{(-(b_i')^{(5)} t)} > 0 \quad \text{for t} > 0$

Definition of $\left((\widehat{M}_{28})^{(5)}\right)_1, \left((\widehat{M}_{28})^{(5)}\right)_2 \text{ and } \left((\widehat{M}_{28})^{(5)}\right)_3$: 356

Remark 3: if G_{28} is bounded, the same property have also G_{29} and G_{30} . indeed if

$G_{28} < (\widehat{M}_{28})^{(5)}$ it follows $\frac{dG_{29}}{dt} \leq \left((\widehat{M}_{28})^{(5)}\right)_1 - (a_{29}')^{(5)} G_{29}$ and by integrating

$G_{29} \leq \left((\widehat{M}_{28})^{(5)}\right)_2 = G_{29}^0 + 2(a_{29})^{(5)}\left((\widehat{M}_{28})^{(5)}\right)_1 / (a_{29}')^{(5)}$

In the same way , one can obtain

$G_{30} \leq \left((\widehat{M}_{28})^{(5)}\right)_3 = G_{30}^0 + 2(a_{30})^{(5)}\left((\widehat{M}_{28})^{(5)}\right)_2 / (a_{30}')^{(5)}$

If G_{29} or G_{30} is bounded, the same property follows for G_{28} , G_{30} and G_{28} , G_{29} respectively.

Remark 4: If G_{28} *is* bounded, from below, the same property holds for G_{29} and G_{30} . The proof is analogous with the preceding one. An analogous property is true if G_{29} is bounded from below. 357

Remark 5: If T_{28} is bounded from below and $\lim_{t\to\infty}((b_i'')^{(5)}((G_{31})(t), t)) = (b_{29}')^{(5)}$ then $T_{29} \to \infty$. 358

Definition of $(m)^{(5)}$ and ε_5 :

Indeed let t_5 be so that for $t > t_5$

$$(b_{29})^{(5)} - (b_i'')^{(5)}((G_{31})(t), t) < \varepsilon_5, T_{28}(t) > (m)^{(5)} \quad 359$$

Then $\frac{dT_{29}}{dt} \geq (a_{29})^{(5)}(m)^{(5)} - \varepsilon_5 T_{29}$ which leads to 360

$T_{29} \geq \left(\frac{(a_{29})^{(5)}(m)^{(5)}}{\varepsilon_5}\right)(1 - e^{-\varepsilon_5 t}) + T_{29}^0 e^{-\varepsilon_5 t}$ If we take t such that $e^{-\varepsilon_5 t} = \frac{1}{2}$ it results

$T_{29} \geq \left(\frac{(a_{29})^{(5)}(m)^{(5)}}{2}\right), \quad t = log\frac{2}{\varepsilon_5}$ By taking now ε_5 sufficiently small one sees that T_{29} is unbounded. The same property holds for T_{30} if $\lim_{t\to\infty}(b_{30}'')^{(5)}\left((G_{31})(t), t\right) = (b_{30}')^{(5)}$

We now state a more precise theorem about the behaviors at infinity of the solutions

Analogous inequalities hold also for $G_{33}, G_{34}, T_{32}, T_{33}, T_{34}$

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It is now sufficient to take $\frac{(a_i)^{(6)}}{(\widehat{M}_{32})^{(6)}}$, $\frac{(b_i)^{(6)}}{(\widehat{M}_{32})^{(6)}} < 1$ and to choose 362

$(\widehat{P}_{32})^{(6)}$ and $(\widehat{Q}_{32})^{(6)}$ large to have

$$\frac{(a_i)^{(6)}}{(\widehat{M}_{32})^{(6)}}\left[(\widehat{P}_{32})^{(6)} + \left((\widehat{P}_{32})^{(6)} + G_j^0\right)e^{-\left(\frac{(\widehat{P}_{32})^{(6)} + G_j^0}{G_j^0}\right)}\right] \leq (\widehat{P}_{32})^{(6)} \quad 363$$

$$\frac{(b_i)^{(6)}}{(\widehat{M}_{32})^{(6)}}\left[\left((\hat{Q}_{32})^{(6)}+T_j^0\right)e^{-\left(\frac{(\hat{Q}_{32})^{(6)}+T_j^0}{T_j^0}\right)}+(\hat{Q}_{32})^{(6)}\right]\leq(\hat{Q}_{32})^{(6)} \quad 364$$

In order that the operator $\mathcal{A}^{(6)}$ transforms the space of sextuples of functions G_i, T_i into itself 365

The operator $\mathcal{A}^{(6)}$ is a contraction with respect to the metric 366

$$d\left(((G_{35})^{(1)},(T_{35})^{(1)}),((G_{35})^{(2)},(T_{35})^{(2)})\right)=$$

$$\sup_i\{\max_{t\in\mathbb{R}_+}\left|G_i^{(1)}(t)-G_i^{(2)}(t)\right|e^{-(\widehat{M}_{32})^{(6)}t},\max_{t\in\mathbb{R}_+}\left|T_i^{(1)}(t)-T_i^{(2)}(t)\right|e^{-(\widehat{M}_{32})^{(6)}t}\}$$

Indeed if we denote

Definition of $(\widetilde{G_{35}}),(\widetilde{T_{35}})$: $\left((\widetilde{G_{35}}),(\widetilde{T_{35}})\right)=\mathcal{A}^{(6)}\left((G_{35}),(T_{35})\right)$

It results

$$\left|\tilde{G}_{32}^{(1)}-\tilde{G}_i^{(2)}\right|\leq\int_0^t(a_{32})^{(6)}\left|G_{33}^{(1)}-G_{33}^{(2)}\right|e^{-(\widehat{M}_{32})^{(6)}s_{(32)}}e^{(\widehat{M}_{32})^{(6)}s_{(32)}}\,ds_{(32)}+$$

$$\int_0^t\{(a_{32}^{'})^{(6)}\left|G_{32}^{(1)}-G_{32}^{(2)}\right|e^{-(\widehat{M}_{32})^{(6)}s_{(32)}}e^{-(\widehat{M}_{32})^{(6)}s_{(32)}}+$$

$$(a_{32}^{''})^{(6)}\left(T_{33}^{(1)},s_{(32)}\right)\left|G_{32}^{(1)}-G_{32}^{(2)}\right|e^{-(\widehat{M}_{32})^{(6)}s_{(32)}}e^{(\widehat{M}_{32})^{(6)}s_{(32)}}+$$

$$G_{32}^{(2)}\left|(a_{32}^{''})^{(6)}\left(T_{33}^{(1)},s_{(32)}\right)-(a_{32}^{''})^{(6)}\left(T_{33}^{(2)},s_{(32)}\right)\right|\;e^{-(\widehat{M}_{32})^{(6)}s_{(32)}}e^{(\widehat{M}_{32})^{(6)}s_{(32)}}\}ds_{(32)}$$

Where $s_{(32)}$ represents integrand that is integrated over the interval $[0,\mathrm{t}]$ 367

From the hypotheses it follows

(1) $(a_i^{'})^{(1)},(a_i^{''})^{(1)},(b_i)^{(1)},(b_i^{'})^{(1)},(b_i^{''})^{(1)}>0,$
$i,j=13,14,15$

(2)The functions $(a_i^{''})^{(1)},(b_i^{''})^{(1)}$ are positive continuous increasing and bounded.

Definition of $(p_i)^{(1)}$, $(r_i)^{(1)}$:

$$(a_i^{''})^{(1)}(T_{14},t)\leq(p_i)^{(1)}\leq(\hat{A}_{13})^{(1)}$$

$$(b_i^{''})^{(1)}(G,t)\leq\;(r_i)^{(1)}\leq(b_i^{'})^{(1)}\leq(\hat{B}_{13})^{(1)}$$

(3) $lim_{T_2\to\infty}(a_i^{''})^{(1)}(T_{14},t)=(p_i)^{(1)}$
$\lim_{G\to\infty}(b_i^{''})^{(1)}(G,t)=\;(r_i)^{(1)}$

Definition of $(\hat{A}_{13})^{(1)},(\hat{B}_{13})^{(1)}$:

Where $\boxed{(\hat{A}_{13})^{(1)},(\hat{B}_{13})^{(1)},(p_i)^{(1)},\;(r_i)^{(1)}}$ are positive constants and $\boxed{i=13,14,15}$

They satisfy Lipschitz condition:

$$|(a_i^{''})^{(1)}(T_{14}^{'},t)-(a_i^{''})^{(1)}(T_{14},t)|\leq(\hat{k}_{13})^{(1)}|T_{14}-T_{14}^{'}|e^{-(\widehat{M}_{13})^{(1)}t}$$

$$|(b_i^{''})^{(1)}(G^{'},t)-(b_i^{''})^{(1)}(G,T)|<(\hat{k}_{13})^{(1)}||G-G^{'}||e^{-(\widehat{M}_{13})^{(1)}t}$$

With the Lipschitz condition, we place a restriction on the behavior of functions $(a_i^{''})^{(1)}(T_{14}^{'},t)$ and$(a_i^{''})^{(1)}(T_{14},t)$. $(T_{14}^{'},t)$ and (T_{14},t) are points belonging to the interval $\left[(\hat{k}_{13})^{(1)},(\widehat{M}_{13})^{(1)}\right]$. It is to be noted that $(a_i^{''})^{(1)}(T_{14},t)$ is uniformly continuous. In the eventuality of the fact, that if $(\widehat{M}_{13})^{(1)}=1$ then the function $(a_i^{''})^{(1)}(T_{14},t)$, the **first augmentation coefficient** attributable to terrestrial organisms, would be absolutely continuous.

Definition of $(\widehat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$:

$(\widehat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)}$, are positive constants

$\frac{(a_i)^{(1)}}{(\widehat{M}_{13})^{(1)}}$, $\frac{(b_i)^{(1)}}{(\widehat{M}_{13})^{(1)}}<1$

Definition of $(\hat{P}_{13})^{(1)},(\hat{Q}_{13})^{(1)}$:

There exists two constants $(\hat{P}_{13})^{(1)}$ and $(\hat{Q}_{13})^{(1)}$ which together with $(\widehat{M}_{13})^{(1)},(\hat{k}_{13})^{(1)},(\hat{A}_{13})^{(1)} and\ (\hat{B}_{13})^{(1)}$ and the constants $(a_i)^{(1)},(a_i^{'})^{(1)},(b_i)^{(1)},(b_i^{'})^{(1)},(p_i)^{(1)},\ (r_i)^{(1)},i=13,14,15,$ satisfy the inequalities

$$\frac{1}{(\widehat{M}_{13})^{(1)}}[(a_i)^{(1)}+(a_i^{'})^{(1)}+\ (\hat{A}_{13})^{(1)}+\ (\hat{P}_{13})^{(1)}(\hat{k}_{13})^{(1)}]<1$$

$$\frac{1}{(\widehat{M}_{13})^{(1)}}[\ (b_i)^{(1)}+(b_i^{'})^{(1)}+\ (\hat{B}_{13})^{(1)}+\ (\hat{Q}_{13})^{(1)}\ (\hat{k}_{13})^{(1)}]<1$$

Analogous inequalities hold also for $G_{37}\ ,G_{38},T_{36},T_{37},T_{38}$ 368

It is now sufficient to take $\frac{(a_i)^{(7)}}{(\widehat{M}_{36})^{(7)}}$, $\frac{(b_i)^{(7)}}{(\widehat{M}_{36})^{(7)}}<7$ and to choose

$(\widehat{\mathrm{P}}_{36})^{(7)}$ and $(\widehat{\mathrm{Q}}_{36})^{(7)}$ large to have

$$\frac{(a_i)^{(7)}}{(\widehat{M}_{36})^{(7)}}\left[(\widehat{P}_{36})^{(7)}+\left((\hat{P}_{36})^{(7)}+G_j^0\right)e^{-\left(\frac{(\hat{P}_{36})^{(7)}+G_j^0}{G_j^0}\right)}\right]\leq(\hat{P}_{36})^{(7)} \quad 369$$

370

$$\frac{(b_i)^{(7)}}{(\widehat{M}_{36})^{(7)}}\left[\left((\hat{Q}_{36})^{(7)}+T_j^0\right)e^{-\left(\frac{(\hat{Q}_{36})^{(7)}+T_j^0}{T_j^0}\right)}+(\hat{Q}_{36})^{(7)}\right]\leq(\hat{Q}_{36})^{(7)}$$

In order that the operator $\mathcal{A}^{(7)}$ transforms the space of sextuples of functions $G_i\ ,T_i$ satisfying into itself 371

Analogous inequalities hold also for $G_{41}\ ,G_{42},T_{40},T_{41},T_{42}$ 372

It is now sufficient to take $\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}$, $\frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}} < 1$ and to choose

$(\hat{P}_{40})^{(8)}$ and $(\hat{Q}_{40})^{(8)}$ large to have

$$\frac{(a_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\left[(\hat{P}_{40})^{(8)} + \left((\hat{P}_{40})^{(8)} + G_j^0\right)e^{-\left(\frac{(\hat{P}_{40})^{(8)}+G_j^0}{G_j^0}\right)}\right] \leq (\hat{P}_{40})^{(8)} \quad 373$$

374

375

$$\frac{(b_i)^{(8)}}{(\hat{M}_{40})^{(8)}}\left[\left((\hat{Q}_{40})^{(8)} + T_j^0\right)e^{-\left(\frac{(\hat{Q}_{40})^{(8)}+T_j^0}{T_j^0}\right)} + (\hat{Q}_{40})^{(8)}\right] \leq (\hat{Q}_{40})^{(8)}$$

In order that the operator $\mathcal{A}^{(8)}$ transforms the space of sextuples of functions G_i , T_i satisfying GLOBAL EQUATIONS into itself 376

The operator $\mathcal{A}^{(8)}$ is a contraction with respect to the metric 377

$$d\left(((G_{43})^{(1)}, (T_{43})^{(1)}), ((G_{43})^{(2)}, (T_{43})^{(2)})\right) =$$

$$\sup_i\{\max_{t\in\mathbb{R}_+}\left|G_i^{(1)}(t) - G_i^{(2)}(t)\right|e^{-(\hat{M}_{40})^{(8)}t}, \max_{t\in\mathbb{R}_+}\left|T_i^{(1)}(t) - T_i^{(2)}(t)\right|e^{-(\hat{M}_{40})^{(8)}t}\}$$

Indeed if we denote

Definition of $\widetilde{(G_{43})}, \widetilde{(T_{43})}$:

$$\left(\widetilde{(G_{43})}, \widetilde{(T_{43})}\right) = \mathcal{A}^{(8)}((G_{43}), (T_{43}))$$

It results

$$\left|\tilde{G}_{40}^{(1)} - \tilde{G}_{i}^{(2)}\right| \leq \int_0^t (a_{40})^{(8)} \left|G_{41}^{(1)} - G_{41}^{(2)}\right| e^{-(\widehat{M}_{40})^{(8)} s_{(40)}} e^{(\widehat{M}_{40})^{(8)} s_{(40)}}\, ds_{(40)} +$$

$$\int_0^t \{(a_{40}^{'})^{(8)} \left|G_{40}^{(1)} - G_{40}^{(2)}\right| e^{-(\widehat{M}_{40})^{(8)} s_{(40)}} e^{-(\widehat{M}_{40})^{(8)} s_{(40)}} +$$

$$(a_{40}^{''})^{(8)} \left(T_{41}^{(1)}, s_{(40)}\right) \left|G_{40}^{(1)} - G_{40}^{(2)}\right| e^{-(\widehat{M}_{40})^{(8)} s_{(40)}} e^{(\widehat{M}_{40})^{(8)} s_{(40)}} +$$

$$G_{40}^{(2)} \left|(a_{40}^{''})^{(8)} \left(T_{41}^{(1)}, s_{(40)}\right) - (a_{40}^{''})^{(8)} \left(T_{41}^{(2)}, s_{(40)}\right)\right| \; e^{-(\widehat{M}_{40})^{(8)} s_{(40)}} e^{(\widehat{M}_{40})^{(8)} s_{(40)}} \} ds_{(40)}$$

Where $s_{(40)}$ represents integrand that is integrated over the interval $[0, \mathrm{t}]$

From the hypotheses IT follows

$$\left|(G_{43})^{(1)} - (G_{43})^{(2)}\right| e^{-(\widehat{M}_{40})^{(8)} t} \leq \qquad 378$$
$$\frac{1}{(\widehat{M}_{40})^{(8)}} \left((a_{40})^{(8)} + (a_{40}^{'})^{(8)} + (\widehat{A}_{40})^{(8)} + \right.$$
$$\left. (\widehat{P}_{40})^{(8)} (\widehat{k}_{40})^{(8)}) d \left(((G_{43})^{(1)}, (T_{43})^{(1)};\ (G_{43})^{(2)}, (T_{43})^{(2)})\right)\right)$$

And analogous inequalities for $G_i \; and \; T_i$. Taking into account the hypothesis (38,35,36) the result follows

Remark 1: The fact that we supposed $(a_{40}^{''})^{(8)}$ and $(b_{40}^{''})^{(8)}$ depending also on t can be considered as not conformal with the reality, however we have put this hypothesis ,in order that we can postulate condition necessary to prove the uniqueness of the solution bounded by $(\widehat{P}_{40})^{(8)} e^{(\widehat{M}_{40})^{(8)} t} \; and \; (\widehat{Q}_{40})^{(8)} e^{(\widehat{M}_{40})^{(8)} t}$ respectively of $\mathbb{R}_+$. 379

If instead of proving the existence of the solution on $\mathbb{R}_+$, we have to prove it only on a compact then it suffices to consider that $(a_i^{''})^{(8)}$ and $(b_i^{''})^{(8)}, i = 40{,}41{,}42$ depend only on T_{41} and respectively on $(G_{43})(and \; not \; on \; \; t)$ and hypothesis can replaced by a usual Lipschitz condition.

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Remark 2: There does not exist any t where $G_i\,(t) = 0 \; and \; T_i\,(t) = 0$

From global equations it results

$$G_i\,(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(8)} - (a_i^{''})^{(8)} (T_{41}(s_{(40)}), s_{(40)})\} ds_{(40)}\right]} \geq 0$$

$T_i\,(t) \geq T_i^0 e^{\left(-(b_i^{'})^{(8)}t\right)} > 0$ for t > 0

Definition of $\left((\widehat{M}_{40})^{(8)}\right)_1, \left((\widehat{M}_{40})^{(8)}\right)_2 \; and \; \left((\widehat{M}_{40})^{(8)}\right)_3$: 381

Remark 3: if G_{40} is bounded, the same property have also $G_{41}\; and\; G_{42}$. indeed if

$G_{40} < (\widehat{M}_{40})^{(8)}$ it follows $\frac{dG_{41}}{dt} \leq \left((\widehat{M}_{40})^{(8)}\right)_1 - (a_{41}^{'})^{(8)} G_{41}$ and by integrating 382

$$G_{41} \leq \left((\widehat{M}_{40})^{(8)}\right)_2 = G_{41}^0 + 2(a_{41})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_1/(a_{41}^{'})^{(8)}$$

In the same way , one can obtain

$$G_{42} \leq \left((\widehat{M}_{40})^{(8)}\right)_3 = G_{42}^0 + 2(a_{42})^{(8)}\left((\widehat{M}_{40})^{(8)}\right)_2/(a_{42}^{'})^{(8)}$$

If $G_{41}\; or\; G_{42}$ is bounded, the same property follows for G_{40} , G_{42} and G_{40} , G_{41} respectively.

Remark 1: If $G_{40}\;$ *is* bounded, from below, the same property holds for $G_{41}\; and\; G_{42}$. The proof is analogous with the preceding one. An analogous property is true if G_{41} is bounded from below. 383

Remark 5: If T_{40} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(8)}\,((G_{43})(t),t)) = (b_{41}^{'})^{(8)}$ then $T_{41} \to \infty$. 384

Definition of $(m)^{(8)}$ and ε_8 :

Indeed let t_8 be so that for $t > t_8$

$$(b_{41})^{(8)} - (b_i^{''})^{(8)}\left((G_{43})(t),t\right) < \varepsilon_8, T_{40}\,(t) > (m)^{(8)}$$

Then $\frac{dT_{41}}{dt} \geq (a_{41})^{(8)}(m)^{(8)} - \varepsilon_8 T_{41}$ which leads to 385

$T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{\varepsilon_8}\right)(1-e^{-\varepsilon_8 t}) + T_{41}^0 e^{-\varepsilon_8 t}$ If we take t such that $e^{-\varepsilon_8 t} = \frac{1}{2}$ it results

$T_{41} \geq \left(\frac{(a_{41})^{(8)}(m)^{(8)}}{2}\right), \quad t = log\frac{2}{\varepsilon_8}$ By taking now ε_8 sufficiently small one sees that T_{41} is unbounded. The same property holds for T_{42} if $\lim_{t\to\infty}(b_{42}^{''})^{(8)}\left((G_{43})(t), t(t), t\right) = (b_{42}^{'})^{(8)}$

We now state a more precise theorem about the behaviors at infinity of the solutions of equations 37 to 82

Remark 2: There does not exist any t where $G_i(t) = 0 \; and \; T_i(t) = 0$ 386

From CONCATENATED GLOBAL EQUATIONS it results

$$G_i(t) \geq G_i^0 e^{\left[-\int_0^t \{(a_i^{'})^{(7)} - (a_i^{''})^{(7)}(T_{37}(s_{(36)}), s_{(36)})\} ds_{(36)}\right]} \geq 0$$

$$T_i(t) \geq T_i^0 e^{\left(-(b_i^{'})^{(7)} t\right)} > 0 \quad \text{for t} > 0$$

Definition of $\left((\widehat{M}_{36})^{(7)}\right)_1, \left((\widehat{M}_{36})^{(7)}\right)_2 \; and \; \left((\widehat{M}_{36})^{(7)}\right)_3$: 387

Remark 3: if G_{36} is bounded, the same property have also $G_{37} \; and \; G_{38}$. indeed if

$G_{36} < (\widehat{M}_{36})^{(7)}$ it follows $\frac{dG_{37}}{dt} \leq \left((\widehat{M}_{36})^{(7)}\right)_1 - (a_{37}^{'})^{(7)} G_{37}$ and by integrating

$$G_{37} \leq \left((\widehat{M}_{36})^{(7)}\right)_2 = G_{37}^0 + 2(a_{37})^{(7)}\left((\widehat{M}_{36})^{(7)}\right)_1 / (a_{37}^{'})^{(7)}$$

In the same way , one can obtain

$$G_{38} \leq \left((\widehat{M}_{36})^{(7)}\right)_3 = G_{38}^0 + 2(a_{38})^{(7)}\left((\widehat{M}_{36})^{(7)}\right)_2 / (a_{38}^{'})^{(7)}$$

If $G_{37} \; or \; G_{38}$ is bounded, the same property follows for G_{36} , G_{38} and G_{36} , G_{37} respectively.

Remark 7: If $G_{36} \; is$ bounded, from below, the same property holds for $G_{37} \; and \; G_{38}$. The proof is analogous with the preceding one. An analogous property is true if G_{37} is bounded from below. 388

Remark 5: If T_{36} is bounded from below and $\lim_{t\to\infty}((b_i^{''})^{(7)}((G_{39})(t), t)) = (b_{37}^{'})^{(7)}$ then $T_{37} \to \infty$. 389

Definition of $(m)^{(7)}$ and ε_7 :

Indeed let t_7 be so that for $t > t_7$

$$(b_{37})^{(7)} - (b_i^{''})^{(7)}((G_{39})(t), t) < \varepsilon_7, T_{36}(t) > (m)^{(7)}$$

Then $\frac{dT_{37}}{dt} \geq (a_{37})^{(7)}(m)^{(7)} - \varepsilon_7 T_{37}$ which leads to 390

$T_{37} \geq \left(\frac{(a_{37})^{(7)}(m)^{(7)}}{\varepsilon_7}\right)(1-e^{-\varepsilon_7 t}) + T_{37}^0 e^{-\varepsilon_7 t}$ If we take t such that $e^{-\varepsilon_7 t} = \frac{1}{2}$ it results

$T_{37} \geq \left(\frac{(a_{37})^{(7)}(m)^{(7)}}{2}\right)$, $t = log\frac{2}{\varepsilon_7}$ By taking now ε_7 sufficiently small one sees that T_{37} is unbounded. The same property holds for T_{38} if $\lim_{t\to\infty}(b_{38}^{''})^{(7)}\left((G_{39})(t),t\right) = (b_{38}^{'})^{(7)}$

We now state a more precise theorem about the behaviors at infinity of the solutions

$$-(\sigma_2)^{(2)} \leq -(a_{16}^{'})^{(2)} + (a_{17}^{'})^{(2)} - (a_{16}^{''})^{(2)}(T_{17}, t) + (a_{17}^{''})^{(2)}(T_{17}, t) \leq -(\sigma_1)^{(2)} \quad 391$$

$$-(\tau_2)^{(2)} \leq -(b_{16}^{'})^{(2)} + (b_{17}^{'})^{(2)} - (b_{16}^{''})^{(2)}\left((G_{19}),t\right) - (b_{17}^{''})^{(2)}\left((G_{19}),t\right) \leq -(\tau_1)^{(2)} \quad 392$$

Definition of $(\nu_1)^{(2)}, (\nu_2)^{(2)}, (u_1)^{(2)}, (u_2)^{(2)}$: 393

By $(\nu_1)^{(2)} > 0$, $(\nu_2)^{(2)} < 0$ and respectively $(u_1)^{(2)} > 0$, $(u_2)^{(2)} < 0$ the roots 394

(a) of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_1)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$ 395

and $(b_{14})^{(2)}\left(u^{(2)}\right)^2 + (\tau_1)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ and 396

Definition of $(\bar{\nu}_1)^{(2)}, , (\bar{\nu}_2)^{(2)}, (\bar{u}_1)^{(2)}, (\bar{u}_2)^{(2)}$: 397

By $(\bar{\nu}_1)^{(2)} > 0$, $(\bar{\nu}_2)^{(2)} < 0$ and respectively $(\bar{u}_1)^{(2)} > 0$, $(\bar{u}_2)^{(2)} < 0$ the 398

roots of the equations $(a_{17})^{(2)}\left(\nu^{(2)}\right)^2 + (\sigma_2)^{(2)}\nu^{(2)} - (a_{16})^{(2)} = 0$ 399

and $(b_{17})^{(2)}\left(u^{(2)}\right)^2 + (\tau_2)^{(2)}u^{(2)} - (b_{16})^{(2)} = 0$ 400

Definition of $(m_1)^{(2)}$, $(m_2)^{(2)}$, $(\mu_1)^{(2)}, (\mu_2)^{(2)}$:- 401

(b) If we define $(m_1)^{(2)}$, $(m_2)^{(2)}$, $(\mu_1)^{(2)}, (\mu_2)^{(2)}$ by 402

$(m_2)^{(2)} = (\nu_0)^{(2)}, (m_1)^{(2)} = (\nu_1)^{(2)}$, $\boldsymbol{if}\ (\nu_0)^{(2)} < (\nu_1)^{(2)}$ 403

$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\bar{\nu}_1)^{(2)}$, $\boldsymbol{if}\ (\nu_1)^{(2)} < (\nu_0)^{(2)} < (\bar{\nu}_1)^{(2)}$, 404

and $\boxed{(\nu_0)^{(2)} = \frac{G_{16}^0}{G_{17}^0}}$

$(m_2)^{(2)} = (\nu_1)^{(2)}, (m_1)^{(2)} = (\nu_0)^{(2)}$, $\boldsymbol{if}\ (\bar{\nu}_1)^{(2)} < (\nu_0)^{(2)}$ 405

and analogously 406

$(\mu_2)^{(2)} = (u_0)^{(2)}, (\mu_1)^{(2)} = (u_1)^{(2)}$, $\boldsymbol{if}\ (u_0)^{(2)} < (u_1)^{(2)}$

$(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (\bar{u}_1)^{(2)}$, $\boldsymbol{if}\ (u_1)^{(2)} < (u_0)^{(2)} < (\bar{u}_1)^{(2)}$,

and $\boxed{(u_0)^{(2)} = \frac{T_{16}^0}{T_{17}^0}}$

$(\mu_2)^{(2)} = (u_1)^{(2)}, (\mu_1)^{(2)} = (u_0)^{(2)}$, $\boldsymbol{if}\ (\bar{u}_1)^{(2)} < (u_0)^{(2)}$ 407

Then the solution satisfies the inequalities 408

$$G_{16}^0 e^{((S_1)^{(2)} - (p_{16})^{(2)})t} \leq G_{16}(t) \leq G_{16}^0 e^{(S_1)^{(2)}t}$$

$(p_i)^{(2)}$ is defined 409

$$\frac{1}{(m_1)^{(2)}} G_{16}^0 e^{((S_1)^{(2)}-(p_{16})^{(2)})t} \le G_{17}(t) \le \frac{1}{(m_2)^{(2)}} G_{16}^0 e^{(S_1)^{(2)}t} \quad 410$$

$$\left(\frac{(a_{18})^{(2)} G_{16}^0}{(m_1)^{(2)}((S_1)^{(2)}-(p_{16})^{(2)}-(S_2)^{(2)})} \left[e^{((S_1)^{(2)}-(p_{16})^{(2)})t} - e^{-(S_2)^{(2)}t} \right] + G_{18}^0 e^{-(S_2)^{(2)}t} \le G_{18}(t) \le \right. \quad 411$$
$$\left. \frac{(a_{18})^{(2)} G_{16}^0}{(m_2)^{(2)}((S_1)^{(2)}-(a_{18}')^{(2)})} [e^{(S_1)^{(2)}t} - e^{-(a_{18}')^{(2)}t}] + G_{18}^0 e^{-(a_{18}')^{(2)}t} \right)$$

$$\boxed{T_{16}^0 e^{(R_1)^{(2)}t} \le T_{16}(t) \le T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t}} \quad 412$$

$$\frac{1}{(\mu_1)^{(2)}} T_{16}^0 e^{(R_1)^{(2)}t} \le T_{16}(t) \le \frac{1}{(\mu_2)^{(2)}} T_{16}^0 e^{((R_1)^{(2)}+(r_{16})^{(2)})t} \quad 413$$

$$\frac{(b_{18})^{(2)} T_{16}^0}{(\mu_1)^{(2)}((R_1)^{(2)}-(b_{18}')^{(2)})} \left[e^{(R_1)^{(2)}t} - e^{-(b_{18}')^{(2)}t} \right] + T_{18}^0 e^{-(b_{18}')^{(2)}t} \le T_{18}(t) \le \quad 414$$

$$\frac{(a_{18})^{(2)} T_{16}^0}{(\mu_2)^{(2)}((R_1)^{(2)}+(r_{16})^{(2)}+(R_2)^{(2)})} \left[e^{((R_1)^{(2)}+(r_{16})^{(2)})t} - e^{-(R_2)^{(2)}t} \right] + T_{18}^0 e^{-(R_2)^{(2)}t}$$

Definition of $(S_1)^{(2)}, (S_2)^{(2)}, (R_1)^{(2)}, (R_2)^{(2)}$:- 415

Where $(S_1)^{(2)} = (a_{16})^{(2)}(m_2)^{(2)} - (a_{16}')^{(2)}$ 416

$$(S_2)^{(2)} = (a_{18})^{(2)} - (p_{18})^{(2)}$$

$$(R_1)^{(2)} = (b_{16})^{(2)}(\mu_2)^{(1)} - (b_{16}')^{(2)} \quad 417$$

$$(R_2)^{(2)} = (b_{18}')^{(2)} - (r_{18})^{(2)}$$

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If we denote and define 419

Definition of $(\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$:

(a) $\sigma_1)^{(3)}, (\sigma_2)^{(3)}, (\tau_1)^{(3)}, (\tau_2)^{(3)}$ four constants satisfying

$$-(\sigma_2)^{(3)} \le -(a_{20}')^{(3)} + (a_{21}')^{(3)} - (a_{20}'')^{(3)}(T_{21}, t) + (a_{21}'')^{(3)}(T_{21}, t) \le -(\sigma_1)^{(3)}$$

$$-(\tau_2)^{(3)} \le -(b_{20}')^{(3)} + (b_{21}')^{(3)} - (b_{20}'')^{(3)}(G, t) - (b_{21}'')^{(3)}((G_{23}), t) \le -(\tau_1)^{(3)}$$

Definition of $(\nu_1)^{(3)}, (\nu_2)^{(3)}, (u_1)^{(3)}, (u_2)^{(3)}$: 420

(b) By $(\nu_1)^{(3)} > 0, (\nu_2)^{(3)} < 0$ and respectively $(u_1)^{(3)} > 0, (u_2)^{(3)} < 0$ the roots of the equations $(a_{21})^{(3)}(\nu^{(3)})^2 + (\sigma_1)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$

and $(b_{21})^{(3)}(u^{(3)})^2 + (\tau_1)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$ and

By $(\bar{\nu}_1)^{(3)} > 0, (\bar{\nu}_2)^{(3)} < 0$ and respectively $(\bar{u}_1)^{(3)} > 0, (\bar{u}_2)^{(3)} < 0$ the

roots of the equations $(a_{21})^{(3)}(\nu^{(3)})^2 + (\sigma_2)^{(3)}\nu^{(3)} - (a_{20})^{(3)} = 0$

and $(b_{21})^{(3)}(u^{(3)})^2 + (\tau_2)^{(3)}u^{(3)} - (b_{20})^{(3)} = 0$

Definition of $(m_1)^{(3)}, (m_2)^{(3)}, (\mu_1)^{(3)}, (\mu_2)^{(3)}$:- 421

(c) If we define $(m_1)^{(3)}, (m_2)^{(3)}, (\mu_1)^{(3)}, (\mu_2)^{(3)}$ by

$(m_2)^{(3)} = (\nu_0)^{(3)}, (m_1)^{(3)} = (\nu_1)^{(3)}$, $\boldsymbol{if}\ (\nu_0)^{(3)} < (\nu_1)^{(3)}$

$(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\bar{\nu}_1)^{(3)}, \boldsymbol{if}\ (\nu_1)^{(3)} < (\nu_0)^{(3)} < (\bar{\nu}_1)^{(3)}$,

and $\boxed{(\nu_0)^{(3)} = \frac{G_{20}^0}{G_{21}^0}}$

$(m_2)^{(3)} = (\nu_1)^{(3)}, (m_1)^{(3)} = (\nu_0)^{(3)}$, $\boldsymbol{if}\ (\bar{\nu}_1)^{(3)} < (\nu_0)^{(3)}$

and analogously 422

$(\mu_2)^{(3)} = (u_0)^{(3)}, (\mu_1)^{(3)} = (u_1)^{(3)}$, $\boldsymbol{if}\ (u_0)^{(3)} < (u_1)^{(3)}$

$(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (\bar{u}_1)^{(3)}, \boldsymbol{if}\ (u_1)^{(3)} < (u_0)^{(3)} < (\bar{u}_1)^{(3)}$, and $\boxed{(u_0)^{(3)} = \frac{T_{20}^0}{T_{21}^0}}$

$(\mu_2)^{(3)} = (u_1)^{(3)}, (\mu_1)^{(3)} = (u_0)^{(3)}$, $\boldsymbol{if}\ (\bar{u}_1)^{(3)} < (u_0)^{(3)}$

Then the solution satisfies the inequalities

$$G_{20}^0 e^{((S_1)^{(3)} - (p_{20})^{(3)})t} \le G_{20}(t) \le G_{20}^0 e^{(S_1)^{(3)} t}$$

$(p_i)^{(3)}$ is defined 423

$$\frac{1}{(m_1)^{(3)}} G_{20}^0 e^{((S_1)^{(3)} - (p_{20})^{(3)})t} \le G_{21}(t) \le \frac{1}{(m_2)^{(3)}} G_{20}^0 e^{(S_1)^{(3)} t} \quad 424$$

$$\left(\frac{(a_{22})^{(3)} G_{20}^0}{(m_1)^{(3)}((S_1)^{(3)} - (p_{20})^{(3)} - (S_2)^{(3)})}\left[e^{((S_1)^{(3)} - (p_{20})^{(3)})t} - e^{-(S_2)^{(3)} t}\right] + G_{22}^0 e^{-(S_2)^{(3)} t} \le G_{22}(t) \le \frac{(a_{22})^{(3)} G_{20}^0}{(m_2)^{(3)}((S_1)^{(3)} - (a_{22}')^{(3)})}\left[e^{(S_1)^{(3)} t} - e^{-(a_{22}')^{(3)} t}\right] + G_{22}^0 e^{-(a_{22}')^{(3)} t}\right) \quad 425$$

$$\boxed{T_{20}^0 e^{(R_1)^{(3)} t} \le T_{20}(t) \le T_{20}^0 e^{((R_1)^{(3)} + (r_{20})^{(3)})t}} \quad 426$$

$$\frac{1}{(\mu_1)^{(3)}} T_{20}^0 e^{(R_1)^{(3)} t} \le T_{20}(t) \le \frac{1}{(\mu_2)^{(3)}} T_{20}^0 e^{((R_1)^{(3)} + (r_{20})^{(3)})t} \quad 427$$

$$\frac{(b_{22})^{(3)} T_{20}^0}{(\mu_1)^{(3)}((R_1)^{(3)} - (b_{22}')^{(3)})}\left[e^{(R_1)^{(3)} t} - e^{-(b_{22}')^{(3)} t}\right] + T_{22}^0 e^{-(b_{22}')^{(3)} t} \le T_{22}(t) \le \quad 428$$

$$\frac{(a_{22})^{(3)} T_{20}^0}{(\mu_2)^{(3)}((R_1)^{(3)} + (r_{20})^{(3)} + (R_2)^{(3)})}\left[e^{((R_1)^{(3)} + (r_{20})^{(3)})t} - e^{-(R_2)^{(3)} t}\right] + T_{22}^0 e^{-(R_2)^{(3)} t}$$

Definition of $(S_1)^{(3)}, (S_2)^{(3)}, (R_1)^{(3)}, (R_2)^{(3)}$:- 429

Where $(S_1)^{(3)} = (a_{20})^{(3)}(m_2)^{(3)} - (a_{20}')^{(3)}$ 430

$(S_2)^{(3)} = (a_{22})^{(3)} - (p_{22})^{(3)}$ 431

$(R_1)^{(3)} = (b_{20})^{(3)}(\mu_2)^{(3)} - (b_{20}')^{(3)}$ 432

$(R_2)^{(3)} = (b_{22}')^{(3)} - (r_{22})^{(3)}$

If we denote and define

Definition of $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$:

(d) $(\sigma_1)^{(4)}, (\sigma_2)^{(4)}, (\tau_1)^{(4)}, (\tau_2)^{(4)}$ four constants satisfying

$$-(\sigma_2)^{(4)} \le -(a_{24}^{'})^{(4)} + (a_{25}^{'})^{(4)} - (a_{24}^{''})^{(4)}(T_{25}, t) + (a_{25}^{''})^{(4)}(T_{25}, t) \le -(\sigma_1)^{(4)}$$

$$-(\tau_2)^{(4)} \le -(b_{24}^{'})^{(4)} + (b_{25}^{'})^{(4)} - (b_{24}^{''})^{(4)}\big((G_{27}), t\big) - (b_{25}^{''})^{(4)}\big((G_{27}), t\big) \le -(\tau_1)^{(4)}$$

Definition of $(\nu_1)^{(4)}, (\nu_2)^{(4)}, (u_1)^{(4)}, (u_2)^{(4)}, \nu^{(4)}, u^{(4)}$: 433

(e) By $(\nu_1)^{(4)} > 0$, $(\nu_2)^{(4)} < 0$ and respectively $(u_1)^{(4)} > 0$, $(u_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\big(\nu^{(4)}\big)^2 + (\sigma_1)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$
and $(b_{25})^{(4)}\big(u^{(4)}\big)^2 + (\tau_1)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ and

Definition of $(\bar{\nu}_1)^{(4)}, , (\bar{\nu}_2)^{(4)}, (\bar{u}_1)^{(4)}, (\bar{u}_2)^{(4)}$: 434
435

By $(\bar{\nu}_1)^{(4)} > 0$, $(\bar{\nu}_2)^{(4)} < 0$ and respectively $(\bar{u}_1)^{(4)} > 0$, $(\bar{u}_2)^{(4)} < 0$ the roots of the equations $(a_{25})^{(4)}\big(\nu^{(4)}\big)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)} = 0$
and $(b_{25})^{(4)}\big(u^{(4)}\big)^2 + (\tau_2)^{(4)}u^{(4)} - (b_{24})^{(4)} = 0$ 436

Definition of $(m_1)^{(4)}, (m_2)^{(4)}, (\mu_1)^{(4)}, (\mu_2)^{(4)}, (\nu_0)^{(4)}$:-

(f) If we define $(m_1)^{(4)}, (m_2)^{(4)}, (\mu_1)^{(4)}, (\mu_2)^{(4)}$ by

$(m_2)^{(4)} = (\nu_0)^{(4)}, (m_1)^{(4)} = (\nu_1)^{(4)}$, $\boldsymbol{if}\ (\nu_0)^{(4)} < (\nu_1)^{(4)}$

$(m_2)^{(4)} = (\nu_1)^{(4)}, (m_1)^{(4)} = (\bar{\nu}_1)^{(4)}$, $\boldsymbol{if}\ (\nu_4)^{(4)} < (\nu_0)^{(4)} < (\bar{\nu}_1)^{(4)}$,
and $\boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$

$(m_2)^{(4)} = (\nu_4)^{(4)}, (m_1)^{(4)} = (\nu_0)^{(4)}$, $\boldsymbol{if}\ (\bar{\nu}_4)^{(4)} < (\nu_0)^{(4)}$

and analogously 437
438

$(\mu_2)^{(4)} = (u_0)^{(4)}, (\mu_1)^{(4)} = (u_1)^{(4)}$, $\boldsymbol{if}\ (u_0)^{(4)} < (u_1)^{(4)}$

$(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (\bar{u}_1)^{(4)}$, $\boldsymbol{if}\ (u_1)^{(4)} < (u_0)^{(4)} < (\bar{u}_1)^{(4)}$,
and $\boxed{(u_0)^{(4)} = \frac{T_{24}^0}{T_{25}^0}}$

$(\mu_2)^{(4)} = (u_1)^{(4)}, (\mu_1)^{(4)} = (u_0)^{(4)}, \boldsymbol{if}\ (\bar{u}_1)^{(4)} < (u_0)^{(4)}$ where $(u_1)^{(4)}, (\bar{u}_1)^{(4)}$ are defined respectively

Then the solution satisfies the inequalities 439
440

$$G_{24}^0 e^{((S_1)^{(4)} - (p_{24})^{(4)})t} \le G_{24}(t) \le G_{24}^0 e^{(S_1)^{(4)}t}$$ 441
442

where $(p_i)^{(4)}$ is defined 443
444
445

$$\frac{1}{(m_1)^{(4)}} G_{24}^0 e^{((S_1)^{(4)} - (p_{24})^{(4)})t} \le G_{25}(t) \le \frac{1}{(m_2)^{(4)}} G_{24}^0 e^{(S_1)^{(4)}t}$$ 446
447

$$\left(\frac{(a_{26})^{(4)} G_{24}^0}{(m_1)^{(4)}((S_1)^{(4)} - (p_{24})^{(4)} - (S_2)^{(4)})}\left[e^{((S_1)^{(4)} - (p_{24})^{(4)})t} - e^{-(S_2)^{(4)}t}\right] + G_{26}^0 e^{-(S_2)^{(4)}t} \le G_{26}(t) \le \frac{(a_{26})^{(4)} G_{24}^0}{(m_2)^{(4)}((S_1)^{(4)} - (a_{26}^{'})^{(4)})}\left[e^{(S_1)^{(4)}t} - e^{-(a_{26}^{'})^{(4)}t}\right] + G_{26}^0 e^{-(a_{26}^{'})^{(4)}t}\right)$$ 448

$$\boxed{T_{24}^0 e^{(R_1)^{(4)}t} \le T_{24}(t) \le T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t}} \quad 449$$

$$\frac{1}{(\mu_1)^{(4)}} T_{24}^0 e^{(R_1)^{(4)}t} \le T_{24}(t) \le \frac{1}{(\mu_2)^{(4)}} T_{24}^0 e^{((R_1)^{(4)}+(r_{24})^{(4)})t} \quad 450$$

$$\frac{(b_{26})^{(4)} T_{24}^0}{(\mu_1)^{(4)}((R_1)^{(4)}-(b_{26}')^{(4)})}\left[e^{(R_1)^{(4)}t} - e^{-(b_{26}')^{(4)}t}\right] + T_{26}^0 e^{-(b_{26}')^{(4)}t} \le T_{26}(t) \le \quad 451$$

$$\frac{(a_{26})^{(4)} T_{24}^0}{(\mu_2)^{(4)}((R_1)^{(4)}+(r_{24})^{(4)}+(R_2)^{(4)})}\left[e^{((R_1)^{(4)}+(r_{24})^{(4)})t} - e^{-(R_2)^{(4)}t}\right] + T_{26}^0 e^{-(R_2)^{(4)}t}$$

Definition of $(S_1)^{(4)}, (S_2)^{(4)}, (R_1)^{(4)}, (R_2)^{(4)}$:- 452

Where $(S_1)^{(4)} = (a_{24})^{(4)}(m_2)^{(4)} - (a_{24}')^{(4)}$

$(S_2)^{(4)} = (a_{26})^{(4)} - (p_{26})^{(4)}$

$(R_1)^{(4)} = (b_{24})^{(4)}(\mu_2)^{(4)} - (b_{24}')^{(4)}$

$(R_2)^{(4)} = (b_{26}')^{(4)} - (r_{26})^{(4)}$ 453

Behavior of the solutions 454

If we denote and define

Definition of $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$:

(g) $(\sigma_1)^{(5)}, (\sigma_2)^{(5)}, (\tau_1)^{(5)}, (\tau_2)^{(5)}$ four constants satisfying

$$-(\sigma_2)^{(5)} \le -(a_{28}')^{(5)} + (a_{29}')^{(5)} - (a_{28}'')^{(5)}(T_{29}, t) + (a_{29}'')^{(5)}(T_{29}, t) \le -(\sigma_1)^{(5)}$$

$$-(\tau_2)^{(5)} \le -(b_{28}')^{(5)} + (b_{29}')^{(5)} - (b_{28}'')^{(5)}\big((G_{31}), t\big) - (b_{29}'')^{(5)}\big((G_{31}), t\big) \le -(\tau_1)^{(5)}$$

Definition of $(\nu_1)^{(5)}, (\nu_2)^{(5)}, (u_1)^{(5)}, (u_2)^{(5)}, \nu^{(5)}, u^{(5)}$: 455

(h) By $(\nu_1)^{(5)} > 0$, $(\nu_2)^{(5)} < 0$ and respectively $(u_1)^{(5)} > 0$, $(u_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$
and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_1)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$ and

Definition of $(\bar{\nu}_1)^{(5)},, (\bar{\nu}_2)^{(5)}, (\bar{u}_1)^{(5)}, (\bar{u}_2)^{(5)}$: 456

By $(\bar{\nu}_1)^{(5)} > 0$, $(\bar{\nu}_2)^{(5)} < 0$ and respectively $(\bar{u}_1)^{(5)} > 0$, $(\bar{u}_2)^{(5)} < 0$ the roots of the equations $(a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)} = 0$
and $(b_{29})^{(5)}\left(u^{(5)}\right)^2 + (\tau_2)^{(5)}u^{(5)} - (b_{28})^{(5)} = 0$

Definition of $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}, (\nu_0)^{(5)}$:-

(i) If we define $(m_1)^{(5)}, (m_2)^{(5)}, (\mu_1)^{(5)}, (\mu_2)^{(5)}$ by

$(m_2)^{(5)} = (\nu_0)^{(5)}, (m_1)^{(5)} = (\nu_1)^{(5)}$, $\boldsymbol{if}$ $(\nu_0)^{(5)} < (\nu_1)^{(5)}$

$(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\bar{\nu}_1)^{(5)}$, $\boldsymbol{if}$ $(\nu_1)^{(5)} < (\nu_0)^{(5)} < (\bar{\nu}_1)^{(5)}$,
and $\boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$

$(m_2)^{(5)} = (\nu_1)^{(5)}, (m_1)^{(5)} = (\nu_0)^{(5)}$, $\boldsymbol{if}$ $(\bar{\nu}_1)^{(5)} < (\nu_0)^{(5)}$

and analogously 457

$(\mu_2)^{(5)} = (u_0)^{(5)}, (\mu_1)^{(5)} = (u_1)^{(5)},\ \boldsymbol{if}\ (u_0)^{(5)} < (u_1)^{(5)}$

$(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (\bar{u}_1)^{(5)}, \boldsymbol{if}\ (u_1)^{(5)} < (u_0)^{(5)} < (\bar{u}_1)^{(5)},$

and $\boxed{(u_0)^{(5)} = \frac{T_{28}^0}{T_{29}^0}}$

$(\mu_2)^{(5)} = (u_1)^{(5)}, (\mu_1)^{(5)} = (u_0)^{(5)}, \boldsymbol{if}\ (\bar{u}_1)^{(5)} < (u_0)^{(5)}$ where $(u_1)^{(5)}, (\bar{u}_1)^{(5)}$ are defined respectively

Then the solution satisfies the inequalities 458

$$G_{28}^0 e^{((S_1)^{(5)} - (p_{28})^{(5)})t} \le G_{28}(t) \le G_{28}^0 e^{(S_1)^{(5)} t}$$

where $(p_i)^{(5)}$ is defined

$$\frac{1}{(m_5)^{(5)}} G_{28}^0 e^{((S_1)^{(5)} - (p_{28})^{(5)})t} \le G_{29}(t) \le \frac{1}{(m_2)^{(5)}} G_{28}^0 e^{(S_1)^{(5)} t} \quad 459$$

460

$$\left(\frac{(a_{30})^{(5)} G_{28}^0}{(m_1)^{(5)}((S_1)^{(5)} - (p_{28})^{(5)} - (S_2)^{(5)})}\left[e^{((S_1)^{(5)} - (p_{28})^{(5)})t} - e^{-(S_2)^{(5)} t}\right] + G_{30}^0 e^{-(S_2)^{(5)} t} \le G_{30}(t) \le \frac{(a_{30})^{(5)} G_{28}^0}{(m_2)^{(5)}((S_1)^{(5)} - (a_{30}')^{(5)})}\left[e^{(S_1)^{(5)} t} - e^{-(a_{30}')^{(5)} t}\right] + G_{30}^0 e^{-(a_{30}')^{(5)} t}\right) \quad 461$$

$$\boxed{T_{28}^0 e^{(R_1)^{(5)} t} \le T_{28}(t) \le T_{28}^0 e^{((R_1)^{(5)} + (r_{28})^{(5)})t}} \quad 462$$

$$\frac{1}{(\mu_1)^{(5)}} T_{28}^0 e^{(R_1)^{(5)} t} \le T_{28}(t) \le \frac{1}{(\mu_2)^{(5)}} T_{28}^0 e^{((R_1)^{(5)} + (r_{28})^{(5)})t} \quad 463$$

$$\frac{(b_{30})^{(5)} T_{28}^0}{(\mu_1)^{(5)}((R_1)^{(5)} - (b_{30}')^{(5)})}\left[e^{(R_1)^{(5)} t} - e^{-(b_{30}')^{(5)} t}\right] + T_{30}^0 e^{-(b_{30}')^{(5)} t} \le T_{30}(t) \le \quad 464$$

$$\frac{(a_{30})^{(5)} T_{28}^0}{(\mu_2)^{(5)}((R_1)^{(5)} + (r_{28})^{(5)} + (R_2)^{(5)})}\left[e^{((R_1)^{(5)} + (r_{28})^{(5)})t} - e^{-(R_2)^{(5)} t}\right] + T_{30}^0 e^{-(R_2)^{(5)} t}$$

Definition of $(S_1)^{(5)}, (S_2)^{(5)}, (R_1)^{(5)}, (R_2)^{(5)}$:- 465

Where $(S_1)^{(5)} = (a_{28})^{(5)}(m_2)^{(5)} - (a_{28}')^{(5)}$

$(S_2)^{(5)} = (a_{30})^{(5)} - (p_{30})^{(5)}$

$(R_1)^{(5)} = (b_{28})^{(5)}(\mu_2)^{(5)} - (b_{28}')^{(5)}$

$(R_2)^{(5)} = (b_{30}')^{(5)} - (r_{30})^{(5)}$

Behavior of the solutions 466

If we denote and define

Definition of $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$:

(j) $(\sigma_1)^{(6)}, (\sigma_2)^{(6)}, (\tau_1)^{(6)}, (\tau_2)^{(6)}$ four constants satisfying

$$-(\sigma_2)^{(6)} \le -(a_{32}')^{(6)} + (a_{33}')^{(6)} - (a_{32}'')^{(6)}(T_{33}, t) + (a_{33}'')^{(6)}(T_{33}, t) \le -(\sigma_1)^{(6)}$$

$$-(\tau_2)^{(6)} \le -(b_{32}')^{(6)} + (b_{33}')^{(6)} - (b_{32}'')^{(6)}\big((G_{35}), t\big) - (b_{33}'')^{(6)}\big((G_{35}), t\big) \le -(\tau_1)^{(6)}$$

Definition of $(\nu_1)^{(6)}, (\nu_2)^{(6)}, (u_1)^{(6)}, (u_2)^{(6)}, \nu^{(6)}, u^{(6)}$: 467

(k) By $(\nu_1)^{(6)} > 0$, $(\nu_2)^{(6)} < 0$ and respectively $(u_1)^{(6)} > 0$, $(u_2)^{(6)} < 0$ the roots of the

equations $(a_{33})^{(6)}\left(v^{(6)}\right)^2 + (\sigma_1)^{(6)}v^{(6)} - (a_{32})^{(6)} = 0$
and $(b_{33})^{(6)}\left(u^{(6)}\right)^2 + (\tau_1)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$ and

Definition of $(\bar{v}_1)^{(6)},, (\bar{v}_2)^{(6)}, (\bar{u}_1)^{(6)}, (\bar{u}_2)^{(6)}$: 468

By $(\bar{v}_1)^{(6)} > 0$, $(\bar{v}_2)^{(6)} < 0$ and respectively $(\bar{u}_1)^{(6)} > 0$, $(\bar{u}_2)^{(6)} < 0$ the roots of the equations $(a_{33})^{(6)}\left(v^{(6)}\right)^2 + (\sigma_2)^{(6)}v^{(6)} - (a_{32})^{(6)} = 0$
and $(b_{33})^{(6)}\left(u^{(6)}\right)^2 + (\tau_2)^{(6)}u^{(6)} - (b_{32})^{(6)} = 0$

Definition of $(m_1)^{(6)}$, $(m_2)^{(6)}$, $(\mu_1)^{(6)}, (\mu_2)^{(6)}, (\nu_0)^{(6)}$:-

(l) If we define $(m_1)^{(6)}$, $(m_2)^{(6)}$, $(\mu_1)^{(6)}, (\mu_2)^{(6)}$ by

$(m_2)^{(6)} = (\nu_0)^{(6)}, (m_1)^{(6)} = (\nu_1)^{(6)}$, $\boldsymbol{if}\ (\nu_0)^{(6)} < (\nu_1)^{(6)}$

$(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\bar{\nu}_6)^{(6)}$, $\boldsymbol{if}\ (\nu_1)^{(6)} < (\nu_0)^{(6)} < (\bar{\nu}_1)^{(6)}$, 470
and $\boxed{(\nu_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$

$(m_2)^{(6)} = (\nu_1)^{(6)}, (m_1)^{(6)} = (\nu_0)^{(6)}$, $\boldsymbol{if}\ (\bar{\nu}_1)^{(6)} < (\nu_0)^{(6)}$

and analogously 471

$(\mu_2)^{(6)} = (u_0)^{(6)}, (\mu_1)^{(6)} = (u_1)^{(6)}$, $\boldsymbol{if}\ (u_0)^{(6)} < (u_1)^{(6)}$

$(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (\bar{u}_1)^{(6)}$, $\boldsymbol{if}\ (u_1)^{(6)} < (u_0)^{(6)} < (\bar{u}_1)^{(6)}$,
and $\boxed{(u_0)^{(6)} = \frac{T_{32}^0}{T_{33}^0}}$

$(\mu_2)^{(6)} = (u_1)^{(6)}, (\mu_1)^{(6)} = (u_0)^{(6)}, \boldsymbol{if}\ (\bar{u}_1)^{(6)} < (u_0)^{(6)}$ where $(u_1)^{(6)}, (\bar{u}_1)^{(6)}$ are defined respectively

Then the solution satisfies the inequalities 472

$$G_{32}^0 e^{((S_1)^{(6)} - (p_{32})^{(6)})t} \le G_{32}(t) \le G_{32}^0 e^{(S_1)^{(6)}t}$$

where $(p_i)^{(6)}$ is defined

$$\frac{1}{(m_1)^{(6)}} G_{32}^0 e^{((S_1)^{(6)} - (p_{32})^{(6)})t} \le G_{33}(t) \le \frac{1}{(m_2)^{(6)}} G_{32}^0 e^{(S_1)^{(6)}t} \quad 473$$

$$\left(\frac{(a_{34})^{(6)} G_{32}^0}{(m_1)^{(6)}((S_1)^{(6)} - (p_{32})^{(6)} - (S_2)^{(6)})}\left[e^{((S_1)^{(6)} - (p_{32})^{(6)})t} - e^{-(S_2)^{(6)}t}\right] + G_{34}^0 e^{-(S_2)^{(6)}t} \le G_{34}(t) \le \right. \quad 474$$
$$\left. \frac{(a_{34})^{(6)} G_{32}^0}{(m_2)^{(6)}((S_1)^{(6)} - (a'_{34})^{(6)})}\left[e^{(S_1)^{(6)}t} - e^{-(a'_{34})^{(6)}t}\right] + G_{34}^0 e^{-(a'_{34})^{(6)}t}\right)$$

$$\boxed{T_{32}^0 e^{(R_1)^{(6)}t} \le T_{32}(t) \le T_{32}^0 e^{((R_1)^{(6)} + (r_{32})^{(6)})t}} \quad 475$$

$$\frac{1}{(\mu_1)^{(6)}} T_{32}^0 e^{(R_1)^{(6)}t} \le T_{32}(t) \le \frac{1}{(\mu_2)^{(6)}} T_{32}^0 e^{((R_1)^{(6)} + (r_{32})^{(6)})t} \quad 476$$

$$\frac{(b_{34})^{(6)} T_{32}^0}{(\mu_1)^{(6)}((R_1)^{(6)} - (b'_{34})^{(6)})}\left[e^{(R_1)^{(6)}t} - e^{-(b'_{34})^{(6)}t}\right] + T_{34}^0 e^{-(b'_{34})^{(6)}t} \le T_{34}(t) \le \quad 477$$

$$\frac{(a_{34})^{(6)} T_{32}^0}{(\mu_2)^{(6)}((R_1)^{(6)} + (r_{32})^{(6)} + (R_2)^{(6)})}\left[e^{((R_1)^{(6)} + (r_{32})^{(6)})t} - e^{-(R_2)^{(6)}t}\right] + T_{34}^0 e^{-(R_2)^{(6)}t}$$

Definition of $(S_1)^{(6)}, (S_2)^{(6)}, (R_1)^{(6)}, (R_2)^{(6)}$:- 478

Where $(S_1)^{(6)} = (a_{32})^{(6)}(m_2)^{(6)} - (a'_{32})^{(6)}$

$(S_2)^{(6)} = (a_{34})^{(6)} - (p_{34})^{(6)}$

$(R_1)^{(6)} = (b_{32})^{(6)}(\mu_2)^{(6)} - (b'_{32})^{(6)}$

$(R_2)^{(6)} = (b'_{34})^{(6)} - (r_{34})^{(6)}$

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If we denote and define

Definition of $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$:

(m) $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying
$-(\sigma_2)^{(7)} \le -(a'_{36})^{(7)} + (a'_{37})^{(7)} - (a''_{36})^{(7)}(T_{37}, t) + (a''_{37})^{(7)}(T_{37}, t) \le -(\sigma_1)^{(7)}$

$-(\tau_2)^{(7)} \le -(b'_{36})^{(7)} + (b'_{37})^{(7)} - (b''_{36})^{(7)}\big((G_{39}), t\big) - (b''_{37})^{(7)}\big((G_{39}), t\big) \le -(\tau_1)^{(7)}$

Definition of $(\nu_1)^{(7)}, (\nu_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, \nu^{(7)}, u^{(7)}$: 480

(n) By $(\nu_1)^{(7)} > 0$, $(\nu_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0$, $(u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\big(\nu^{(7)}\big)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$ 481
and $(b_{37})^{(7)}\big(u^{(7)}\big)^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and

Definition of $(\bar{\nu}_1)^{(7)}, , (\bar{\nu}_2)^{(7)}, (\bar{u}_1)^{(7)}, (\bar{u}_2)^{(7)}$: 482

By $(\bar{\nu}_1)^{(7)} > 0$, $(\bar{\nu}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0$, $(\bar{u}_2)^{(7)} < 0$ the

roots of the equations $(a_{37})^{(7)}\big(\nu^{(7)}\big)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)} = 0$

and $(b_{37})^{(7)}\big(u^{(7)}\big)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$

Definition of $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}, (\nu_0)^{(7)}$:-

(o) If we define $(m_1)^{(7)}, (m_2)^{(7)}, (\mu_1)^{(7)}, (\mu_2)^{(7)}$ by

$(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)}$, $\boldsymbol{if}\ (\nu_0)^{(7)} < (\nu_1)^{(7)}$

$(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)}$, $\boldsymbol{if}\ (\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)}$,

and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$

$(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)}$, $\boldsymbol{if}\ (\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$

and analogously 483

$(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)}$, $\boldsymbol{if}\ (u_0)^{(7)} < (u_1)^{(7)}$

$(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)}$, $\boldsymbol{if}$ $(u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)}$,

and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$

$(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if}$ $(\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$

are defined respectively

Then the solution satisfies the inequalities 484

$$G_{36}^0 e^{((S_1)^{(7)} - (p_{36})^{(7)})t} \leq G_{36}(t) \leq G_{36}^0 e^{(S_1)^{(7)} t}$$

where $(p_i)^{(7)}$ is defined

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$$\frac{1}{(m_7)^{(7)}} G_{36}^0 e^{((S_1)^{(7)} - (p_{36})^{(7)})t} \leq G_{37}(t) \leq \frac{1}{(m_2)^{(7)}} G_{36}^0 e^{(S_1)^{(7)} t} \quad 486$$

$$\left(\frac{(a_{38})^{(7)} G_{36}^0}{(m_1)^{(7)}((S_1)^{(7)} - (p_{36})^{(7)} - (S_2)^{(7)})} \left[e^{((S_1)^{(7)} - (p_{36})^{(7)})t} - e^{-(S_2)^{(7)} t} \right] + G_{38}^0 e^{-(S_2)^{(7)} t} \leq G_{38}(t) \leq \right. \quad 487$$
$$\left. \frac{(a_{38})^{(7)} G_{36}^0}{(m_2)^{(7)}((S_1)^{(7)} - (a_{38}')^{(7)})} [e^{(S_1)^{(7)} t} - e^{-(a_{38}')^{(7)} t}] + G_{38}^0 e^{-(a_{38}')^{(7)} t} \right)$$

$$\boxed{T_{36}^0 e^{(R_1)^{(7)} t} \leq T_{36}(t) \leq T_{36}^0 e^{((R_1)^{(7)} + (r_{36})^{(7)})t}} \quad 488$$

$$\frac{1}{(\mu_1)^{(7)}} T_{36}^0 e^{(R_1)^{(7)} t} \leq T_{36}(t) \leq \frac{1}{(\mu_2)^{(7)}} T_{36}^0 e^{((R_1)^{(7)} + (r_{36})^{(7)})t} \quad 489$$

$$\frac{(b_{38})^{(7)} T_{36}^0}{(\mu_1)^{(7)}((R_1)^{(7)} - (b_{38}')^{(7)})} \left[e^{(R_1)^{(7)} t} - e^{-(b_{38}')^{(7)} t} \right] + T_{38}^0 e^{-(b_{38}')^{(7)} t} \leq T_{38}(t) \leq \quad 490$$

$$\frac{(a_{38})^{(7)} T_{36}^0}{(\mu_2)^{(7)}((R_1)^{(7)} + (r_{36})^{(7)} + (R_2)^{(7)})} \left[e^{((R_1)^{(7)} + (r_{36})^{(7)})t} - e^{-(R_2)^{(7)} t} \right] + T_{38}^0 e^{-(R_2)^{(7)} t}$$

Definition of $(S_1)^{(7)}, (S_2)^{(7)}, (R_1)^{(7)}, (R_2)^{(7)}$:- 491

Where $(S_1)^{(7)} = (a_{36})^{(7)}(m_2)^{(7)} - (a'_{36})^{(7)}$

$(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$

$(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b'_{36})^{(7)}$

$(R_2)^{(7)} = (b'_{38})^{(7)} - (r_{38})^{(7)}$

Behavior of the solutions 492

Theorem 2: If we denote and define

Definition of $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$:

(p) $(\sigma_1)^{(8)}, (\sigma_2)^{(8)}, (\tau_1)^{(8)}, (\tau_2)^{(8)}$ four constants satisfying

$$-(\sigma_2)^{(8)} \le -(a'_{40})^{(8)} + (a'_{41})^{(8)} - (a''_{40})^{(8)}(T_{41}, t) + (a''_{41})^{(8)}(T_{41}, t) \le -(\sigma_1)^{(8)}$$

$$-(\tau_2)^{(8)} \le -(b'_{40})^{(8)} + (b'_{41})^{(8)} - (b''_{40})^{(8)}\big((G_{43}), t\big) - (b''_{41})^{(8)}\big((G_{43}), t\big) \le -(\tau_1)^{(8)}$$

Definition of $(\nu_1)^{(8)}, (\nu_2)^{(8)}, (u_1)^{(8)}, (u_2)^{(8)}, \nu^{(8)}, u^{(8)}$: 493

(q) By $(\nu_1)^{(8)} > 0$, $(\nu_2)^{(8)} < 0$ and respectively $(u_1)^{(8)} > 0$, $(u_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\big(\nu^{(8)}\big)^2 + (\sigma_1)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$ and $(b_{41})^{(8)}\big(u^{(8)}\big)^2 + (\tau_1)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$ and

Definition of $(\bar{\nu}_1)^{(8)}, , (\bar{\nu}_2)^{(8)}, (\bar{u}_1)^{(8)}, (\bar{u}_2)^{(8)}$: 494

By $(\bar{\nu}_1)^{(8)} > 0$, $(\bar{\nu}_2)^{(8)} < 0$ and respectively $(\bar{u}_1)^{(8)} > 0$, $(\bar{u}_2)^{(8)} < 0$ the roots of the equations $(a_{41})^{(8)}\big(\nu^{(8)}\big)^2 + (\sigma_2)^{(8)}\nu^{(8)} - (a_{40})^{(8)} = 0$ and $(b_{41})^{(8)}\big(u^{(8)}\big)^2 + (\tau_2)^{(8)}u^{(8)} - (b_{40})^{(8)} = 0$

Definition of $(m_1)^{(8)}, (m_2)^{(8)}, (\mu_1)^{(8)}, (\mu_2)^{(8)}, (\nu_0)^{(8)}$:-

(r) If we define $(m_1)^{(8)}, (m_2)^{(8)}, (\mu_1)^{(8)}, (\mu_2)^{(8)}$ by

$(m_2)^{(8)} = (\nu_0)^{(8)}, (m_1)^{(8)} = (\nu_1)^{(8)},\ \boldsymbol{if}\ (\nu_0)^{(8)} < (\nu_1)^{(8)}$

$(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\bar{\nu}_1)^{(8)}, \boldsymbol{if}\ (\nu_1)^{(8)} < (\nu_0)^{(8)} < (\bar{\nu}_1)^{(8)},$

and $\boxed{(\nu_0)^{(8)} = \frac{G_{40}^0}{G_{41}^0}}$

$(m_2)^{(8)} = (\nu_1)^{(8)}, (m_1)^{(8)} = (\nu_0)^{(8)},\ \boldsymbol{if}\ (\bar{\nu}_1)^{(8)} < (\nu_0)^{(8)}$

and analogously 495

$(\mu_2)^{(8)} = (u_0)^{(8)}, (\mu_1)^{(8)} = (u_1)^{(8)},\ \boldsymbol{if}\ (u_0)^{(8)} < (u_1)^{(8)}$

$(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (\bar{u}_1)^{(8)}, \boldsymbol{if}\ (u_1)^{(8)} < (u_0)^{(8)} < (\bar{u}_1)^{(8)},$

and $\boxed{(u_0)^{(8)} = \frac{T_{40}^0}{T_{41}^0}}$

$(\mu_2)^{(8)} = (u_1)^{(8)}, (\mu_1)^{(8)} = (u_0)^{(8)}, \boldsymbol{if}\ (\bar{u}_1)^{(8)} < (u_0)^{(8)}$ where $(u_1)^{(8)}, (\bar{u}_1)^{(8)}$ are defined respectively

Then the solution of GLOBAL EQUATIONS satisfies the inequalities 496

496A

$$G_{40}^0 e^{((S_1)^{(8)} - (p_{40})^{(8)})t} \le G_{40}(t) \le G_{40}^0 e^{(S_1)^{(8)} t}$$ 496B

496C

497C

where $(p_i)^{(8)}$ is defined

497D

497E

497F

497G

$$\frac{1}{(m_1)^{(8)}} G_{40}^0 e^{((S_1)^{(8)} - (p_{40})^{(8)})t} \le G_{41}(t) \le \frac{1}{(m_2)^{(8)}} G_{40}^0 e^{(S_1)^{(8)} t}$$ 497

$$\left(\frac{(a_{42})^{(8)}G_{40}^{0}}{(m_1)^{(8)}((S_1)^{(8)}-(p_{40})^{(8)}-(S_2)^{(8)})}\left[e^{((S_1)^{(8)}-(p_{40})^{(8)})t}-e^{-(S_2)^{(8)}t}\right]+G_{42}^{0}e^{-(S_2)^{(8)}t}\leq G_{42}(t)\leq \frac{(a_{42})^{(8)}G_{40}^{0}}{(m_2)^{(8)}((S_1)^{(8)}-(a_{42}^{'})^{(8)})}\left[e^{(S_1)^{(8)}t}-e^{-(a_{42}^{'})^{(8)}t}\right]+G_{42}^{0}e^{-(a_{42}^{'})^{(8)}t}\right) \quad 498$$

$$\boxed{T_{40}^{0}e^{(R_1)^{(8)}t}\leq T_{40}(t)\leq T_{40}^{0}e^{((R_1)^{(8)}+(r_{40})^{(8)})t}} \quad 499$$

$$\frac{1}{(\mu_1)^{(8)}}T_{40}^{0}e^{(R_1)^{(8)}t}\leq T_{40}(t)\leq \frac{1}{(\mu_2)^{(8)}}T_{40}^{0}e^{((R_1)^{(8)}+(r_{40})^{(8)})t} \quad 500$$

$$\frac{(b_{42})^{(8)}T_{40}^{0}}{(\mu_1)^{(8)}((R_1)^{(8)}-(b_{42}^{'})^{(8)})}\left[e^{(R_1)^{(8)}t}-e^{-(b_{42}^{'})^{(8)}t}\right]+T_{42}^{0}e^{-(b_{42}^{'})^{(8)}t}\leq T_{42}(t)\leq \quad 501$$

$$\frac{(a_{42})^{(8)}T_{40}^{0}}{(\mu_2)^{(8)}((R_1)^{(8)}+(r_{40})^{(8)}+(R_2)^{(8)})}\left[e^{((R_1)^{(8)}+(r_{40})^{(8)})t}-e^{-(R_2)^{(8)}t}\right]+T_{42}^{0}e^{-(R_2)^{(8)}t}$$

Definition of $(S_1)^{(8)}, (S_2)^{(8)}, (R_1)^{(8)}, (R_2)^{(8)}$:- 502

Where $(S_1)^{(8)}=(a_{40})^{(8)}(m_2)^{(8)}-(a_{40}^{'})^{(8)}$

$$(S_2)^{(8)}=(a_{42})^{(8)}-(p_{42})^{(8)}$$

$$(R_1)^{(8)}=(b_{40})^{(8)}(\mu_2)^{(8)}-(b_{40}^{'})^{(8)}$$

$$(R_2)^{(8)}=(b_{42}^{'})^{(8)}-(r_{42})^{(8)}$$

From GLOBAL EQUATIONS we obtain 503

$$\frac{d\nu^{(8)}}{dt}=(a_{40})^{(8)}-\left((a_{40}^{'})^{(8)}-(a_{41}^{'})^{(8)}+(a_{40}^{''})^{(8)}(T_{41},t)\right)-(a_{41}^{''})^{(8)}(T_{41},t)\nu^{(8)}-(a_{41})^{(8)}\nu^{(8)}$$

Definition of $\nu^{(8)}$:- $\boxed{\nu^{(8)}=\frac{G_{40}}{G_{41}}}$

It follows

$$-\left((a_{41})^{(8)}\left(v^{(8)}\right)^2+(\sigma_2)^{(8)}v^{(8)}-(a_{40})^{(8)}\right)\leq\frac{dv^{(8)}}{dt}\leq$$

$$-\left((a_{41})^{(8)}\left(v^{(8)}\right)^2+(\sigma_1)^{(8)}v^{(8)}-(a_{40})^{(8)}\right)$$

From which one obtains

Definition of $(\bar{v}_1)^{(8)},(v_0)^{(8)}$:-

(a) For $0<\boxed{(v_0)^{(8)}=\frac{G_{40}^0}{G_{41}^0}}<(v_1)^{(8)}<(\bar{v}_1)^{(8)}$

$$v^{(8)}(t)\geq\frac{(v_1)^{(8)}+(C)^{(8)}(v_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((v_1)^{(8)}-(v_0)^{(8)}\right)t\right]}}{1+(C)^{(8)}e^{\left[-(a_{41})^{(8)}\left((v_1)^{(8)}-(v_0)^{(8)}\right)t\right]}}\quad,\quad\boxed{(C)^{(8)}=\frac{(v_1)^{(8)}-(v_0)^{(8)}}{(v_0)^{(8)}-(v_2)^{(8)}}}$$

it follows $(v_0)^{(8)}\leq v^{(8)}(t)\leq(v_1)^{(8)}$

In the same manner , we get 504

$$v^{(8)}(t)\leq\frac{(\bar{v}_1)^{(8)}+(\bar{C})^{(8)}(\bar{v}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{v}_1)^{(8)}-(\bar{v}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{v}_1)^{(8)}-(\bar{v}_2)^{(8)}\right)t\right]}}\quad,\quad\boxed{(\bar{C})^{(8)}=\frac{(\bar{v}_1)^{(8)}-(v_0)^{(8)}}{(v_0)^{(8)}-(\bar{v}_2)^{(8)}}}$$

From which we deduce $(v_0)^{(8)}\leq v^{(8)}(t)\leq(\bar{v}_8)^{(8)}$

(b) If $0<(v_1)^{(8)}<(v_0)^{(8)}=\frac{G_{40}^0}{G_{41}^0}<(\bar{v}_1)^{(8)}$ we find like in the previous case, 505

$$(v_1)^{(8)}\leq\frac{(v_1)^{(8)}+(C)^{(8)}(v_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((v_1)^{(8)}-(v_2)^{(8)}\right)t\right]}}{1+(C)^{(8)}e^{\left[-(a_{41})^{(8)}\left((v_1)^{(8)}-(v_2)^{(8)}\right)t\right]}}\leq v^{(8)}(t)\leq$$

$$\frac{(\bar{v}_1)^{(8)}+(\bar{C})^{(8)}(\bar{v}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{v}_1)^{(8)}-(\bar{v}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{v}_1)^{(8)}-(\bar{v}_2)^{(8)}\right)t\right]}}\leq(\bar{v}_1)^{(8)}$$

(c) If $0<(v_1)^{(8)}\leq(\bar{v}_1)^{(8)}\leq\boxed{(v_0)^{(8)}=\frac{G_{40}^0}{G_{41}^0}}$, we obtain 506

$$(\nu_1)^{(8)} \leq \nu^{(8)}(t) \leq \frac{(\bar{\nu}_1)^{(8)}+(\bar{C})^{(8)}(\bar{\nu}_2)^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}}{1+(\bar{C})^{(8)}e^{\left[-(a_{41})^{(8)}\left((\bar{\nu}_1)^{(8)}-(\bar{\nu}_2)^{(8)}\right)t\right]}} \leq (\nu_0)^{(8)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(8)}(t)$:-

$$(m_2)^{(8)} \leq \nu^{(8)}(t) \leq (m_1)^{(8)}, \quad \boxed{\nu^{(8)}(t) = \frac{G_{40}(t)}{G_{41}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(8)}(t)$:-

$$(\mu_2)^{(8)} \leq u^{(8)}(t) \leq (\mu_1)^{(8)}, \quad \boxed{u^{(8)}(t) = \frac{T_{40}(t)}{T_{41}(t)}}$$

Now, using this result and replacing it in CONCATENATED GLOBAL EQUATIONS we get easily the result stated in the theorem.

Particular case :

If $(a_{40}^{''})^{(8)} = (a_{41}^{''})^{(8)}, then\ (\sigma_1)^{(8)} = (\sigma_2)^{(8)}$ and in this case $(\nu_1)^{(8)} = (\bar{\nu}_1)^{(8)}$ if in addition $(\nu_0)^{(8)} = (\nu_1)^{(8)}$ then $\nu^{(8)}(t) = (\nu_0)^{(8)}$ and as a consequence $G_{40}(t) = (\nu_0)^{(8)}G_{41}(t)$ **this also defines** $(\nu_0)^{(8)}$ **for the special case**.

Analogously if $(b_{40}^{''})^{(8)} = (b_{41}^{''})^{(8)}, then\ (\tau_1)^{(8)} = (\tau_2)^{(8)}$ and then

$(u_1)^{(8)} = (\bar{u}_1)^{(8)}$if in addition $(u_0)^{(8)} = (u_1)^{(8)}$ then $T_{40}(t) = (u_0)^{(8)}T_{41}(t)$ This is an important consequence of the relation between $(\nu_1)^{(8)}$ and $(\bar{\nu}_1)^{(8)}$, **and definition of** $(u_0)^{(8)}$.

: From GLOBAL EQUATIONS we obtain 507

$$\frac{d\nu^{(4)}}{dt} = (a_{24})^{(4)} - \left((a_{24}^{'})^{(4)} - (a_{25}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25},t)\right) - (a_{25}^{''})^{(4)}(T_{25},t)\nu^{(4)} - (a_{25})^{(4)}\nu^{(4)}$$

Definition of $\nu^{(4)}$:- $\boxed{\nu^{(4)} = \frac{G_{24}}{G_{25}}}$ 508

It follows

$$-\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_2)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right) \leq \frac{d\nu^{(4)}}{dt} \leq -\left((a_{25})^{(4)}\left(\nu^{(4)}\right)^2 + (\sigma_4)^{(4)}\nu^{(4)} - (a_{24})^{(4)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(4)}, (\nu_0)^{(4)}$:-

(d) For $0 < \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}} < (\nu_1)^{(4)} < (\bar{\nu}_1)^{(4)}$

$$\nu^{(4)}(t) \geq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}}{4 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_0)^{(4)}\right)t\right]}} \quad , \quad \boxed{(C)^{(4)} = \frac{(\nu_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\nu_2)^{(4)}}}$$

it follows $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\nu_1)^{(4)}$

In the same manner , we get 509

$$\nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{4 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(4)} = \frac{(\bar{\nu}_1)^{(4)} - (\nu_0)^{(4)}}{(\nu_0)^{(4)} - (\bar{\nu}_2)^{(4)}}}$$

From which we deduce $(\nu_0)^{(4)} \leq \nu^{(4)}(t) \leq (\bar{\nu}_1)^{(4)}$

(e) If $0 < (\nu_1)^{(4)} < (\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0} < (\bar{\nu}_1)^{(4)}$ we find like in the previous case, 510

$$(\nu_1)^{(4)} \leq \frac{(\nu_1)^{(4)} + (C)^{(4)}(\nu_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_2)^{(4)}\right)t\right]}}{1 + (C)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\nu_1)^{(4)} - (\nu_2)^{(4)}\right)t\right]}} \leq \nu^{(4)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(4)} + (C)^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{1 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\bar{\nu}_1)^{(4)}$$

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(f) If $0 < (\nu_1)^{(4)} \leq (\bar{\nu}_1)^{(4)} \leq \boxed{(\nu_0)^{(4)} = \frac{G_{24}^0}{G_{25}^0}}$, we obtain 512

$$(\nu_1)^{(4)} \leq \nu^{(4)}(t) \leq \frac{(\bar{\nu}_1)^{(4)} + (\bar{C})^{(4)}(\bar{\nu}_2)^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}}{1 + (\bar{C})^{(4)} e^{\left[-(a_{25})^{(4)}\left((\bar{\nu}_1)^{(4)} - (\bar{\nu}_2)^{(4)}\right)t\right]}} \leq (\nu_0)^{(4)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(4)}(t)$:-

$(m_2)^{(4)} \leq \nu^{(4)}(t) \leq (m_1)^{(4)}$, $\boxed{\nu^{(4)}(t) = \frac{G_{24}(t)}{G_{25}(t)}}$

In a completely analogous way, we obtain

Definition of $u^{(4)}(t)$:-

$(\mu_2)^{(4)} \leq u^{(4)}(t) \leq (\mu_1)^{(4)}$, $\boxed{u^{(4)}(t) = \frac{T_{24}(t)}{T_{25}(t)}}$

Now, using this result and replacing it in GLOBAL EQUATIONS we get easily the result stated in the theorem.

Particular case :

If $(a_{24}^{''})^{(4)} = (a_{25}^{''})^{(4)}, then\ (\sigma_1)^{(4)} = (\sigma_2)^{(4)}$ and in this case $(\nu_1)^{(4)} = (\bar{\nu}_1)^{(4)}$ if in addition 513
$(\nu_0)^{(4)} = (\nu_1)^{(4)}$ then $\nu^{(4)}(t) = (\nu_0)^{(4)}$ and as a consequence $G_{24}(t) = (\nu_0)^{(4)} G_{25}(t)$ **this also defines** $(\nu_0)^{(4)}$ **for the special case** .

Analogously if $(b_{24}^{''})^{(4)} = (b_{25}^{''})^{(4)}, then\ (\tau_1)^{(4)} = (\tau_2)^{(4)}$ and then
$(u_1)^{(4)} = (\bar{u}_4)^{(4)}$if in addition $(u_0)^{(4)} = (u_1)^{(4)}$ then $T_{24}(t) = (u_0)^{(4)} T_{25}(t)$ This is an important

consequence of the relation between $(\nu_1)^{(4)}$ and $(\bar{\nu}_1)^{(4)}$, **and definition of** $(u_0)^{(4)}$.

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From GLOBAL EQUATIONS we obtain 515

$$\frac{d\nu^{(5)}}{dt} = (a_{28})^{(5)} - \left((a_{28}^{'})^{(5)} - (a_{29}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29},t)\right) - (a_{29}^{''})^{(5)}(T_{29},t)\nu^{(5)} - (a_{29})^{(5)}\nu^{(5)}$$

Definition of $\nu^{(5)}$:- $\boxed{\nu^{(5)} = \frac{G_{28}}{G_{29}}}$

It follows

$$-\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_2)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right) \leq \frac{d\nu^{(5)}}{dt} \leq -\left((a_{29})^{(5)}\left(\nu^{(5)}\right)^2 + (\sigma_1)^{(5)}\nu^{(5)} - (a_{28})^{(5)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(5)}, (\nu_0)^{(5)}$:-

(g) For $0 < \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}} < (\nu_1)^{(5)} < (\bar{\nu}_1)^{(5)}$

$$\nu^{(5)}(t) \geq \frac{(\nu_1)^{(5)} + (C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}}{5 + (C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_0)^{(5)}\right)t\right]}} \quad , \quad \boxed{(C)^{(5)} = \frac{(\nu_1)^{(5)} - (\nu_0)^{(5)}}{(\nu_0)^{(5)} - (\nu_2)^{(5)}}}$$

it follows $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\nu_1)^{(5)}$

In the same manner , we get 516

$$\nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)} + (\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}}{5 + (\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(5)} = \frac{(\bar{\nu}_1)^{(5)} - (\nu_0)^{(5)}}{(\nu_0)^{(5)} - (\bar{\nu}_2)^{(5)}}}$$

From which we deduce $(\nu_0)^{(5)} \leq \nu^{(5)}(t) \leq (\bar{\nu}_5)^{(5)}$

(h) If $0 < (\nu_1)^{(5)} < (\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0} < (\bar{\nu}_1)^{(5)}$ we find like in the previous case, 517

$$(\nu_1)^{(5)} \leq \frac{(\nu_1)^{(5)} + (C)^{(5)}(\nu_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_2)^{(5)}\right)t\right]}}{1 + (C)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\nu_1)^{(5)} - (\nu_2)^{(5)}\right)t\right]}} \leq \nu^{(5)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(5)} + (\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}}{1 + (\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\bar{\nu}_1)^{(5)}$$

(i) If $0 < (\nu_1)^{(5)} \leq (\bar{\nu}_1)^{(5)} \leq \boxed{(\nu_0)^{(5)} = \frac{G_{28}^0}{G_{29}^0}}$, we obtain 518

$$(\nu_1)^{(5)} \leq \nu^{(5)}(t) \leq \frac{(\bar{\nu}_1)^{(5)} + (\bar{C})^{(5)}(\bar{\nu}_2)^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}}{1 + (\bar{C})^{(5)}e^{\left[-(a_{29})^{(5)}\left((\bar{\nu}_1)^{(5)} - (\bar{\nu}_2)^{(5)}\right)t\right]}} \leq (\nu_0)^{(5)}$$

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And so with the notation of the first part of condition (c) , we have

Definition of $\nu^{(5)}(t)$:-

$$(m_2)^{(5)} \leq \nu^{(5)}(t) \leq (m_1)^{(5)}, \quad \boxed{\nu^{(5)}(t) = \frac{G_{28}(t)}{G_{29}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(5)}(t)$:-

$(\mu_2)^{(5)} \leq u^{(5)}(t) \leq (\mu_1)^{(5)}$, $\boxed{u^{(5)}(t) = \frac{T_{28}(t)}{T_{29}(t)}}$

Now, using this result and replacing it in GLOBAL EQUATIONS we get easily the result stated in the theorem.

Particular case :

If $(a''_{28})^{(5)} = (a''_{29})^{(5)}, then\ (\sigma_1)^{(5)} = (\sigma_2)^{(5)}$ and in this case $(\nu_1)^{(5)} = (\bar{\nu}_1)^{(5)}$ if in addition $(\nu_0)^{(5)} = (\nu_5)^{(5)}$ then $\nu^{(5)}(t) = (\nu_0)^{(5)}$ and as a consequence $G_{28}(t) = (\nu_0)^{(5)} G_{29}(t)$ **this also defines** $(\nu_0)^{(5)}$ **for the special case** .

Analogously if $(b''_{28})^{(5)} = (b''_{29})^{(5)}, then\ (\tau_1)^{(5)} = (\tau_2)^{(5)}$ and then $(u_1)^{(5)} = (\bar{u}_1)^{(5)}$if in addition $(u_0)^{(5)} = (u_1)^{(5)}$ then $T_{28}(t) = (u_0)^{(5)} T_{29}(t)$ This is an important consequence of the relation between $(\nu_1)^{(5)}$ and $(\bar{\nu}_1)^{(5)}$, **and definition of** $(u_0)^{(5)}$.

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we obtain 521

$$\frac{d\nu^{(6)}}{dt} = (a_{32})^{(6)} - \left((a'_{32})^{(6)} - (a'_{33})^{(6)} + (a''_{32})^{(6)}(T_{33}, t)\right) - (a''_{33})^{(6)}(T_{33}, t)\nu^{(6)} - (a_{33})^{(6)}\nu^{(6)}$$

Definition of $\nu^{(6)}$:- $\boxed{\nu^{(6)} = \frac{G_{32}}{G_{33}}}$

It follows

$$-\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_2)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right) \leq \frac{d\nu^{(6)}}{dt} \leq -\left((a_{33})^{(6)}\left(\nu^{(6)}\right)^2 + (\sigma_1)^{(6)}\nu^{(6)} - (a_{32})^{(6)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(6)}, (\nu_0)^{(6)}$:-

(j) For $0 < \boxed{(\nu_0)^{(6)} = \frac{G^0_{32}}{G^0_{33}}} < (\nu_1)^{(6)} < (\bar{\nu}_1)^{(6)}$

$$\nu^{(6)}(t) \geq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_0)^{(6)}\right)t\right]}} \quad , \quad \boxed{(C)^{(6)} = \frac{(\nu_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\nu_2)^{(6)}}}$$

it follows $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\nu_1)^{(6)}$

In the same manner , we get 522

$$\nu^{(6)}(t) \leq \frac{(\bar{\nu}_1)^{(6)} + (\bar{C})^{(6)}(\bar{\nu}_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}}{1 + (\bar{C})^{(6)} e^{\left[-(a_{33})^{(6)}\left((\bar{\nu}_1)^{(6)} - (\bar{\nu}_2)^{(6)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(6)} = \frac{(\bar{\nu}_1)^{(6)} - (\nu_0)^{(6)}}{(\nu_0)^{(6)} - (\bar{\nu}_2)^{(6)}}} \qquad 523$$

From which we deduce $(\nu_0)^{(6)} \leq \nu^{(6)}(t) \leq (\bar{\nu}_1)^{(6)}$

(k) If $0 < (\nu_1)^{(6)} < (\nu_0)^{(6)} = \frac{G^0_{32}}{G^0_{33}} < (\bar{\nu}_1)^{(6)}$ we find like in the previous case, 524

$$(\nu_1)^{(6)} \leq \frac{(\nu_1)^{(6)} + (C)^{(6)}(\nu_2)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}}{1 + (C)^{(6)} e^{\left[-(a_{33})^{(6)}\left((\nu_1)^{(6)} - (\nu_2)^{(6)}\right)t\right]}} \leq \nu^{(6)}(t) \leq$$

$$\frac{(\bar{v}_1)^{(6)}+(C)^{(6)}(\bar{v}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{v}_1)^{(6)}-(\bar{v}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{v}_1)^{(6)}-(\bar{v}_2)^{(6)}\right)t\right]}} \leq (\bar{v}_1)^{(6)}$$

(l) If $0 < (v_1)^{(6)} \leq (\bar{v}_1)^{(6)} \leq \boxed{(v_0)^{(6)} = \frac{G_{32}^0}{G_{33}^0}}$, we obtain 525

$$(v_1)^{(6)} \leq v^{(6)}(t) \leq \frac{(\bar{v}_1)^{(6)}+(\bar{C})^{(6)}(\bar{v}_2)^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{v}_1)^{(6)}-(\bar{v}_2)^{(6)}\right)t\right]}}{1+(\bar{C})^{(6)}e^{\left[-(a_{33})^{(6)}\left((\bar{v}_1)^{(6)}-(\bar{v}_2)^{(6)}\right)t\right]}} \leq (v_0)^{(6)}$$

And so with the notation of the first part of condition (c) , we have

Definition of $v^{(6)}(t)$:-

$$(m_2)^{(6)} \leq v^{(6)}(t) \leq (m_1)^{(6)}, \quad \boxed{v^{(6)}(t) = \frac{G_{32}(t)}{G_{33}(t)}}$$

In a completely analogous way, we obtain

Definition of $u^{(6)}(t)$:-

$$(\mu_2)^{(6)} \leq u^{(6)}(t) \leq (\mu_1)^{(6)}, \quad \boxed{u^{(6)}(t) = \frac{T_{32}(t)}{T_{33}(t)}}$$

Now, using this result and replacing it in GLOBAL EQUATIONS we get easily the result stated in the theorem.

Particular case :

If $(a_{32}^{''})^{(6)} = (a_{33}^{''})^{(6)}, then\ (\sigma_1)^{(6)} = (\sigma_2)^{(6)}$ and in this case $(v_1)^{(6)} = (\bar{v}_1)^{(6)}$ if in addition $(v_0)^{(6)} = (v_1)^{(6)}$ then $v^{(6)}(t) = (v_0)^{(6)}$ and as a consequence $G_{32}(t) = (v_0)^{(6)}G_{33}(t)$ **this also defines** $(v_0)^{(6)}$ **for the special case** .

Analogously if $(b_{32}^{''})^{(6)} = (b_{33}^{''})^{(6)}, then\ (\tau_1)^{(6)} = (\tau_2)^{(6)}$ and then $(u_1)^{(6)} = (\bar{u}_1)^{(6)}$if in addition $(u_0)^{(6)} = (u_1)^{(6)}$ then $T_{32}(t) = (u_0)^{(6)}T_{33}(t)$ This is an important consequence of the relation between $(v_1)^{(6)}$ and $(\bar{v}_1)^{(6)}$, **and definition of** $(u_0)^{(6)}$.

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Behavior of the solutions 527

If we denote and define

Definition of $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$:

(s) $(\sigma_1)^{(7)}, (\sigma_2)^{(7)}, (\tau_1)^{(7)}, (\tau_2)^{(7)}$ four constants satisfying

$$-(\sigma_2)^{(7)} \leq -(a_{36}^{'})^{(7)} + (a_{37}^{'})^{(7)} - (a_{36}^{''})^{(7)}(T_{37}, t) + (a_{37}^{''})^{(7)}(T_{37}, t) \leq -(\sigma_1)^{(7)}$$

$$-(\tau_2)^{(7)} \leq -(b_{36}^{'})^{(7)} + (b_{37}^{'})^{(7)} - (b_{36}^{''})^{(7)}\left((G_{39}), t\right) - (b_{37}^{''})^{(7)}\left((G_{39}), t\right) \leq -(\tau_1)^{(7)}$$

Definition of $(v_1)^{(7)}, (v_2)^{(7)}, (u_1)^{(7)}, (u_2)^{(7)}, v^{(7)}, u^{(7)}$: 528

(t) By $(v_1)^{(7)} > 0$, $(v_2)^{(7)} < 0$ and respectively $(u_1)^{(7)} > 0$, $(u_2)^{(7)} < 0$ the roots of the equations $(a_{37})^{(7)}\left(v^{(7)}\right)^2 + (\sigma_1)^{(7)}v^{(7)} - (a_{36})^{(7)} = 0$
and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_1)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$ and

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Definition of $(\bar{v}_1)^{(7)},,(\bar{v}_2)^{(7)},(\bar{u}_1)^{(7)},(\bar{u}_2)^{(7)}$: 530.

By $(\bar{v}_1)^{(7)} > 0$, $(\bar{v}_2)^{(7)} < 0$ and respectively $(\bar{u}_1)^{(7)} > 0$, $(\bar{u}_2)^{(7)} < 0$ the

roots of the equations $(a_{37})^{(7)}\left(v^{(7)}\right)^2 + (\sigma_2)^{(7)}v^{(7)} - (a_{36})^{(7)} = 0$

and $(b_{37})^{(7)}\left(u^{(7)}\right)^2 + (\tau_2)^{(7)}u^{(7)} - (b_{36})^{(7)} = 0$

Definition of $(m_1)^{(7)}$, $(m_2)^{(7)}$, $(\mu_1)^{(7)},(\mu_2)^{(7)},(\nu_0)^{(7)}$:-

(u) If we define $(m_1)^{(7)}$, $(m_2)^{(7)}$, $(\mu_1)^{(7)},(\mu_2)^{(7)}$ by

$(m_2)^{(7)} = (\nu_0)^{(7)}, (m_1)^{(7)} = (\nu_1)^{(7)},$ $\boldsymbol{if}$ $(\nu_0)^{(7)} < (\nu_1)^{(7)}$

$(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\bar{\nu}_1)^{(7)}$, $\boldsymbol{if}$ $(\nu_1)^{(7)} < (\nu_0)^{(7)} < (\bar{\nu}_1)^{(7)}$,

and $\boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}}$

$(m_2)^{(7)} = (\nu_1)^{(7)}, (m_1)^{(7)} = (\nu_0)^{(7)},$ $\boldsymbol{if}$ $(\bar{\nu}_1)^{(7)} < (\nu_0)^{(7)}$

and analogously 531

$(\mu_2)^{(7)} = (u_0)^{(7)}, (\mu_1)^{(7)} = (u_1)^{(7)},$ $\boldsymbol{if}$ $(u_0)^{(7)} < (u_1)^{(7)}$

$(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (\bar{u}_1)^{(7)}$, $\boldsymbol{if}$ $(u_1)^{(7)} < (u_0)^{(7)} < (\bar{u}_1)^{(7)}$,

and $\boxed{(u_0)^{(7)} = \frac{T_{36}^0}{T_{37}^0}}$

$(\mu_2)^{(7)} = (u_1)^{(7)}, (\mu_1)^{(7)} = (u_0)^{(7)}, \boldsymbol{if}$ $(\bar{u}_1)^{(7)} < (u_0)^{(7)}$ where $(u_1)^{(7)}, (\bar{u}_1)^{(7)}$

are defined respectively

Then the solution of GLOBAL EQUATIONS satisfies the inequalities 532

$$G_{36}^{0}e^{((S_1)^{(7)}-(p_{36})^{(7)})t} \le G_{36}(t) \le G_{36}^{0}e^{(S_1)^{(7)}t}$$

where $(p_i)^{(7)}$ is defined

$$\frac{1}{(m_7)^{(7)}}G_{36}^{0}e^{((S_1)^{(7)}-(p_{36})^{(7)})t} \le G_{37}(t) \le \frac{1}{(m_2)^{(7)}}G_{36}^{0}e^{(S_1)^{(7)}t} \quad 533$$

$$\left(\frac{(a_{38})^{(7)}G_{36}^{0}}{(m_1)^{(7)}((S_1)^{(7)}-(p_{36})^{(7)}-(S_2)^{(7)})}\left[e^{((S_1)^{(7)}-(p_{36})^{(7)})t} - e^{-(S_2)^{(7)}t}\right] + G_{38}^{0}e^{-(S_2)^{(7)}t} \le G_{38}(t) \le \right. \quad 534$$
$$\left.\frac{(a_{38})^{(7)}G_{36}^{0}}{(m_2)^{(7)}((S_1)^{(7)}-(a_{38}^{'})^{(7)})}[e^{(S_1)^{(7)}t} - e^{-(a_{38}^{'})^{(7)}t}] + G_{38}^{0}e^{-(a_{38}^{'})^{(7)}t}\right)$$

$$\boxed{T_{36}^{0}e^{(R_1)^{(7)}t} \le T_{36}(t) \le T_{36}^{0}e^{((R_1)^{(7)}+(r_{36})^{(7)})t}} \quad 535$$

$$\frac{1}{(\mu_1)^{(7)}}T_{36}^{0}e^{(R_1)^{(7)}t} \le T_{36}(t) \le \frac{1}{(\mu_2)^{(7)}}T_{36}^{0}e^{((R_1)^{(7)}+(r_{36})^{(7)})t} \quad 536$$

$$\frac{(b_{38})^{(7)}T_{36}^{0}}{(\mu_1)^{(7)}((R_1)^{(7)}-(b_{38}^{'})^{(7)})}\left[e^{(R_1)^{(7)}t} - e^{-(b_{38}^{'})^{(7)}t}\right] + T_{38}^{0}e^{-(b_{38}^{'})^{(7)}t} \le T_{38}(t) \le \quad 537$$

$$\frac{(a_{38})^{(7)}T_{36}^{0}}{(\mu_2)^{(7)}((R_1)^{(7)}+(r_{36})^{(7)}+(R_2)^{(7)})}\left[e^{((R_1)^{(7)}+(r_{36})^{(7)})t} - e^{-(R_2)^{(7)}t}\right] + T_{38}^{0}e^{-(R_2)^{(7)}t}$$

Definition of $(S_1)^{(7)}, (S_2)^{(7)}, (R_1)^{(7)}, (R_2)^{(7)}$:- 538

Where $(S_1)^{(7)} = (a_{36})^{(7)}(m_2)^{(7)} - (a_{36}^{'})^{(7)}$

$$(S_2)^{(7)} = (a_{38})^{(7)} - (p_{38})^{(7)}$$
$$(R_1)^{(7)} = (b_{36})^{(7)}(\mu_2)^{(7)} - (b_{36}^{'})^{(7)} \quad 539$$
$$(R_2)^{(7)} = (b_{38}^{'})^{(7)} - (r_{38})^{(7)}$$

From CONCATENATED GLOBAL EQUATIONS we obtain 540

$$\frac{dv^{(7)}}{dt} = (a_{36})^{(7)} - \left((a_{36}^{'})^{(7)} - (a_{37}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37}, t)\right) -$$
$$(a_{37}^{''})^{(7)}(T_{37}, t)v^{(7)} - (a_{37})^{(7)}v^{(7)}$$

Definition of $\nu^{(7)}$:- $\boxed{\nu^{(7)} = \frac{G_{36}}{G_{37}}}$

It follows

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_2)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right) \leq \frac{d\nu^{(7)}}{dt} \leq$$

$$-\left((a_{37})^{(7)}\left(\nu^{(7)}\right)^2 + (\sigma_1)^{(7)}\nu^{(7)} - (a_{36})^{(7)}\right)$$

From which one obtains

Definition of $(\bar{\nu}_1)^{(7)}, (\nu_0)^{(7)}$:-

(m) For $0 < \boxed{(\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0}} < (\nu_1)^{(7)} < (\bar{\nu}_1)^{(7)}$

$$\nu^{(7)}(t) \geq \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}}{1 + (C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_0)^{(7)}\right)t\right]}} \quad , \quad \boxed{(C)^{(7)} = \frac{(\nu_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\nu_2)^{(7)}}}$$

it follows $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\nu_1)^{(7)}$

In the same manner , we get 541

$$\nu^{(7)}(t) \leq \frac{(\bar{\nu}_1)^{(7)} + (\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)} - (\bar{\nu}_2)^{(7)}\right)t\right]}}{1 + (\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)} - (\bar{\nu}_2)^{(7)}\right)t\right]}} \quad , \quad \boxed{(\bar{C})^{(7)} = \frac{(\bar{\nu}_1)^{(7)} - (\nu_0)^{(7)}}{(\nu_0)^{(7)} - (\bar{\nu}_2)^{(7)}}}$$

From which we deduce $(\nu_0)^{(7)} \leq \nu^{(7)}(t) \leq (\bar{\nu}_1)^{(7)}$

(n) If $0 < (\nu_1)^{(7)} < (\nu_0)^{(7)} = \frac{G_{36}^0}{G_{37}^0} < (\bar{\nu}_1)^{(7)}$ we find like in the previous case, 542

$$(\nu_1)^{(7)} \leq \frac{(\nu_1)^{(7)} + (C)^{(7)}(\nu_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_2)^{(7)}\right)t\right]}}{1 + (C)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\nu_1)^{(7)} - (\nu_2)^{(7)}\right)t\right]}} \leq \nu^{(7)}(t) \leq$$

$$\frac{(\bar{\nu}_1)^{(7)} + (\bar{C})^{(7)}(\bar{\nu}_2)^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)} - (\bar{\nu}_2)^{(7)}\right)t\right]}}{1 + (\bar{C})^{(7)}e^{\left[-(a_{37})^{(7)}\left((\bar{\nu}_1)^{(7)} - (\bar{\nu}_2)^{(7)}\right)t\right]}} \leq (\bar{\nu}_1)^{(7)}$$

Theorem 3: If $(a_i^{''})^{(8)} and\ (b_i^{''})^{(8)}$ are independent on t , and the conditions 543

$$(a_{44}^{'})^{(8)}(a_{45}^{'})^{(8)} - (a_{44})^{(8)}(a_{45})^{(8)} < 0$$

$(a'_{44})^{(8)}(a'_{45})^{(8)} - (a_{44})^{(8)}(a_{45})^{(8)} + (a_{44})^{(8)}(p_{44})^{(8)} + (a'_{45})^{(8)}(p_{45})^{(8)} + (p_{44})^{(8)}(p_{45})^{(8)} > 0$

$(b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{42})^{(8)}(b_{43})^{(8)} > 0$,

$(b'_{40})^{(8)}(b'_{41})^{(8)} - (b_{42})^{(8)}(b_{43})^{(8)} - (b'_{40})^{(8)}(r_{41})^{(8)} - (b'_{41})^{(9)}(r_{41})^{(9)} + (r_{43})^{(9)}(r_{41})^{(9)} < 0$

$with\ \ (p_{40})^{(8)}, (r_{41})^{(8)}$ as defined are satisfied , then the system

$$(a_{40})^{(8)}G_{41} - \left[(a'_{40})^{(8)} + (a''_{40})^{(8)}(T_{41})\right]G_{40} = 0 \qquad 544$$

$$(a_{41})^{(8)}G_{40} - \left[(a'_{41})^{(8)} + (a''_{41})^{(8)}(T_{41})\right]G_{41} = 0 \qquad 545$$

$$(a_{42})^{(8)}G_{41} - \left[(a'_{42})^{(8)} + (a''_{42})^{(8)}(T_{41})\right]G_{42} = 0 \qquad 546$$

$$(b_{40})^{(8)}T_{41} - [(b'_{40})^{(8)} - (b''_{40})^{(8)}(G_{43})\ ]T_{40} = 0 \qquad 547$$

$$(b_{41})^{(8)}T_{40} - [(b'_{41})^{(8)} - (b''_{41})^{(8)}(G_{43})\ ]T_{41} = 0 \qquad 548$$

$$(b_{42})^{(8)}T_{41} - [(b'_{42})^{(8)} - (b''_{42})^{(8)}(G_{43})\ ]T_{42} = 0 \qquad 549$$

has a unique positive solution , which is an equilibrium solution for the system 550

Proof:

(a) Indeed the first two equations have a nontrivial solution G_{40}, G_{41} if

$F(T_{43}) = (a'_{40})^{(8)}(a'_{41})^{(8)} - (a_{40})^{(8)}(a_{41})^{(8)} + (a'_{40})^{(8)}(a''_{41})^{(8)}(T_{41}) + (a'_{41})^{(8)}(a''_{40})^{(8)}(T_{41}) + (a''_{40})^{(8)}(T_{41})(a''_{41})^{(8)}(T_{41}) = 0$

Definition and uniqueness of T_{41}^{*} :-

After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(8)}(T_{41})$ being increasing, it follows that there exists a unique T_{41}^{*} for which $f(T_{41}^{*}) = 0$. With this value , we obtain from the three first equations

$$G_{44} = \frac{(a_{41})^{(8)} G_{41}}{[(a_{41}^{'})^{(8)} + (a_{41}^{''})^{(9)}(T_{41}^{*})]} \quad , \quad G_{46} = \frac{(a_{42})^{(8)} G_{41}}{[(a_{42}^{'})^{(9)} + (a_{42}^{''})^{(9)}(T_{41}^{*})]}$$

(a) By the same argument, the equations(GLOBAL) admit solutions G_{40}, G_{41} if

$$\varphi(G_{43}) = (b_{40}^{'})^{(8)}(b_{41}^{'})^{(8)} - (b_{40})^{(8)}(b_{45})^{(8)} -$$

$$\left[(b_{40}^{'})^{(8)}(b_{41}^{''})^{(8)}(G_{43}) + (b_{41}^{'})^{(8)}(b_{40}^{''})^{(8)}(G_{43})\right] + (b_{40}^{''})^{(8)}(G_{43})(b_{41}^{''})^{(8)}(G_{43}) = 0$$

Where in $(G_{43})(G_{40}, G_{41}, G_{42}), G_{40}, G_{42}$ must be replaced by their values . It is easy to see that φ is a decreasing function in G_{45} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G_{41}^{*} such that $\varphi((G_{43})^{*}) = 0$ 552

Finally we obtain the unique solution

G_{41}^{*} given by $\varphi((G_{43})^{*}) = 0$, T_{41}^{*} given by $f(T_{41}^{*}) = 0$ and

$$G_{40}^{*} = \frac{(a_{40})^{(8)} G_{41}^{*}}{[(a_{40}^{'})^{(8)} + (a_{40}^{''})^{(8)}(T_{41}^{*})]} \quad , \quad G_{42}^{*} = \frac{(a_{42})^{(8)} G_{41}^{*}}{[(a_{42}^{'})^{(8)} + (a_{42}^{''})^{(8)}(T_{41}^{*})]}$$

$$T_{44}^{*} = \frac{(b_{40})^{(8)} T_{41}^{*}}{[(b_{40}^{'})^{(8)} - (b_{40}^{''})^{(8)}((G_{43})^{*})]} \quad , \quad T_{42}^{*} = \frac{(b_{42})^{(8)} T_{41}^{*}}{[(b_{42}^{'})^{(8)} - (b_{42}^{''})^{(8)}((G_{43})^{*})]} \qquad 553$$

$$(b_{14})^{(1)} T_{13} - [(b_{14}^{'})^{(1)} - (b_{14}^{''})^{(1)}(G)\,] T_{14} = 0 \qquad 554$$

$$(b_{15})^{(1)} T_{14} - [(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G)\,] T_{15} = 0 \qquad 555$$

has a unique positive solution , which is an equilibrium solution for the system 556

$$(a_{16})^{(2)} G_{17} - \left[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17})\right] G_{16} = 0 \qquad 557$$

$$(a_{17})^{(2)} G_{16} - \left[(a_{17}^{'})^{(2)} + (a_{17}^{''})^{(2)}(T_{17})\right] G_{17} = 0 \qquad 558$$

$$(a_{18})^{(2)} G_{17} - \left[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17})\right] G_{18} = 0 \qquad 559$$

$$(b_{16})^{(2)}T_{17} - [(b'_{16})^{(2)} - (b''_{16})^{(2)}(G_{19})\,]T_{16} = 0 \quad 560$$

$$(b_{17})^{(2)}T_{16} - [(b'_{17})^{(2)} - (b''_{17})^{(2)}(G_{19})\,]T_{17} = 0$$

$$(b_{18})^{(2)}T_{17} - [(b'_{18})^{(2)} - (b''_{18})^{(2)}(G_{19})\,]T_{18} = 0$$

$$(a_{24})^{(4)}G_{25} - \left[(a'_{24})^{(4)} + (a''_{24})^{(4)}(T_{25})\right]G_{24} = 0 \quad 561$$

$$(a_{25})^{(4)}G_{24} - \left[(a'_{25})^{(4)} + (a''_{25})^{(4)}(T_{25})\right]G_{25} = 0 \quad 563$$

$$(a_{26})^{(4)}G_{25} - \left[(a'_{26})^{(4)} + (a''_{26})^{(4)}(T_{25})\right]G_{26} = 0 \quad 564$$

$$(b_{24})^{(4)}T_{25} - [(b'_{24})^{(4)} - (b''_{24})^{(4)}\big((G_{27})\big)\,]T_{24} = 0 \quad 565$$

$$(b_{25})^{(4)}T_{24} - [(b'_{25})^{(4)} - (b''_{25})^{(4)}\big((G_{27})\big)\,]T_{25} = 0 \quad 566$$

$$(b_{26})^{(4)}T_{25} - [(b'_{26})^{(4)} - (b''_{26})^{(4)}\big((G_{27})\big)\,]T_{26} = 0 \quad 567$$

has a unique positive solution , which is an equilibrium solution for the system 568

$$(a_{28})^{(5)}G_{29} - \left[(a'_{28})^{(5)} + (a''_{28})^{(5)}(T_{29})\right]G_{28} = 0 \quad 569$$

$$(a_{29})^{(5)}G_{28} - \left[(a'_{29})^{(5)} + (a''_{29})^{(5)}(T_{29})\right]G_{29} = 0 \quad 570$$

$$(a_{30})^{(5)}G_{29} - \left[(a'_{30})^{(5)} + (a''_{30})^{(5)}(T_{29})\right]G_{30} = 0 \quad 571$$

$$(b_{28})^{(5)}T_{29} - [(b'_{28})^{(5)} - (b''_{28})^{(5)}(G_{31})\,]T_{28} = 0 \quad 572$$

$$(b_{29})^{(5)}T_{28} - [(b'_{29})^{(5)} - (b''_{29})^{(5)}(G_{31})\,]T_{29} = 0 \quad 573$$

$$(b_{30})^{(5)}T_{29} - [(b'_{30})^{(5)} - (b''_{30})^{(5)}(G_{31})\,]T_{30} = 0 \quad 574$$

has a unique positive solution , which is an equilibrium solution for the system 575

$$(a_{32})^{(6)}G_{33} - \left[(a'_{32})^{(6)} + (a''_{32})^{(6)}(T_{33})\right]G_{32} = 0 \quad 576$$

$$(a_{33})^{(6)}G_{32} - \left[(a'_{33})^{(6)} + (a''_{33})^{(6)}(T_{33})\right]G_{33} = 0 \quad 577$$

$$(a_{34})^{(6)}G_{33} - \left[(a'_{34})^{(6)} + (a''_{34})^{(6)}(T_{33})\right]G_{34} = 0 \quad 578$$

$$(b_{32})^{(6)}T_{33} - [(b'_{32})^{(6)} - (b''_{32})^{(6)}(G_{35})\,]T_{32} = 0 \quad 579$$

$$(b_{33})^{(6)}T_{32} - [(b'_{33})^{(6)} - (b''_{33})^{(6)}(G_{35})\,]T_{33} = 0 \quad 580$$

$$(b_{34})^{(6)}T_{33} - [(b'_{34})^{(6)} - (b''_{34})^{(6)}(G_{35})\,]T_{34} = 0 \quad 584$$

has a unique positive solution , which is an equilibrium solution for the system 582

$$(a_{36})^{(7)}G_{37} - \left[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37})\right]G_{36} = 0 \quad 583$$

$$(a_{37})^{(7)}G_{36} - \left[(a_{37}^{'})^{(7)} + (a_{37}^{''})^{(7)}(T_{37})\right]G_{37} = 0 \quad 584$$

$$(a_{38})^{(7)}G_{37} - \left[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37})\right]G_{38} = 0 \quad 585$$

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$$(b_{36})^{(7)}T_{37} - [(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}(G_{39})]T_{36} = 0 \quad 587$$

$$(b_{37})^{(7)}T_{36} - [(b_{37}^{'})^{(7)} - (b_{37}^{''})^{(7)}(G_{39})\,]T_{37} = 0 \quad 588$$

$$(b_{38})^{(7)}T_{37} - [(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}(G_{39})\,]T_{38} = 0 \quad 589$$

has a unique positive solution , which is an equilibrium solution for the system 560

(a) Indeed the first two equations have a nontrivial solution G_{36}, G_{37} if

$$F(T_{39}) = (a_{36}^{'})^{(7)}(a_{37}^{'})^{(7)} - (a_{36})^{(7)}(a_{37})^{(7)} + (a_{36}^{'})^{(7)}(a_{37}^{''})^{(7)}(T_{37}) + (a_{37}^{'})^{(7)}(a_{36}^{''})^{(7)}(T_{37}) + (a_{36}^{''})^{(7)}(T_{37})(a_{37}^{''})^{(7)}(T_{37}) = 0$$

Definition and uniqueness of T_{37}^{*} :- 561

After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(7)}(T_{37})$ being increasing, it follows that there exists a unique T_{37}^{*} for which $f(T_{37}^{*}) = 0$. With this value , we obtain from the three first equations

$$G_{36} = \frac{(a_{36})^{(7)}G_{37}}{[(a_{36}^{'})^{(7)}+(a_{36}^{''})^{(7)}(T_{37}^{*})]} \quad , \quad G_{38} = \frac{(a_{38})^{(7)}G_{37}}{[(a_{38}^{'})^{(7)}+(a_{38}^{''})^{(7)}(T_{37}^{*})]}$$

(b) By the same argument, the equations(SOLUTIONAL) admit solutions G_{36}, G_{37} if

$$\varphi(G_{39}) = (b_{36}^{'})^{(7)}(b_{37}^{'})^{(7)} - (b_{36})^{(7)}(b_{37})^{(7)} -$$

$$\left[(b_{36}^{'})^{(7)}(b_{37}^{''})^{(7)}(G_{39}) + (b_{37}^{'})^{(7)}(b_{36}^{''})^{(7)}(G_{39})\right] + (b_{36}^{''})^{(7)}(G_{39})(b_{37}^{''})^{(7)}(G_{39}) = 0$$

Where in $(G_{39})(G_{36}, G_{37}, G_{38}), G_{36}, G_{38}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{37} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G_{37}^{*} such that $\varphi(G^{*}) = 0$ 562

Finally we obtain the unique solution OF THE SYSTEM

G_{37}^{*} given by $\varphi((G_{39})^{*}) = 0$, T_{37}^{*} given by $f(T_{37}^{*}) = 0$ and

$$G_{36}^{*} = \frac{(a_{36})^{(7)} G_{37}^{*}}{[(a_{36}^{'})^{(7)} + (a_{36}^{''})^{(7)}(T_{37}^{*})]} \quad , \quad G_{38}^{*} = \frac{(a_{38})^{(7)} G_{37}^{*}}{[(a_{38}^{'})^{(7)} + (a_{38}^{''})^{(7)}(T_{37}^{*})]}$$

$$T_{36}^{*} = \frac{(b_{36})^{(7)} T_{37}^{*}}{[(b_{36}^{'})^{(7)} - (b_{36}^{''})^{(7)}((G_{39})^{*})]} \quad , \quad T_{38}^{*} = \frac{(b_{38})^{(7)} T_{37}^{*}}{[(b_{38}^{'})^{(7)} - (b_{38}^{''})^{(7)}((G_{39})^{*})]} \qquad 563$$

Definition and uniqueness of T_{21}^{*} :- 564

After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(1)}(T_{21})$ being increasing, it follows that there exists a unique T_{21}^{*} for which $f(T_{21}^{*}) = 0$. With this value , we obtain from the three first equations

$$G_{20} = \frac{(a_{20})^{(3)} G_{21}}{[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21}^{*})]} \quad , \quad G_{22} = \frac{(a_{22})^{(3)} G_{21}}{[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21}^{*})]}$$

565

Definition and uniqueness of T_{25}^{*} :- 566

After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(4)}(T_{25})$ being increasing, it follows that there exists a unique T_{25}^{*} for which $f(T_{25}^{*}) = 0$. With this value , we obtain from the three first equations

$$G_{24} = \frac{(a_{24})^{(4)} G_{25}}{[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25}^{*})]} \quad , \quad G_{26} = \frac{(a_{26})^{(4)} G_{25}}{[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25}^{*})]}$$

Definition and uniqueness of T_{29}^{*} :- 567

After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(5)}(T_{29})$ being increasing, it follows that there exists a unique T_{29}^{*} for which $f(T_{29}^{*}) = 0$. With this value , we obtain from the three first equations

$$G_{28} = \frac{(a_{28})^{(5)} G_{29}}{[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29}^{*})]} \quad , \quad G_{30} = \frac{(a_{30})^{(5)} G_{29}}{[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29}^{*})]}$$

Definition and uniqueness of T_{33}^{*} :- 568

After hypothesis $f(0) < 0, f(\infty) > 0$ and the functions $(a_i^{''})^{(6)}(T_{33})$ are increasing, it follows that there exists a unique T_{33}^{*} for which $f(T_{33}^{*}) = 0$. With this value , we obtain from the three first equations

$$G_{32} = \frac{(a_{32})^{(6)} G_{33}}{[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33}^{*})]} \quad , \quad G_{34} = \frac{(a_{34})^{(6)} G_{33}}{[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}^{*})]}$$

(c) By the same argument, the equationsGLOBAL admit solutions G_{13}, G_{14} if 569

$$\varphi(G) = (b_{13}^{'})^{(1)}(b_{14}^{'})^{(1)} - (b_{13})^{(1)}(b_{14})^{(1)} -$$

$$\left[(b_{13}^{'})^{(1)}(b_{14}^{''})^{(1)}(G) + (b_{14}^{'})^{(1)}(b_{13}^{''})^{(1)}(G)\right] + (b_{13}^{''})^{(1)}(G)(b_{14}^{''})^{(1)}(G) = 0$$

Where in $G(G_{13}, G_{14}, G_{15}), G_{13}, G_{15}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{14} taking into account the hypothesis $\varphi(0) > 0$, $\varphi(\infty) < 0$ it follows that there exists a unique G_{14}^{*} such that $\varphi(G^{*}) = 0$

(d) By the same argument, the equations 92,93 admit solutions G_{16}, G_{17} if 570

$$\varphi(G_{19}) = (b'_{16})^{(2)}(b'_{17})^{(2)} - (b_{16})^{(2)}(b_{17})^{(2)} -$$

$$\left[(b'_{16})^{(2)}(b''_{17})^{(2)}(G_{19}) + (b'_{17})^{(2)}(b''_{16})^{(2)}(G_{19})\right] + (b''_{16})^{(2)}(G_{19})(b''_{17})^{(2)}(G_{19}) = 0$$

Where in $(G_{19})(G_{16}, G_{17}, G_{18}), G_{16}, G_{18}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{17} taking into account the hypothesis $\varphi(0) > 0\,, \varphi(\infty) < 0$ it follows that there exists a unique G_{14}^{*} such that $\varphi((G_{19})^{*}) = 0$ 571

(a) By the same argument, the concatenated equations admit solutions G_{20}, G_{21} if 572

$$\varphi(G_{23}) = (b'_{20})^{(3)}(b'_{21})^{(3)} - (b_{20})^{(3)}(b_{21})^{(3)} -$$

$$\left[(b'_{20})^{(3)}(b''_{21})^{(3)}(G_{23}) + (b'_{21})^{(3)}(b''_{20})^{(3)}(G_{23})\right] + (b''_{20})^{(3)}(G_{23})(b''_{21})^{(3)}(G_{23}) = 0$$

Where in $G_{23}(G_{20}, G_{21}, G_{22}), G_{20}, G_{22}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{21} taking into account the hypothesis $\varphi(0) > 0\,, \varphi(\infty) < 0$ it follows that there exists a unique G_{21}^{*} such that $\varphi((G_{23})^{*}) = 0$ 573

(b) By the same argument, the equations of modules admit solutions G_{24}, G_{25} if 574

$$\varphi(G_{27}) = (b'_{24})^{(4)}(b'_{25})^{(4)} - (b_{24})^{(4)}(b_{25})^{(4)} -$$

$$\left[(b'_{24})^{(4)}(b''_{25})^{(4)}(G_{27}) + (b'_{25})^{(4)}(b''_{24})^{(4)}(G_{27})\right] + (b''_{24})^{(4)}(G_{27})(b''_{25})^{(4)}(G_{27}) = 0$$

Where in $(G_{27})(G_{24}, G_{25}, G_{26}), G_{24}, G_{26}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{25} taking into account the hypothesis $\varphi(0) > 0\,, \varphi(\infty) < 0$ it follows that there exists a unique G_{25}^{*} such that $\varphi((G_{27})^{*}) = 0$

(c) By the same argument, the equations (modules) admit solutions G_{28}, G_{29} if 575

$$\varphi(G_{31}) = (b'_{28})^{(5)}(b'_{29})^{(5)} - (b_{28})^{(5)}(b_{29})^{(5)} -$$

$$\left[(b'_{28})^{(5)}(b''_{29})^{(5)}(G_{31}) + (b'_{29})^{(5)}(b''_{28})^{(5)}(G_{31})\right] + (b''_{28})^{(5)}(G_{31})(b''_{29})^{(5)}(G_{31}) = 0$$

Where in $(G_{31})(G_{28}, G_{29}, G_{30}), G_{28}, G_{30}$ must be replaced by their values from 96. It is easy to see that φ is a decreasing function in G_{29} taking into account the hypothesis $\varphi(0) > 0\,, \varphi(\infty) < 0$ it follows that there exists a unique G_{29}^{*} such that $\varphi((G_{31})^{*}) = 0$

(d) By the same argument, the equations (modules) admit solutions G_{32}, G_{33} if 578

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$$\varphi(G_{35}) = (b'_{32})^{(6)}(b'_{33})^{(6)} - (b_{32})^{(6)}(b_{33})^{(6)} -$$

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$$\left[(b'_{32})^{(6)}(b''_{33})^{(6)}(G_{35}) + (b'_{33})^{(6)}(b''_{32})^{(6)}(G_{35})\right] + (b''_{32})^{(6)}(G_{35})(b''_{33})^{(6)}(G_{35}) = 0$$

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Where in $(G_{35})(G_{32}, G_{33}, G_{34}), G_{32}, G_{34}$ must be replaced by their values It is easy to see that φ is a decreasing function in G_{33} taking into account the hypothesis $\varphi(0) > 0\,, \varphi(\infty) < 0$ it follows that there exists a unique G_{33}^{*} such that $\varphi(G^{*}) = 0$

Finally we obtain the unique solution 582

G_{14}^{*} given by $\varphi(G^{*}) = 0$, T_{14}^{*} given by $f(T_{14}^{*}) = 0$ and

$$G_{13}^{*} = \frac{(a_{13})^{(1)}G_{14}^{*}}{[(a'_{13})^{(1)} + (a''_{13})^{(1)}(T_{14}^{*})]} \quad , \quad G_{15}^{*} = \frac{(a_{15})^{(1)}G_{14}^{*}}{[(a'_{15})^{(1)} + (a''_{15})^{(1)}(T_{14}^{*})]}$$

$T_{13}^{*} = \frac{(b_{13})^{(1)} T_{14}^{*}}{[(b_{13}^{'})^{(1)} - (b_{13}^{''})^{(1)}(G^{*})]}$, $T_{15}^{*} = \frac{(b_{15})^{(1)} T_{14}^{*}}{[(b_{15}^{'})^{(1)} - (b_{15}^{''})^{(1)}(G^{*})]}$

Obviously, these values represent an equilibrium solution

Finally we obtain the unique solution 583

G_{17}^{*} given by $\varphi((G_{19})^{*}) = 0$, T_{17}^{*} given by $f(T_{17}^{*}) = 0$ and 584

$G_{16}^{*} = \frac{(a_{16})^{(2)} G_{17}^{*}}{[(a_{16}^{'})^{(2)} + (a_{16}^{''})^{(2)}(T_{17}^{*})]}$, $G_{18}^{*} = \frac{(a_{18})^{(2)} G_{17}^{*}}{[(a_{18}^{'})^{(2)} + (a_{18}^{''})^{(2)}(T_{17}^{*})]}$ 585

$T_{16}^{*} = \frac{(b_{16})^{(2)} T_{17}^{*}}{[(b_{16}^{'})^{(2)} - (b_{16}^{''})^{(2)}((G_{19})^{*})]}$, $T_{18}^{*} = \frac{(b_{18})^{(2)} T_{17}^{*}}{[(b_{18}^{'})^{(2)} - (b_{18}^{''})^{(2)}((G_{19})^{*})]}$ 586

Obviously, these values represent an equilibrium solution 587

Finally we obtain the unique solution 588

G_{21}^{*} given by $\varphi((G_{23})^{*}) = 0$, T_{21}^{*} given by $f(T_{21}^{*}) = 0$ and

$G_{20}^{*} = \frac{(a_{20})^{(3)} G_{21}^{*}}{[(a_{20}^{'})^{(3)} + (a_{20}^{''})^{(3)}(T_{21}^{*})]}$, $G_{22}^{*} = \frac{(a_{22})^{(3)} G_{21}^{*}}{[(a_{22}^{'})^{(3)} + (a_{22}^{''})^{(3)}(T_{21}^{*})]}$

$T_{20}^{*} = \frac{(b_{20})^{(3)} T_{21}^{*}}{[(b_{20}^{'})^{(3)} - (b_{20}^{''})^{(3)}(G_{23}{}^{*})]}$, $T_{22}^{*} = \frac{(b_{22})^{(3)} T_{21}^{*}}{[(b_{22}^{'})^{(3)} - (b_{22}^{''})^{(3)}(G_{23}{}^{*})]}$

Obviously, these values represent an equilibrium solution

Finally we obtain the unique solution 589

G_{25}^{*} given by $\varphi(G_{27}) = 0$, T_{25}^{*} given by $f(T_{25}^{*}) = 0$ and

$G_{24}^{*} = \frac{(a_{24})^{(4)} G_{25}^{*}}{[(a_{24}^{'})^{(4)} + (a_{24}^{''})^{(4)}(T_{25}^{*})]}$, $G_{26}^{*} = \frac{(a_{26})^{(4)} G_{25}^{*}}{[(a_{26}^{'})^{(4)} + (a_{26}^{''})^{(4)}(T_{25}^{*})]}$

$T_{24}^{*} = \frac{(b_{24})^{(4)} T_{25}^{*}}{[(b_{24}^{'})^{(4)} - (b_{24}^{''})^{(4)}((G_{27})^{*})]}$, $T_{26}^{*} = \frac{(b_{26})^{(4)} T_{25}^{*}}{[(b_{26}^{'})^{(4)} - (b_{26}^{''})^{(4)}((G_{27})^{*})]}$ 590

Obviously, these values represent an equilibrium solution

Finally we obtain the unique solution 591

G_{29}^{*} given by $\varphi((G_{31})^{*}) = 0$, T_{29}^{*} given by $f(T_{29}^{*}) = 0$ and

$G_{28}^{*} = \frac{(a_{28})^{(5)} G_{29}^{*}}{[(a_{28}^{'})^{(5)} + (a_{28}^{''})^{(5)}(T_{29}^{*})]}$, $G_{30}^{*} = \frac{(a_{30})^{(5)} G_{29}^{*}}{[(a_{30}^{'})^{(5)} + (a_{30}^{''})^{(5)}(T_{29}^{*})]}$

$T_{28}^{*} = \frac{(b_{28})^{(5)} T_{29}^{*}}{[(b_{28}^{'})^{(5)} - (b_{28}^{''})^{(5)}((G_{31})^{*})]}$, $T_{30}^{*} = \frac{(b_{30})^{(5)} T_{29}^{*}}{[(b_{30}^{'})^{(5)} - (b_{30}^{''})^{(5)}((G_{31})^{*})]}$ 592

Obviously, these values represent an equilibrium solution

Finally we obtain the unique solution 593

G_{33}^{*} given by $\varphi((G_{35})^{*}) = 0$, T_{33}^{*} given by $f(T_{33}^{*}) = 0$ and

$G_{32}^{*} = \frac{(a_{32})^{(6)} G_{33}^{*}}{[(a_{32}^{'})^{(6)} + (a_{32}^{''})^{(6)}(T_{33}^{*})]}$, $G_{34}^{*} = \frac{(a_{34})^{(6)} G_{33}^{*}}{[(a_{34}^{'})^{(6)} + (a_{34}^{''})^{(6)}(T_{33}^{*})]}$

$$T_{32}^{*} = \frac{(b_{32})^{(6)} T_{33}^{*}}{[(b_{32}^{'})^{(6)} - (b_{32}^{''})^{(6)}((G_{35})^{*})]} \quad , \quad T_{34}^{*} = \frac{(b_{34})^{(6)} T_{33}^{*}}{[(b_{34}^{'})^{(6)} - (b_{34}^{''})^{(6)}((G_{35})^{*})]} \qquad 594$$

Obviously, these values represent an equilibrium solution

ASYMPTOTIC STABILITY ANALYSIS 595

Theorem 4: If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(1)}$ and $(b_i^{''})^{(1)}$ Belong to $C^{(1)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.

Proof: Denote

Definition of $\mathbb{G}_i, \mathbb{T}_i$:-

$$G_i = G_i^{*} + \mathbb{G}_i \qquad , T_i = T_i^{*} + \mathbb{T}_i$$
$$\frac{\partial (a_{14}^{''})^{(1)}}{\partial T_{14}}(T_{14}^{*}) = (q_{14})^{(1)} \quad , \quad \frac{\partial (b_i^{''})^{(1)}}{\partial G_j}(G^{*}) = s_{ij} \qquad 596$$

Then taking into account equations (global) and neglecting the terms of power 2, we obtain 597

$$\frac{d\mathbb{G}_{13}}{dt} = -\left((a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)\mathbb{G}_{13} + (a_{13})^{(1)}\mathbb{G}_{14} - (q_{13})^{(1)} G_{13}^{*}\mathbb{T}_{14} \qquad 598$$

$$\frac{d\mathbb{G}_{14}}{dt} = -\left((a_{14}^{'})^{(1)} + (p_{14})^{(1)}\right)\mathbb{G}_{14} + (a_{14})^{(1)}\mathbb{G}_{13} - (q_{14})^{(1)} G_{14}^{*}\mathbb{T}_{14} \qquad 599$$

$$\frac{d\mathbb{G}_{15}}{dt} = -\left((a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)\mathbb{G}_{15} + (a_{15})^{(1)}\mathbb{G}_{14} - (q_{15})^{(1)} G_{15}^{*}\mathbb{T}_{14} \qquad 600$$

$$\frac{d\mathbb{T}_{13}}{dt} = -\left((b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)\mathbb{T}_{13} + (b_{13})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(13)(j)} T_{13}^{*}\mathbb{G}_j\right) \qquad 601$$

$$\frac{d\mathbb{T}_{14}}{dt} = -\left((b_{14}^{'})^{(1)} - (r_{14})^{(1)}\right)\mathbb{T}_{14} + (b_{14})^{(1)}\mathbb{T}_{13} + \sum_{j=13}^{15}\left(s_{(14)(j)} T_{14}^{*}\mathbb{G}_j\right) \qquad 602$$

$$\frac{d\mathbb{T}_{15}}{dt} = -\left((b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\mathbb{T}_{15} + (b_{15})^{(1)}\mathbb{T}_{14} + \sum_{j=13}^{15}\left(s_{(15)(j)} T_{15}^{*}\mathbb{G}_j\right) \qquad 603$$

If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(2)}$ and $(b_i^{''})^{(2)}$ Belong to $C^{(2)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable 604

Denote 605

Definition of $\mathbb{G}_i, \mathbb{T}_i$:-

$$G_i = G_i^{*} + \mathbb{G}_i \qquad , T_i = T_i^{*} + \mathbb{T}_i \qquad 606$$

$$\frac{\partial (a_{17}^{''})^{(2)}}{\partial T_{17}}(T_{17}^{*}) = (q_{17})^{(2)} \quad , \quad \frac{\partial (b_i^{''})^{(2)}}{\partial G_j}((G_{19})^{*}) = s_{ij} \qquad 607$$

taking into account equations (global)and neglecting the terms of power 2, we obtain 608

$$\frac{d\mathbb{G}_{16}}{dt} = -\left((a_{16}^{'})^{(2)} + (p_{16})^{(2)}\right)\mathbb{G}_{16} + (a_{16})^{(2)}\mathbb{G}_{17} - (q_{16})^{(2)} G_{16}^{*}\mathbb{T}_{17} \qquad 609$$

$$\frac{d\mathbb{G}_{17}}{dt} = -\left((a_{17}^{'})^{(2)} + (p_{17})^{(2)}\right)\mathbb{G}_{17} + (a_{17})^{(2)}\mathbb{G}_{16} - (q_{17})^{(2)} G_{17}^{*}\mathbb{T}_{17} \qquad 610$$

$$\frac{d\mathbb{G}_{18}}{dt} = -\left((a_{18}^{'})^{(2)} + (p_{18})^{(2)}\right)\mathbb{G}_{18} + (a_{18})^{(2)}\mathbb{G}_{17} - (q_{18})^{(2)} G_{18}^{*}\mathbb{T}_{17} \qquad 611$$

$$\frac{d\mathbb{T}_{16}}{dt} = -\left((b_{16}^{'})^{(2)} - (r_{16})^{(2)}\right)\mathbb{T}_{16} + (b_{16})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(16)(j)} T_{16}^{*}\mathbb{G}_j\right) \qquad 612$$

$$\frac{\mathrm{d}\mathbb{T}_{17}}{\mathrm{dt}} = -\left((b_{17}^{'})^{(2)} - (r_{17})^{(2)}\right)\mathbb{T}_{17} + (b_{17})^{(2)}\mathbb{T}_{16} + \sum_{j=16}^{18}\left(s_{(17)(j)}\mathrm{T}_{17}^{*}\mathbb{G}_j\right) \quad 613$$

$$\frac{\mathrm{d}\mathbb{T}_{18}}{\mathrm{dt}} = -\left((b_{18}^{'})^{(2)} - (r_{18})^{(2)}\right)\mathbb{T}_{18} + (b_{18})^{(2)}\mathbb{T}_{17} + \sum_{j=16}^{18}\left(s_{(18)(j)}\mathrm{T}_{18}^{*}\mathbb{G}_j\right) \quad 614$$

If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(3)}\ and\ (b_i^{''})^{(3)}$ 615
Belong to $C^{(3)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stabl

Denote

Definition of $\mathbb{G}_i, \mathbb{T}_i$:-

$$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$$

$$\frac{\partial(a_{21}^{''})^{(3)}}{\partial T_{21}}(T_{21}^*) = (q_{21})^{(3)} \quad , \frac{\partial(b_i^{''})^{(3)}}{\partial G_j}(\,(G_{23})^*\,) = s_{ij}$$

616

Then taking into account equations (global) and neglecting the terms of power 2, we obtain 617

$$\frac{d\mathbb{G}_{20}}{dt} = -\left((a_{20}^{'})^{(3)} + (p_{20})^{(3)}\right)\mathbb{G}_{20} + (a_{20})^{(3)}\mathbb{G}_{21} - (q_{20})^{(3)}G_{20}^{*}\mathbb{T}_{21} \quad 618$$

$$\frac{d\mathbb{G}_{21}}{dt} = -\left((a_{21}^{'})^{(3)} + (p_{21})^{(3)}\right)\mathbb{G}_{21} + (a_{21})^{(3)}\mathbb{G}_{20} - (q_{21})^{(3)}G_{21}^{*}\mathbb{T}_{21} \quad 619$$

$$\frac{d\mathbb{G}_{22}}{dt} = -\left((a_{22}^{'})^{(3)} + (p_{22})^{(3)}\right)\mathbb{G}_{22} + (a_{22})^{(3)}\mathbb{G}_{21} - (q_{22})^{(3)}G_{22}^{*}\mathbb{T}_{21} \quad 6120$$

$$\frac{d\mathbb{T}_{20}}{dt} = -\left((b_{20}^{'})^{(3)} - (r_{20})^{(3)}\right)\mathbb{T}_{20} + (b_{20})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(20)(j)}T_{20}^{*}\mathbb{G}_j\right) \quad 621$$

$$\frac{d\mathbb{T}_{21}}{dt} = -\left((b_{21}^{'})^{(3)} - (r_{21})^{(3)}\right)\mathbb{T}_{21} + (b_{21})^{(3)}\mathbb{T}_{20} + \sum_{j=20}^{22}\left(s_{(21)(j)}T_{21}^{*}\mathbb{G}_j\right) \quad 622$$

$$\frac{d\mathbb{T}_{22}}{dt} = -\left((b_{22}^{'})^{(3)} - (r_{22})^{(3)}\right)\mathbb{T}_{22} + (b_{22})^{(3)}\mathbb{T}_{21} + \sum_{j=20}^{22}\left(s_{(22)(j)}T_{22}^{*}\mathbb{G}_j\right) \quad 623$$

If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(4)}\ and\ (b_i^{''})^{(4)}$ 624
Belong to $C^{(4)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stabl

Denote

Definition of $\mathbb{G}_i, \mathbb{T}_i$:- 625

$$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$$

$$\frac{\partial(a_{25}^{''})^{(4)}}{\partial T_{25}}(T_{25}^*) = (q_{25})^{(4)} \quad , \frac{\partial(b_i^{''})^{(4)}}{\partial G_j}((G_{27})^*\,) = s_{ij}$$

Then taking into account equations (global) and neglecting the terms of power 2, we obtain 626

$$\frac{d\mathbb{G}_{24}}{dt} = -\left((a_{24}^{'})^{(4)} + (p_{24})^{(4)}\right)\mathbb{G}_{24} + (a_{24})^{(4)}\mathbb{G}_{25} - (q_{24})^{(4)}G_{24}^{*}\mathbb{T}_{25} \quad 627$$

$$\frac{d\mathbb{G}_{25}}{dt} = -\left((a_{25}^{'})^{(4)} + (p_{25})^{(4)}\right)\mathbb{G}_{25} + (a_{25})^{(4)}\mathbb{G}_{24} - (q_{25})^{(4)}G_{25}^{*}\mathbb{T}_{25} \quad 628$$

$$\frac{d\mathbb{G}_{26}}{dt} = -\left((a_{26}^{'})^{(4)} + (p_{26})^{(4)}\right)\mathbb{G}_{26} + (a_{26})^{(4)}\mathbb{G}_{25} - (q_{26})^{(4)}G_{26}^{*}\mathbb{T}_{25} \quad 629$$

$$\frac{d\mathbb{T}_{24}}{dt} = -\left((b'_{24})^{(4)} - (r_{24})^{(4)}\right)\mathbb{T}_{24} + (b_{24})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(24)(j)}T^*_{24}\mathbb{G}_j\right) \quad 630$$

$$\frac{d\mathbb{T}_{25}}{dt} = -\left((b'_{25})^{(4)} - (r_{25})^{(4)}\right)\mathbb{T}_{25} + (b_{25})^{(4)}\mathbb{T}_{24} + \sum_{j=24}^{26}\left(s_{(25)(j)}T^*_{25}\mathbb{G}_j\right) \quad 631$$

$$\frac{d\mathbb{T}_{26}}{dt} = -\left((b'_{26})^{(4)} - (r_{26})^{(4)}\right)\mathbb{T}_{26} + (b_{26})^{(4)}\mathbb{T}_{25} + \sum_{j=24}^{26}\left(s_{(26)(j)}T^*_{26}\mathbb{G}_j\right) \quad 632$$

633

If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(5)}$ and $(b_i^{''})^{(5)}$ Belong to $C^{(5)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable

Denote

Definition of $\mathbb{G}_i, \mathbb{T}_i$:- 634

$$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$$

$$\frac{\partial(a_{29}^{''})^{(5)}}{\partial T_{29}}(T^*_{29}) = (q_{29})^{(5)} \quad , \frac{\partial(b_i^{''})^{(5)}}{\partial G_j}\left((G_{31})^*\right) = s_{ij}$$

Then taking into account equations (global) and neglecting the terms of power 2, we obtain 635

$$\frac{d\mathbb{G}_{28}}{dt} = -\left((a'_{28})^{(5)} + (p_{28})^{(5)}\right)\mathbb{G}_{28} + (a_{28})^{(5)}\mathbb{G}_{29} - (q_{28})^{(5)}G^*_{28}\mathbb{T}_{29} \quad 636$$

$$\frac{d\mathbb{G}_{29}}{dt} = -\left((a'_{29})^{(5)} + (p_{29})^{(5)}\right)\mathbb{G}_{29} + (a_{29})^{(5)}\mathbb{G}_{28} - (q_{29})^{(5)}G^*_{29}\mathbb{T}_{29} \quad 637$$

$$\frac{d\mathbb{G}_{30}}{dt} = -\left((a'_{30})^{(5)} + (p_{30})^{(5)}\right)\mathbb{G}_{30} + (a_{30})^{(5)}\mathbb{G}_{29} - (q_{30})^{(5)}G^*_{30}\mathbb{T}_{29} \quad 638$$

$$\frac{d\mathbb{T}_{28}}{dt} = -\left((b'_{28})^{(5)} - (r_{28})^{(5)}\right)\mathbb{T}_{28} + (b_{28})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(28)(j)}T^*_{28}\mathbb{G}_j\right) \quad 639$$

$$\frac{d\mathbb{T}_{29}}{dt} = -\left((b'_{29})^{(5)} - (r_{29})^{(5)}\right)\mathbb{T}_{29} + (b_{29})^{(5)}\mathbb{T}_{28} + \sum_{j=28}^{30}\left(s_{(29)(j)}T^*_{29}\mathbb{G}_j\right) \quad 640$$

$$\frac{d\mathbb{T}_{30}}{dt} = -\left((b'_{30})^{(5)} - (r_{30})^{(5)}\right)\mathbb{T}_{30} + (b_{30})^{(5)}\mathbb{T}_{29} + \sum_{j=28}^{30}\left(s_{(30)(j)}T^*_{30}\mathbb{G}_j\right) \quad 641$$

If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(6)}$ and $(b_i^{''})^{(6)}$ 642
Belong to $C^{(6)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable

Denote

Definition of $\mathbb{G}_i, \mathbb{T}_i$:- 643

$$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$$

$$\frac{\partial(a_{33}^{''})^{(6)}}{\partial T_{33}}(T^*_{33}) = (q_{33})^{(6)} \quad , \frac{\partial(b_i^{''})^{(6)}}{\partial G_j}\left((G_{35})^*\right) = s_{ij}$$

Then taking into account equations(global) and neglecting the terms of power 2, we obtain 644

$$\frac{d\mathbb{G}_{32}}{dt} = -\left((a'_{32})^{(6)} + (p_{32})^{(6)}\right)\mathbb{G}_{32} + (a_{32})^{(6)}\mathbb{G}_{33} - (q_{32})^{(6)}G^*_{32}\mathbb{T}_{33} \quad 645$$

$$\frac{d\mathbb{G}_{33}}{dt} = -\left((a'_{33})^{(6)} + (p_{33})^{(6)}\right)\mathbb{G}_{33} + (a_{33})^{(6)}\mathbb{G}_{32} - (q_{33})^{(6)}G^*_{33}\mathbb{T}_{33} \quad 646$$

$$\frac{d\mathbb{G}_{34}}{dt} = -\left((a'_{34})^{(6)} + (p_{34})^{(6)}\right)\mathbb{G}_{34} + (a_{34})^{(6)}\mathbb{G}_{33} - (q_{34})^{(6)}G^*_{34}\mathbb{T}_{33} \quad 647$$

$$\frac{d\mathbb{T}_{32}}{dt} = -\left((b'_{32})^{(6)} - (r_{32})^{(6)}\right)\mathbb{T}_{32} + (b_{32})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(32)(j)}T^*_{32}\mathbb{G}_j\right) \quad 648$$

$$\frac{d\mathbb{T}_{33}}{dt} = -\left((b'_{33})^{(6)} - (r_{33})^{(6)}\right)\mathbb{T}_{33} + (b_{33})^{(6)}\mathbb{T}_{32} + \sum_{j=32}^{34}\left(s_{(33)(j)}T^*_{33}\mathbb{G}_j\right) \quad 649$$

$$\frac{d\mathbb{T}_{34}}{dt} = -\left((b'_{34})^{(6)} - (r_{34})^{(6)}\right)\mathbb{T}_{34} + (b_{34})^{(6)}\mathbb{T}_{33} + \sum_{j=32}^{34}\left(s_{(34)(j)}T^*_{34}\mathbb{G}_j\right) \quad 650$$

Obviously, these values represent an equilibrium solution of 79,20,36,22,23, 651

If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(7)}\ and\ (b_i^{''})^{(7)}$ Belong to $C^{(7)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable.

Proof: Denote

Definition of $\mathbb{G}_i, \mathbb{T}_i$:- 652

$$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i \quad 653$$

$$\frac{\partial(a_{37}^{''})^{(7)}}{\partial T_{37}}(T^*_{37}) = (q_{37})^{(7)} \quad , \frac{\partial(b_i^{''})^{(7)}}{\partial G_j}\left((G_{39})^{**}\right) = s_{ij}$$

Then taking into account equations(SOLUTIONAL) and neglecting the terms of power 2, we obtain 654

655

$$\frac{d\mathbb{G}_{36}}{dt} = -\left((a'_{36})^{(7)} + (p_{36})^{(7)}\right)\mathbb{G}_{36} + (a_{36})^{(7)}\mathbb{G}_{37} - (q_{36})^{(7)}G^*_{36}\mathbb{T}_{37} \quad 656$$

$$\frac{d\mathbb{G}_{37}}{dt} = -\left((a'_{37})^{(7)} + (p_{37})^{(7)}\right)\mathbb{G}_{37} + (a_{37})^{(7)}\mathbb{G}_{36} - (q_{37})^{(7)}G^*_{37}\mathbb{T}_{37} \quad 657$$

$$\frac{d\mathbb{G}_{38}}{dt} = -\left((a'_{38})^{(7)} + (p_{38})^{(7)}\right)\mathbb{G}_{38} + (a_{38})^{(7)}\mathbb{G}_{37} - (q_{38})^{(7)}G^*_{38}\mathbb{T}_{37} \quad 658$$

$$\frac{d\mathbb{T}_{36}}{dt} = -\left((b'_{36})^{(7)} - (r_{36})^{(7)}\right)\mathbb{T}_{36} + (b_{36})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(36)(j)}T^*_{36}\mathbb{G}_j\right) \quad 659$$

$$\frac{d\mathbb{T}_{37}}{dt} = -\left((b'_{37})^{(7)} - (r_{37})^{(7)}\right)\mathbb{T}_{37} + (b_{37})^{(7)}\mathbb{T}_{36} + \sum_{j=36}^{38}\left(s_{(37)(j)}T^*_{37}\mathbb{G}_j\right) \quad 660$$

$$\frac{d\mathbb{T}_{38}}{dt} = -\left((b_{38}^{'})^{(7)} - (r_{38})^{(7)}\right)\mathbb{T}_{38} + (b_{38})^{(7)}\mathbb{T}_{37} + \sum_{j=36}^{38}\left(s_{(38)(j)}T_{38}^{*}\mathbb{G}_j\right) \quad 661$$

If the conditions of the previous theorem are satisfied and if the functions $(a_i^{''})^{(8)}\ and\ (b_i^{''})^{(8)}$ Belong to $C^{(8)}(\mathbb{R}_+)$ then the above equilibrium point is asymptotically stable. 662

Denote

Definition of $\mathbb{G}_i, \mathbb{T}_i$:- 663

$$G_i = G_i^* + \mathbb{G}_i \qquad , T_i = T_i^* + \mathbb{T}_i$$

$$\frac{\partial(a_{41}^{''})^{(8)}}{\partial T_{41}}(T_{41}^{*}) = (q_{41})^{(8)} \quad , \frac{\partial(b_i^{''})^{(8)}}{\partial G_j}(\,(G_{43})^{*}\,) = s_{ij}$$

Then taking into account equations CONCATENATED EQUATIONS and neglecting the terms of power 2, we obtain 664

$$\frac{d\mathbb{G}_{40}}{dt} = -\left((a_{40}^{'})^{(8)} + (p_{40})^{(8)}\right)\mathbb{G}_{40} + (a_{40})^{(8)}\mathbb{G}_{41} - (q_{40})^{(8)}G_{40}^{*}\mathbb{T}_{41} \quad 665$$

$$\frac{d\mathbb{G}_{41}}{dt} = -\left((a_{41}^{'})^{(8)} + (p_{41})^{(8)}\right)\mathbb{G}_{41} + (a_{41})^{(8)}\mathbb{G}_{40} - (q_{41})^{(8)}G_{41}^{*}\mathbb{T}_{41} \quad 666$$

$$\frac{d\mathbb{G}_{42}}{dt} = -\left((a_{42}^{'})^{(8)} + (p_{42})^{(8)}\right)\mathbb{G}_{42} + (a_{42})^{(8)}\mathbb{G}_{41} - (q_{42})^{(8)}G_{42}^{*}\mathbb{T}_{41} \quad 667$$

$$\frac{d\mathbb{T}_{40}}{dt} = -\left((b_{40}^{'})^{(8)} - (r_{40})^{(8)}\right)\mathbb{T}_{40} + (b_{40})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(40)(j)}T_{40}^{*}\mathbb{G}_j\right) \quad 668$$

$$\frac{d\mathbb{T}_{41}}{dt} = -\left((b_{41}^{'})^{(8)} - (r_{41})^{(8)}\right)\mathbb{T}_{41} + (b_{41})^{(8)}\mathbb{T}_{40} + \sum_{j=40}^{42}\left(s_{(41)(j)}T_{41}^{*}\mathbb{G}_j\right) \quad 669$$

$$\frac{d\mathbb{T}_{42}}{dt} = -\left((b_{42}^{'})^{(8)} - (r_{42})^{(8)}\right)\mathbb{T}_{42} + (b_{42})^{(8)}\mathbb{T}_{41} + \sum_{j=40}^{42}\left(s_{(42)(j)}T_{42}^{*}\mathbb{G}_j\right) \quad 670$$

2. 671

The characteristic equation of this system is

$$\left((\lambda)^{(1)} + (b_{15}^{'})^{(1)} - (r_{15})^{(1)}\right)\{\left((\lambda)^{(1)} + (a_{15}^{'})^{(1)} + (p_{15})^{(1)}\right)$$

$$\left[\left(\left((\lambda)^{(1)} + (a_{13}^{'})^{(1)} + (p_{13})^{(1)}\right)(q_{14})^{(1)}G_{14}^{*} + (a_{14})^{(1)}(q_{13})^{(1)}G_{13}^{*}\right)\right]$$

$$\left(\left((\lambda)^{(1)} + (b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(14)}T_{14}^{*} + (b_{14})^{(1)}s_{(13),(14)}T_{14}^{*}\right)$$

$$+\left(\left((\lambda)^{(1)} + (a_{14}^{'})^{(1)} + (p_{14})^{(1)}\right)(q_{13})^{(1)}G_{13}^{*} + (a_{13})^{(1)}(q_{14})^{(1)}G_{14}^{*}\right)$$

$$\left(\left((\lambda)^{(1)} + (b_{13}^{'})^{(1)} - (r_{13})^{(1)}\right)s_{(14),(13)}T_{14}^{*} + (b_{14})^{(1)}s_{(13),(13)}T_{13}^{*}\right)$$

$$\left(\left((\lambda)^{(1)}\right)^2 + \left(\,(a_{13}^{'})^{(1)} + (a_{14}^{'})^{(1)} + (p_{13})^{(1)} + (p_{14})^{(1)}\right)(\lambda)^{(1)}\right)$$

$$\left(\left((\lambda)^{(1)}\right)^2 + \left(\,(b_{13}^{'})^{(1)} + (b_{14}^{'})^{(1)} - (r_{13})^{(1)} + (r_{14})^{(1)}\right)(\lambda)^{(1)}\right)$$

$$+\left(\left((\lambda)^{(1)}\right)^2+\left((a_{13}')^{(1)}+(a_{14}')^{(1)}+(p_{13})^{(1)}+(p_{14})^{(1)}\right)(\lambda)^{(1)}\right)(q_{15})^{(1)}G_{15}$$

$$+\left((\lambda)^{(1)}+(a_{13}')^{(1)}+(p_{13})^{(1)}\right)\left((a_{15})^{(1)}(q_{14})^{(1)}G_{14}^*+(a_{14})^{(1)}(a_{15})^{(1)}(q_{13})^{(1)}G_{13}^*\right)$$

$$\left((\lambda)^{(1)}+(b_{13}')^{(1)}-(r_{13})^{(1)}\right)s_{(14),(15)}T_{14}^*+(b_{14})^{(1)}s_{(13),(15)}T_{13}^*\Big)\}=0$$

$$+$$

$$(\lambda)^{(2)}+(b_{18}')^{(2)}-(r_{18})^{(2)}\{\left((\lambda)^{(2)}+(a_{18}')^{(2)}+(p_{18})^{(2)}\right)$$

$$\left[\left((\lambda)^{(2)}+(a_{16}')^{(2)}+(p_{16})^{(2)}\right)(q_{17})^{(2)}\mathrm{G}_{17}^*+(a_{17})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^*\right)\Big]$$

$$\left((\lambda)^{(2)}+(b_{16}')^{(2)}-(r_{16})^{(2)}\right)s_{(17),(17)}\mathrm{T}_{17}^*+(b_{17})^{(2)}s_{(16),(17)}\mathrm{T}_{17}^*\Big)$$

$$+\left((\lambda)^{(2)}+(a_{17}')^{(2)}+(p_{17})^{(2)}\right)(q_{16})^{(2)}\mathrm{G}_{16}^*+(a_{16})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^*\Big)$$

$$\left((\lambda)^{(2)}+(b_{16}')^{(2)}-(r_{16})^{(2)}\right)s_{(17),(16)}\mathrm{T}_{17}^*+(b_{17})^{(2)}s_{(16),(16)}\mathrm{T}_{16}^*\Big)$$

$$\left((\lambda)^{(2)}\right)^2+\left((a_{16}')^{(2)}+(a_{17}')^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\Big)$$

$$\left((\lambda)^{(2)}\right)^2+\left((b_{16}')^{(2)}+(b_{17}')^{(2)}-(r_{16})^{(2)}+(r_{17})^{(2)}\right)(\lambda)^{(2)}\Big)$$

$$+\left((\lambda)^{(2)}\right)^2+\left((a_{16}')^{(2)}+(a_{17}')^{(2)}+(p_{16})^{(2)}+(p_{17})^{(2)}\right)(\lambda)^{(2)}\Big)(q_{18})^{(2)}\mathrm{G}_{18}$$

$$+\left((\lambda)^{(2)}+(a_{16}')^{(2)}+(p_{16})^{(2)}\right)\left((a_{18})^{(2)}(q_{17})^{(2)}\mathrm{G}_{17}^*+(a_{17})^{(2)}(a_{18})^{(2)}(q_{16})^{(2)}\mathrm{G}_{16}^*\right)$$

$$\left((\lambda)^{(2)}+(b_{16}')^{(2)}-(r_{16})^{(2)}\right)s_{(17),(18)}\mathrm{T}_{17}^*+(b_{17})^{(2)}s_{(16),(18)}\mathrm{T}_{16}^*\Big)\}=0$$

$$+$$

$$(\lambda)^{(3)}+(b_{22}')^{(3)}-(r_{22})^{(3)}\{\left((\lambda)^{(3)}+(a_{22}')^{(3)}+(p_{22})^{(3)}\right)$$

$$\left[\left((\lambda)^{(3)}+(a_{20}')^{(3)}+(p_{20})^{(3)}\right)(q_{21})^{(3)}G_{21}^*+(a_{21})^{(3)}(q_{20})^{(3)}G_{20}^*\right)\Big]$$

$$\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(21)}T_{21}^*+(b_{21})^{(3)}s_{(20),(21)}T_{21}^*\Big)$$

$$+\left((\lambda)^{(3)}+(a_{21}')^{(3)}+(p_{21})^{(3)}\right)(q_{20})^{(3)}G_{20}^*+(a_{20})^{(3)}(q_{21})^{(1)}G_{21}^*\Big)$$

$$\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(20)}T_{21}^*+(b_{21})^{(3)}s_{(20),(20)}T_{20}^*\Big)$$

$$\left((\lambda)^{(3)}\right)^2+\left((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\Big)$$

$$\left((\lambda)^{(3)}\right)^2+\left((b_{20}')^{(3)}+(b_{21}')^{(3)}-(r_{20})^{(3)}+(r_{21})^{(3)}\right)(\lambda)^{(3)}\Big)$$

$$+\left((\lambda)^{(3)}\right)^2+\left((a_{20}')^{(3)}+(a_{21}')^{(3)}+(p_{20})^{(3)}+(p_{21})^{(3)}\right)(\lambda)^{(3)}\Big)(q_{22})^{(3)}G_{22}$$

$$+\left((\lambda)^{(3)}+(a_{20}')^{(3)}+(p_{20})^{(3)}\right)\left((a_{22})^{(3)}(q_{21})^{(3)}G_{21}^*+(a_{21})^{(3)}(a_{22})^{(3)}(q_{20})^{(3)}G_{20}^*\right)$$

$$\left((\lambda)^{(3)}+(b_{20}')^{(3)}-(r_{20})^{(3)}\right)s_{(21),(22)}T_{21}^*+(b_{21})^{(3)}s_{(20),(22)}T_{20}^*\Big)\}=0$$

$$+$$

$$\left((\lambda)^{(4)}+(b'_{26})^{(4)}-(r_{26})^{(4)}\right)\{\left((\lambda)^{(4)}+(a'_{26})^{(4)}+(p_{26})^{(4)}\right)$$

$$\left[\left(\left((\lambda)^{(4)}+(a'_{24})^{(4)}+(p_{24})^{(4)}\right)(q_{25})^{(4)}G^{*}_{25}+(a_{25})^{(4)}(q_{24})^{(4)}G^{*}_{24}\right)\right]$$

$$\left(\left((\lambda)^{(4)}+(b'_{24})^{(4)}-(r_{24})^{(4)}\right)s_{(25),(25)}T^{*}_{25}+(b_{25})^{(4)}s_{(24),(25)}T^{*}_{25}\right)$$

$$+\left(\left((\lambda)^{(4)}+(a'_{25})^{(4)}+(p_{25})^{(4)}\right)(q_{24})^{(4)}G^{*}_{24}+(a_{24})^{(4)}(q_{25})^{(4)}G^{*}_{25}\right)$$

$$\left(\left((\lambda)^{(4)}+(b'_{24})^{(4)}-(r_{24})^{(4)}\right)s_{(25),(24)}T^{*}_{25}+(b_{25})^{(4)}s_{(24),(24)}T^{*}_{24}\right)$$

$$\left(\left((\lambda)^{(4)}\right)^{2}+\left((a'_{24})^{(4)}+(a'_{25})^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)$$

$$\left(\left((\lambda)^{(4)}\right)^{2}+\left((b'_{24})^{(4)}+(b'_{25})^{(4)}-(r_{24})^{(4)}+(r_{25})^{(4)}\right)(\lambda)^{(4)}\right)$$

$$+\left(\left((\lambda)^{(4)}\right)^{2}+\left((a'_{24})^{(4)}+(a'_{25})^{(4)}+(p_{24})^{(4)}+(p_{25})^{(4)}\right)(\lambda)^{(4)}\right)(q_{26})^{(4)}G_{26}$$

$$+\left((\lambda)^{(4)}+(a'_{24})^{(4)}+(p_{24})^{(4)}\right)\left((a_{26})^{(4)}(q_{25})^{(4)}G^{*}_{25}+(a_{25})^{(4)}(a_{26})^{(4)}(q_{24})^{(4)}G^{*}_{24}\right)$$

$$\left(\left((\lambda)^{(4)}+(b'_{24})^{(4)}-(r_{24})^{(4)}\right)s_{(25),(26)}T^{*}_{25}+(b_{25})^{(4)}s_{(24),(26)}T^{*}_{24}\right)\}=0$$

$$+$$

$$\left((\lambda)^{(5)}+(b'_{30})^{(5)}-(r_{30})^{(5)}\right)\{\left((\lambda)^{(5)}+(a'_{30})^{(5)}+(p_{30})^{(5)}\right)$$

$$\left[\left(\left((\lambda)^{(5)}+(a'_{28})^{(5)}+(p_{28})^{(5)}\right)(q_{29})^{(5)}G^{*}_{29}+(a_{29})^{(5)}(q_{28})^{(5)}G^{*}_{28}\right)\right]$$

$$\left(\left((\lambda)^{(5)}+(b'_{28})^{(5)}-(r_{28})^{(5)}\right)s_{(29),(29)}T^{*}_{29}+(b_{29})^{(5)}s_{(28),(29)}T^{*}_{29}\right)$$

$$+\left(\left((\lambda)^{(5)}+(a'_{29})^{(5)}+(p_{29})^{(5)}\right)(q_{28})^{(5)}G^{*}_{28}+(a_{28})^{(5)}(q_{29})^{(5)}G^{*}_{29}\right)$$

$$\left(\left((\lambda)^{(5)}+(b'_{28})^{(5)}-(r_{28})^{(5)}\right)s_{(29),(28)}T^{*}_{29}+(b_{29})^{(5)}s_{(28),(28)}T^{*}_{28}\right)$$

$$\left(\left((\lambda)^{(5)}\right)^{2}+\left((a'_{28})^{(5)}+(a'_{29})^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)$$

$$\left(\left((\lambda)^{(5)}\right)^{2}+\left((b'_{28})^{(5)}+(b'_{29})^{(5)}-(r_{28})^{(5)}+(r_{29})^{(5)}\right)(\lambda)^{(5)}\right)$$

$$+\left(\left((\lambda)^{(5)}\right)^{2}+\left((a'_{28})^{(5)}+(a'_{29})^{(5)}+(p_{28})^{(5)}+(p_{29})^{(5)}\right)(\lambda)^{(5)}\right)(q_{30})^{(5)}G_{30}$$

$$+\left((\lambda)^{(5)}+(a'_{28})^{(5)}+(p_{28})^{(5)}\right)\left((a_{30})^{(5)}(q_{29})^{(5)}G^{*}_{29}+(a_{29})^{(5)}(a_{30})^{(5)}(q_{28})^{(5)}G^{*}_{28}\right)$$

$$\left(\left((\lambda)^{(5)}+(b'_{28})^{(5)}-(r_{28})^{(5)}\right)s_{(29),(30)}T^{*}_{29}+(b_{29})^{(5)}s_{(28),(30)}T^{*}_{28}\right)\}=0$$

$$+$$

$$\left((\lambda)^{(6)}+(b'_{34})^{(6)}-(r_{34})^{(6)}\right)\{\left((\lambda)^{(6)}+(a'_{34})^{(6)}+(p_{34})^{(6)}\right)$$

$$\left[\left(\left((\lambda)^{(6)}+(a'_{32})^{(6)}+(p_{32})^{(6)}\right)(q_{33})^{(6)}G^{*}_{33}+(a_{33})^{(6)}(q_{32})^{(6)}G^{*}_{32}\right)\right]$$

$$\left(\left((\lambda)^{(6)}+(b'_{32})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(33)}T^{*}_{33}+(b_{33})^{(6)}s_{(32),(33)}T^{*}_{33}\right)$$

$$+\left(\left((\lambda)^{(6)}+(a'_{33})^{(6)}+(p_{33})^{(6)}\right)(q_{32})^{(6)}G^{*}_{32}+(a_{32})^{(6)}(q_{33})^{(6)}G^{*}_{33}\right)$$

$$\left(\left((\lambda)^{(6)}+(b'_{32})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(32)}T^{*}_{33}+(b_{33})^{(6)}s_{(32),(32)}T^{*}_{32}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((a'_{32})^{(6)}+(a'_{33})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$\left(\left((\lambda)^{(6)}\right)^{2}+\left((b'_{32})^{(6)}+(b'_{33})^{(6)}-(r_{32})^{(6)}+(r_{33})^{(6)}\right)(\lambda)^{(6)}\right)$$

$$+\left(\left((\lambda)^{(6)}\right)^{2}+\left((a'_{32})^{(6)}+(a'_{33})^{(6)}+(p_{32})^{(6)}+(p_{33})^{(6)}\right)(\lambda)^{(6)}\right)(q_{34})^{(6)}G_{34}$$

$$+\left((\lambda)^{(6)}+(a'_{32})^{(6)}+(p_{32})^{(6)}\right)\left((a_{34})^{(6)}(q_{33})^{(6)}G^{*}_{33}+(a_{33})^{(6)}(a_{34})^{(6)}(q_{32})^{(6)}G^{*}_{32}\right)$$

$$\left(\left((\lambda)^{(6)}+(b'_{32})^{(6)}-(r_{32})^{(6)}\right)s_{(33),(34)}T^{*}_{33}+(b_{33})^{(6)}s_{(32),(34)}T^{*}_{32}\right)\}=0$$

$$+$$

$$\left((\lambda)^{(7)}+(b'_{38})^{(7)}-(r_{38})^{(7)}\right)\{\left((\lambda)^{(7)}+(a'_{38})^{(7)}+(p_{38})^{(7)}\right)$$

$$\left[\left(\left((\lambda)^{(7)}+(a'_{36})^{(7)}+(p_{36})^{(7)}\right)(q_{37})^{(7)}G^{*}_{37}+(a_{37})^{(7)}(q_{36})^{(7)}G^{*}_{36}\right)\right]$$

$$\left(\left((\lambda)^{(7)}+(b'_{36})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(37)}T^{*}_{37}+(b_{37})^{(7)}s_{(36),(37)}T^{*}_{37}\right)$$

$$+\left(\left((\lambda)^{(7)}+(a'_{37})^{(7)}+(p_{37})^{(7)}\right)(q_{36})^{(7)}G^{*}_{36}+(a_{36})^{(7)}(q_{37})^{(7)}G^{*}_{37}\right)$$

$$\left(\left((\lambda)^{(7)}+(b'_{36})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(36)}T^{*}_{37}+(b_{37})^{(7)}s_{(36),(36)}T^{*}_{36}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((a'_{36})^{(7)}+(a'_{37})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$\left(\left((\lambda)^{(7)}\right)^{2}+\left((b'_{36})^{(7)}+(b'_{37})^{(7)}-(r_{36})^{(7)}+(r_{37})^{(7)}\right)(\lambda)^{(7)}\right)$$

$$+\left(\left((\lambda)^{(7)}\right)^{2}+\left((a'_{36})^{(7)}+(a'_{37})^{(7)}+(p_{36})^{(7)}+(p_{37})^{(7)}\right)(\lambda)^{(7)}\right)(q_{38})^{(7)}G_{38}$$

$$+\left((\lambda)^{(7)}+(a'_{36})^{(7)}+(p_{36})^{(7)}\right)\left((a_{38})^{(7)}(q_{37})^{(7)}G^{*}_{37}+(a_{37})^{(7)}(a_{38})^{(7)}(q_{36})^{(7)}G^{*}_{36}\right)$$

$$\left(\left((\lambda)^{(7)}+(b'_{36})^{(7)}-(r_{36})^{(7)}\right)s_{(37),(38)}T^{*}_{37}+(b_{37})^{(7)}s_{(36),(38)}T^{*}_{36}\right)\}=0$$

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≡ 1000 calories used.

(22)^ Assuming the dam is generating at its peak capacity of 6,809 MW.

(23)^ Assuming a 90/10 alloy of Pt/Ir by weight, a C_p of 25.9 for Pt and 25.1 for Ir, a Pt-dominated average C_p of 25.8, 5.134 moles of metal, and 132 $J.K^{-1}$ for the prototype. A variation of ±1.5 picograms is of course, much smaller than the actual uncertainty in the mass of the international prototype, which are ±2 micrograms.

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