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Fundamental Equation of Complete Factor Synergetics of Complex Systems with Normalization of Dimension

Li Zong-Cheng

***Abstract*—**It is by reason of the unified measure of varieties of resources and the unified processing of the disposal of varieties of resources, that these closely related three of new basic models called the resources assembled node and the disposition integrated node as well as the intelligent organizing node are put forth in this paper; the three closely related quantities of integrative analytical mechanics including the disposal intensity and disposal- weighted intensity as well as the charge of resource charge are set; and then the resources assembled space and the disposition integrated space as well as the intelligent organizing space are put forth. The system of fundamental equations and model of complete factor synergetics is preliminarily approached for the general situation in this paper, to form the analytical base of complete factor synergetics. By the essential variables constituting this system of equations we should set twenty variables respectively with relation to the essential dynamical effect, external synergetic action and internal synergetic action of the system.

***Keywords*—**complex system; disposal of resources; complete factor synergetics; fundamental equation.

I. INTRODUCTION

COMPLEX systems are prone to open, being always with the various components, structures and efficiencies. It is necessary in the analysis of complex systems to settle the problem of unified measure. At the basic level we should divide various resources into these three major kinds, i.e. the matter resource, the information resource and the spirit resource. Further we should divide both the matter resource into mass and energy, and the spirit resource into knowledge and intelligence, while the information resource is between the matter resource and the spirit resource. In the most abstract meaning, information should be taken on the one hand as the expressive form of the movement and development of matter, on the other as the real content of the movement and development of spirit [1– 3] . By reason of the analysis on the integration of resources, we must put the spirit resource into the information resource, thus into the higher information with relation to grammar information and semantic information as well as pragmatic information, and take the amount of this high information as the measure for spirit resource. The related problem for this higher information is still being approached by the academic circle of the communication theory [1– 3] . We should combine the research of the papers [5]–[8] concerned, to pay attention to use the measure of information.

The newly rising science of complexity is facing a series of knotty problems in the research object and field [3][9][10] : on the one hand, there is the need to analyze and explain anew by the sequence in time the technological progress, the evolution of history, and the change of institution as well as the complex organization which are more complex than the evolution of nature and the growth of life; on the other, there is the need to approach and design by space the complex united organization with many layers, large scale, high openness, complex structure, multitudinous factors, a large amount of interactive information, and integrative function. For the technological progress, the giant system of historical evolution and the complex organization, we shouldn't only deeply research the synergic relation among people and the technological system to the internal environment of the organization, but also widely the synergic relation among people and the technological system to the external environment of the organization. The result of these researches should be capable of explanation for the problems [3][4] [11] [12] such as the population, the endowment of resources, the uncertain environment, the innovation and progress of technology, the game, the relation of property rights, the specialization, the division structure of labor, the information space, the institution arrangement, the production organization, the rule of behaviors, the cooperation and competition, the relation of principal and agent, the value, the transaction cost, the region, the knowledge, the market system, the interest group, the confliction, the confrontation, the coordination, the flexible organization, the international trade, the fictitiousness, the network, the nonlinear dynamical process, the probability distribution, the motion equation, the change of history, and the dynamical organization of alliance [4][5] (or the virtual enterprise, VE) as well as as the sharing of resources.

It is necessary of complex systems, particularly of giant complex systems of open, to expand and improve completely synergetics only for giant simple system, so as to carry out the overall analysis and description on the various components, structures and efficacies of different types as well as the complex change and synergetic processes. For this reason, there have been a series of approaches in the papers [13]–[18].

On the basis of the approaches of the papers [13]–[18], let us set the mathematical base of all the analyses for giant complex systems in the essential dynamical relation, the essential effect relation and the state variable of system as well as the response

Li Zongcheng is with the RG of Interdisciplinary Science, Suzhou University, CHINA (corresponding author to provide phone: 86-0512-67165315; fax: 86-0512-67165315; e-mail: lizongcheng@hotmail.com).

behavior of system. Starting from this base, we should reveal the basic property and causality of complexity phenomena, thus approaching to set the theory of giant complex systems which should be called "complete factor synergetics ".

This paper and its follow-up papers try to set the general presupposition of complexity analysis, taking complex systems as resources disposing systems. All the giant complex system, regardless of the giant complex systems of nature or life or society, should be taken as the resources disposing system. As the resources disposing system, a giant complex system contains the various resources of energy, mass and information, even the various resources of spirit (the knowledge) and society (the institution).

To reveal more deeply the basic property and causality of complexity phenomena, it will be considered below to approach setting the base of all the analyses from the essential dynamical effect relations of complex system. In further analysis, the essential dynamical-effect relation of any complex system is divided into such two basic aspects, i.e. (1) the equilibrium and non-equilibrium relations of disposal action – resources load; (2) the equilibrium and non-equilibrium relations of system efficacy – system attrition.

On the approach of the papers [13]–[18], the system of fundamental equations and model of complete factor synergetics is approached preliminarily in this paper for the general situation, to form the analytical base of complete factor synergetics.

II. BASE OF ANALYSIS ON RADICAL DYNAMICS FOR GIANT COMPLEX SYSTEM

It is necessary to approach on the setting of the base of all the analyses of the giant complex system in the fundamental dynamical relation, the fundamental effect relation and the state variable of system and the response behavior of system. On this base, we can reveal the fundamental property and causality of complex phenomena, and then approach to set the theory of complete factor synergetics for the giant complex system.

The factors of fundamental dynamical relation should be divided into these two respects, i.e. the disposal action and the disposal load. The former is from but outsider the category of classical mechanics for force; the latter is from but outsider the category of classical mechanics for mass. The disposal action of resources not only is relative to the external resources load of system, but also to the internal resources load of system. The factors of this fundamental relation influence and decide the sufficient condition for the giant complex system to exist, move and develop as well as change. This radical hypothesis evident in itself without the necessity of proof can be lifted into the principle of fundamental dynamical analysis.

To reveal more deeply the basic property and causality of complexity phenomena, it will be considered below to approach setting the base of all the analyses from the essential dynamical effect relations of complex system. In further analysis, the essential dynamical-effect relation of any complex system is divided into such two basic aspects, i.e. (1) the equilibrium and non-equilibrium relations of disposal action – resources load; (2) the equilibrium and non-equilibrium relations of system efficacy – system attrition.

The analysis shows that the relation of this pair factors of the disposal action and resources load of complex system influences and decides the sufficient condition of the whole motion and itself development as well as overall change of a giant complex system; and the relation of this pair factors of the efficacy and attrition of complex system influences and decides the necessary condition of the whole motion and itself development as well as overall change of a giant complex system; while the relation of this pair factors of the complex system and its environment influences and decides the boundary condition of the whole motion and itself development as well as overall change of a giant complex system; and then the relation of this pair factors of the gain tendency and reasonable pattern of complex system influences and decides the behavior condition of the whole motion and itself development as well as overall change of a giant complex system. the relation expression of the disposal to load and the relation expression of the efficacy to loss should become the analytical base of general dynamics for the complex system, and then the analytical base of complete factor synergetics for the giant complex system to set afterwards.

The establishment of complete factor synergetics [12−16] started from these two aims : one is to put all processes of motion, change and development in that of resources disposal, and then expand the research of complexity from physics merely for the field of matter into the theory for all the fields of resources; the other is to combine nonlinear dynamics with irreversible process thermodynamics and statistical theory of non-equilibrium state, and then set the fundamental and universal dynamics for modern science.

The giant complex system should be taken as the disposal system of resources consisting of various properties and components of resources, where there are both the matter resources and the information resources as well as as spirit resources; in other words, both the natural resources (with matter material, energy resources, tool, equipment and installation as well as technology) and social resources (with management, organization and network).

For the complex system with a variety of components, we should derive interdisciplinary integrative variable, which in new analysis is to set on the basis of the normalization of dimension with relation to resource- disposing intensity, called as "cross-integrative variable " for short. For the resources node, and then for the resources-integrated node, we should put in the time rate of resources distribution, by the load amount consisting of the integrating-disposal intensity and resources-integrated quantity. For example, For a disposal node *k*, with the product of resources-disposing intensity $c_{d,k}(t)$ and disposal quantity q_k of resources, we should determine a new basic amount:

$$m_{d,k}(t) = c_{d,k}(t) \cdot q_k \,, \tag{1}$$

which should be called the disposal load of resources. The disposal intensity should be considered the capacity of resources in offsetting the disposing action force, marked as $c_d(t)$. Obviously the disposal intensity should be at least with closely relation to the scarcity and impediment of resources. Marking the scarcity as $\eta_d(t)$, and the impediment rate as $\lambda_r(t)$, we should define the impedimental rate into the condition probability for the impediment to occur possibly in an unit of time after some moment t while the mobility $F_r(t)$ that the impediment not having occurred until t. we further set the resources- disposing intensity by the following relation:

$$c_d(t) = \lambda_r(t)\eta_d(t) = -\frac{d(t)}{s(t)} \cdot \left[\left(\frac{dF_r(t)}{dt} \right) \Big/ F_r(t) \right] \quad (2)$$

Based on the disposal intensity and disposal-weighted intensity, it isn't difficult to give various cross-integrative variables.

Hence we can approach to set the base of analytical mechanics for the equilibrium and non-equilibrium boundary interflows of complex open system, where for a complex disposal system consisting of u organization groups with n organization nodes of m disposal nodes from l resources nodes, it is necessary to set the boundary interflow space (C_d ,Q) of integrating disposal of poly-layer consisting of the resources- disposing intensity C_d (or the disposal-weighted intensity $C_{d,R}$ of resources) and disposed quantity Q (including the number of volume elements), and take the resources-disposing intensity C_d (or the disposal-weighted intensity $C_{d,R}$ of resources) as the core to put forth the analytical mathematics for the equilibrium and non-equilibrium interflows of the boundary of an open complex system.

Corresponding to the basic model of poly-layer analysis —the resources node, the disposal node and the organization node as well as the organization group set in the papers [7] and [12], the boundary interflow space (C_d , Q) of integrating disposal of poly-layer should be divided into the following four basic layers: At the level of the primary analysis, for one or l resources nodes, the boundary interflow space ($C_{d,l}$, Q_l) (or ($C_{d,l,R}$, Q_l)) of the primary integrating disposal is consisted of the resources-disposing intensity $C_{d,l}$ (or the disposal- weighted intensity $C_{d,l,R}$ of resources) and disposed quantity Q_l (including the number of volume elements); At the level of the grade-3 analysis, for one or m disposal nodes, the boundary interflow space ($C_{d,m}$, Q_m) (or ($C_{d,m,R}$, Q_m)) of the grade-3 integrating disposal is consisted of the resources-disposing intensity $C_{d,m}$ (or the disposal- weighted intensity $C_{d,m,R}$ of resources) and disposed quantity Q_m (including the number of volume elements); At the level of the grade-2 analysis, for one or n organization nodes, the boundary interflow space ($C_{d,n}$, Q_n) (or ($C_{d,n,R}$, Q_n)) of the grade-2 integrating disposal is consisted of the resources- disposing intensity $C_{d,n}$ (or the disposal-weighted intensity $C_{d,n,R}$ of resources) and disposed quantity Q_n (including the number of volume elements); At the level of the grade-1 (advanced) analysis, for one or u organization groups, the boundary interflow space ($C_{d,u}$, Q_u) (or ($C_{d,u,R}$, Q_u)) of the grade-1 (advanced) integrating disposal is consisted of the resources-disposing intensity $C_{d,u}$ (or the disposal-weighted intensity $C_{d,u,R}$ of resources) and disposed quantity Q_u (including the number of volume elements).

For an open complex system, it is necessary to consider not only the input of mass and energy, but also the entropy flow and negative entropy flow with relation to structure, thus considering indirectly the input of information and then the input of knowledge and intelligence put into higher information. In this situation, we should consider the integrated resources V of the input of the environment to this complex system and the integrated resources U of the output of this complex system to its environment, and then the exchange (U, V) between this open complex system S and its environment E.

The analysis on the fundamental dynamical factor constitutes the feasibility analysis on the fundamental dynamical effect, while the analysis on the fundamental effect factor constitutes the effectiveness analysis of the fundamental dynamical effect. Only combining the feasibility analysis with the effectiveness analysis, we can have a truly deep analysis on the base of the movement and evolution of complex system. The efficacy of system is the function and effect of system, in relation to the aim and goal of system; the loss of system is various energies, masses and as information and even various spirit and social resources for system to lose in exerting of function, in relation to the efficacy of system. The factors of this fundamental relation influence and decide the necessary condition for the giant complex system to exist, move and develop as well as change. This radical hypothesis evident in itself without the necessity of proof can be lifted into the principle of fundamental effect analysis.

A complex system should be first put in the resource integrated system, and then in the integrating disposal system, and further in the intelligent organization system. Let the state variable of a complex system be R , while the state variable fitting the demand of the target $\underline{S}$ of the complex system be $\underline{R}$, thus deriving in the quantity which should be called the reasonable integrated distributive factor should be: $\delta = |\,\underline{R} - R\,|$, and then putting by the following expression in the efficacy coefficient of the complex system:

$$a_F = \frac{\underline{R} - \delta}{\underline{R} + \delta} \quad \in [-1,\ +1] \quad (3)$$

We should consider combining the efficient coefficient of the system with the disposal organizing force F_D and the change dR of relevant integrative distribution state variable, to evaluate the efficacy of the system.

For a complex system as the resources disposing system, suppose there are l resources node $k = 1\ \ 2\ \cdots\ l$ and m disposal nodes (or disposal subjects, $j = 1\ \ 2\ \ \ldots\ \ m$ as well as n organization nodes ($i = 1, 2, \cdots, n$). For the k-th resources node ($k = 1, 2, \cdots, l$), let the resources integrated force be $F_{D,\ i}$, the relevant integrated shift be du_k; for the j-th disposal node ($j = 1, 2, \cdots, m$), let the integrating disposal force be $F_{D,j}$, the relevant organizing shift be du_j; for the i-th organizing node ($i = 1, 2, \cdots, n$), let the disposing organization force be $F_{D,i}$, the relevant organizing shift be du_i , then there should be the following three kinds of possibilities:

The efficacy S_F of the system

$$S_F = \sum_{i=1}^{n} a_{F,i} \int_{A_i}^{B_i} F_{D,i} du_i = \sum_{i=1}^{n} \sum_{j=1}^{m_i} \sum_{k=1}^{l_j} a_{F,ijk} \int_{A_{ijk}}^{B_{ijk}} F_{D,ijk} du_{ijk} \quad (4\,a)$$

The efficacy S_F of the system

$$S_F > \sum_{i=1}^{n} a_{F,i} \int_{A_i}^{B_i} F_{D,i} du_i = \sum_{i=1}^{n} \sum_{j=1}^{m_i} \sum_{k=1}^{l_j} a_{F,ijk} \int_{A_{ijk}}^{B_{ijk}} F_{D,ijk} du_{ijk} \quad (4\,b)$$

The efficacy S_F of the system

$$S_F < \sum_{i=1}^{n} a_{F,i} \int_{A_i}^{B_i} F_{D,i} du_i = \sum_{i=1}^{n}\sum_{j=1}^{m_i}\sum_{k=1}^{l_j} a_{F,ijk} \int_{A_{ijk}}^{B_{ijk}} F_{D,ijk} du_{ijk} \quad (4c)$$

Generally we should set the following expression of relation

$$S_F = a_F \int_A^B F_D du \,. \quad (5)$$

Between the resources disposing amount M_F caused of the exertion of a system to its efficacy and the resources disposing amount M_L expended of the exertion of a system to its efficacy, there should be the following three of relations:

$$M_F - M_L > 0 \,, M_F - M_L < 0 \,, M_F - M_L = 0 \,. \quad (6)$$

Here the state variables of complex system are divided into these two kinds : the goal state variable and the actual state variable. The former is the state variable for the system to fit the realistic requirement of the large system (or the whole system of its environment), the latter is the state for the system to be in adjusting. The deviation between the goal state variable and the actual state variable forms the state tending factor of complex system, which can reflect the process for the state of system to tend to rationalization.

III. BASE OF ANALYSIS ON COMPLETE SYNERGIC RELATION OF GIANT COMPLEX SYSTEM

We can approach to set the dynamical analysis of resources disposal dynamics for the external synergic factors of giant complex system, about the external coupling relation, between the complex system and its environment.

Between the complex system and its environment there are always the mutual selection and mutual adaptation, as well as the mutual influence and mutual change. In the whole world, there exist not only the selection and influence as well as the change of some environment E for a series of systems S_1, $S_2, \cdots, S_n$, but also the selection and influence as well as the change of some system S for a series of environments E_1, $E_2, \cdots, E_n$. The complex system in the course of it's whole life always lies in the various environments, with the various relations to the various environments.

In the interaction between the giant complex system and its environment there always present these three basic forms, i.e. the cooperation (consistency), the competition (confliction), and the outsider (independency). By the feedback phenomenon of "order preserving flow ", we should analyze these relation of cooperation and competition of dynamical systems.

Let $C_{d,S}$ and $C_{d,E}$ express respectively the resources disposing intensity of the complex system and the resources disposing intensity of the environment, we should give the following Kolmogorov model:

$$\dot{C}_{d,S} = C_{d,S} f_S (C_{d,S}, C_{d,E}) \,,$$

$$\dot{C}_{d,E} = C_{d,E} f_E (C_{d,S}, C_{d,E}), \ (C_{d,S}, C_{d,E}) \in R_+^2 \quad .(7)$$

Which reflects that the relation between the complex system and its environment is the cooperative under the condition of $\partial f_S / \partial C_{d,E} \geq 0$ and $\partial f_E / \partial C_{d,S} \geq 0$, while the competitive under the condition of $\partial f_S / \partial C_{d,E} \leq 0$ and $\partial f_E / \partial C_{d,S} \leq 0$; in addition, the interaction between the complex system and its environment is not favorable to its environment but itself under the condition $\partial f_S / \partial C_{d,E} \geq 0$ and $\partial f_E / \partial C_{d,S} \leq 0$, while not favorable to itself but its environment under the condition $\partial f_S / \partial C_{d,E} \leq 0$ and $\partial f_E / \partial C_{d,S} \geq 0$.

Suppose that there are a series of exchanges ($M_{\text{out},1}$, $M_{\text{int},1}$) , ($M_{\text{out},2}$, $M_{\text{int},2}$) , $\cdots$, ($M_{\text{out},n}$, $M_{\text{int},n}$) between some open complex system S and a series of subsystems (or resources disposing units) E_1, E_2, $\cdots$, E_n of its environment.

When the external interflow of resources by the complex system S is mainly concentrated going to some subsystem E_1 (or the disposal unite of the environmental resources) of its environment E, there should be the following relation:

$$M(S,E_1) \geq M(S,E_2) \geq \cdots \geq M(S,E_n) \,,$$

$$M(S,E_1) >> [M(S,E_2) + M(S,E_3) + \cdots + M(S,E_n)]/(n-1) \quad (8)$$

In this situation, we should take the maximum interflow quantity of the complex system S to some subsystem of its environment E as the concentrating interflow quantity, which should be marked as

$M_{SE,\Lambda}$, i.e. $M_{SE,\Lambda} = M_{SE,\max}$.

When the external interflow of resources by the complex system S is basically dispersed going to many subsystems E_1, E_2, $\cdots$, E_n (or the disposal unite of the environmental resources) of its environment E, there should be the following relation:

$$M(S,E_1) \geq M(S,E_2) \geq \cdots \geq M(S,E_n) \,,$$

$$M(S,E_1) < M(S,E_2) + M(S,E_3) + \cdots + M(S,E_n) \quad (9)$$

The concentrating and dispersing interflow quantities of the complex system for its environment constitute the external synergetic factors. By the external concentrating and dispersing interflow quantities, we should derive the external synergetic tendency factor as follows:

$$H_{SE}(t) = | M_{SE,\Lambda}(t) - M_{SE,V}(t) | \quad (10)$$

For the giant system and its subsystem, let $C_{d,S}$ and $C_{d,S\,i}$ express respectively the resources disposing intensity of the giant system and the resources disposing intensity of the subsystem, we should give the following Kolmogorov model:

$$\dot{C}_{d,S} = C_{d,S} f_S (C_{d,S}, C_{d,S\,i}) \,,$$

$$\dot{C}_{d,S\,i} = C_{d,S\,i} f_{S\,i} (C_{d,S}, C_{d,S\,i}), \ (C_{d,S}, C_{d,S\,i}) \in R_+^2 \quad (11)$$

Which reflects that the relation between the giant system and its subsystems is the cooperative under the condition of $\partial f_S / \partial C_{d,S\,i} \geq 0$ and $\partial f_{S\,i} / \partial C_{d,S} \geq 0$, while the competitive under the condition of $\partial f_S / \partial C_{d,S\,i} \leq 0$ and $\partial f_{S\,i} / \partial C_{d,S} \leq 0$; in addition, the interaction between the giant system and its subsystems is not favorable to its subsystems but itself under the condition $\partial f_S / \partial C_{d,S\,i} \geq 0$ and $\partial f_{S\,i} / \partial C_{d,S} \leq 0$, while not favorable to itself but its subsystems under the condition $\partial f_S / \partial C_{d,S\,i} \le 0$ and $\partial f_{S\,i} / \partial C_{d,S} \ge 0$.

Suppose that all the subsystems (or the resources disposal units) of some giant complex system should be divided into such three kinds: the 1st kind is that with cooperative relation to the giant system, marked as S_Γ; the 2nd kind is that with competitive relation to the giant system, marked as S_L; the 3rd kind is with mixed relation to the giant system, marked as S_Ω. By these three subsystems, we should set the following coupling dynamic system:

$$\dot{C}_{d,S} = F_S(C_{d,S}, C_{d,S\Gamma}, C_{d,SL}, C_{d,S\Omega}),$$
$$\dot{C}_{d,S\Gamma} = F_{S\Gamma}(C_{d,S}, C_{d,S\Gamma}, C_{d,SL}, C_{d,S\Omega}),$$
$$\dot{C}_{d,SL} = F_{SL}(C_{d,S}, C_{d,S\Gamma}, C_{d,SL}, C_{d,S\Omega}),$$
$$\dot{C}_{d,S\Omega} = F_{S\Omega}(C_{d,S}, C_{d,S\Gamma}, C_{d,SL}, C_{d,S\Omega}), \tag{12}$$

where $\partial F_S / \partial C_{d,S\Gamma} > 0$, $\partial F_{S\Gamma} / \partial C_{d,S} > 0$, $\partial F_S / \partial C_{d,SL} < 0$, $\partial F_{SL} / \partial C_{d,S} < 0$, $|\partial F_S / \partial C_{d,S\Omega}| < \delta$, $|\partial F_{S\Omega} / \partial C_{d,S}| < \delta$, $C_{d,S}, C_{d,S\Gamma}, C_{d,SL}, C_{d,S\Omega} \in C$.

We should take $\dot{C}_{d,S\Gamma}$, $\dot{C}_{d,SL}$ and $\dot{C}_{d,S\Omega}$ respectively as the internal cooperative effectiveness, internal competitive effectiveness and internal mixed effectiveness of some complex system.

For some complex system, let the resources disposing amount of the cooperative subsystem, the resources disposing amount of the competitive subsystem and the resources disposing amount be respectively

$$M_{d,\Gamma} = C_{d,\Gamma} Q_\Gamma,\; M_{d,L} = C_{d,L} Q_L,\; M_{d,\Omega} = C_{d,\Omega} Q_\Omega.$$

For the internal coupling dynamic system of some complex system (12), we should determine by the following relation respectively the internal cooperative effect, external competitive effect and internal mixed effect of the complex system:

$$W_{S,\Gamma} = \dot{C}_{d,S\Gamma} \cdot Q_\Gamma = F_{S,\Gamma}(C_{d,S}, C_{d,S\Gamma}, C_{d,SL}, C_{d,S\Omega}) \cdot Q_\Gamma$$
$$W_{S,L} = \dot{C}_{d,SL} \cdot Q_L = F_{S,L}(C_{d,S}, C_{d,S\Gamma}, C_{d,SL}, C_{d,S\Omega}) \cdot Q_L$$
$$W_{S,\Omega} = \dot{C}_{d,S\Omega} \cdot Q_\Omega = F_{S,\Omega}(C_{d,S}, C_{d,S\Gamma}, C_{d,SL}, C_{d,S\Omega}) \cdot Q_\Omega \tag{13}$$

For some complex system, by the internal cooperative effect and internal competitive effect to set the internal dynamic factor, we should derive the internal dynamic tendency factor as follows:

$$\chi_S(t) = W_{S,\Gamma}(t) - W_{S,L}(t) = \dot{C}_{d,S\Gamma} Q_\Gamma - \dot{C}_{d,SL} Q_L. \tag{14}$$

IV. BASIC SYSTEM OF EQUATIONS OF COMPLETE FACTOR SYNERGETICS

The analytical base of complete factor synergetics for complex systems is set preliminarily in the papers [1]-[16]. This analysis involves the essential dynamical factors and external synergetic factors as well as internal synergetic factors to influence and decide the existence and motion as well as development of the giant complex system. Any giant complex system, regardless of the giant complex system of nature and the giant complex system of life or the giant complex system of society, should be taken as the resources disposing system. As the resources disposing system, the giant complex system contains various energy resources and mass resources (the material of matter) as well as information resources, and even various spirit resources (the knowledge) and social resources (the institution). Under the presupposition for the giant complex system to be taken as the resources disposing system, we should put the dynamical relation of the giant complex system in the four aspects, i.e. the essential dynamical effect relation, the systematic state responding relation and the external dynamical synergy relation as well as the internal dynamical synergy relation.

The analyses in the papers [1]-[16] show that the factors constituting the internal dynamical synergetic relation should be divided into the two aspects, i.e. on the one hand as the internal cooperation and the internal competition, on the other as the concentrating interflow and the dispersing interflow. Between the complex system and its internal subsystems there are always the mutual selection and mutual adaptation, as well as the mutual influence and mutual change. In some giant complex system, there exist not only the selection and influence as well as the change of some giant complex system S for a series of its internal subsystem $S_1, S_2, \cdots, S_l$, but also the selection and influence as well as the change of a series of its internal subsystem $S_1, S_2, \cdots, S_l$ for the giant complex system S. The giant complex system in the course of it's whole life always consist of the various subsystems, with the various relations to the various subsystems. Between the giant complex system and its internal subsystems there should present the three kinds of forms of interactions, i.e. the cooperation (the unanimity) and the competition (the confliction) as well as the outsider (the independence). The internal dynamical factors formed of the cooperative effect amount $W_{S,\Gamma}$ and competitive effect amount $W_{S,L}$ are set forth in this paper, thus putting in the internal dynamical tendency factor χ_{SE}; and the internal synergetic factors formed of the concentrating interflow $M_{S,A}$ and dispersing interflow amount $M_{S,V}$ are set forth in this paper, thus putting in the internal synergetic tendency factor h_S.

On the analytical base of complete factor synergetics set in the papers [1]-[16], we should further consider now setting forth the analytical base of complete factor synergetics for complex systems.

Let $x_1 = \underline{X}$ be the targeting state variable (the reasonable state variable or non-reasonable variable) of some system, $x_2 = X$ be the practical state variable of some system, $x_3 = \underline{Y}$ be the targeting response variable (the reasonable response variable or non-reasonable response variable), $x_4 = Y$ be the practical response variable of some system, $x_5 = M_{d,F}$ be the resource amount fitting the requirement of the disposal force F_d, $x_6 = M_{d,C}$ be the resources load, $x_7 = M_{d,S}$ be the resources amount fitting the requirement of the system efficacy S_F, $x_8 = M_{d,L}$ be the system attrition, $x_9 = M_{d,EF}$ be the resources amount fitting the requirement of the environment load force E_F, $x_{10} = M_{d,EC}$ be the load formed by the system to its environment, $x_{11} = M_{d,ES}$ be the resource amount fitting the requirement of the eco- system efficacy S_{EF} , $x_{12} = M_{d,EL}$ be the ecosystem attrition, $x_{13} = W_{SE,\Gamma}$ be the external cooperative resources amount, $x_{14} = W_{SE,L}$ be the external competitive resources amount, $x_{15} = M_{SE,\Lambda}$ be the external concentrating interflow amount, $x_{16} = M_{SE,V}$ be the external dispersing interflow amount, $x_{17} = W_{S,\Gamma}$ be the internal cooperative resources amount, $x_{18} = W_{S,L}$ be the internal competitive resources amount, $x_{19} = M_{S,\Lambda}$ be the internal concentrating interflow amount, $x_{20} = M_{S,V}$ be the internal dispersing interflow amount, hence we should set the following form of basic system of equations:

The basic system of dynamical equations

$$\frac{dx_i(t)}{dt} = F_i(x_1, x_2, \cdots, x_{20}) + f_i \qquad i = 1, 2, \cdots, 20 \tag{15a}$$

The essential dynamical restriction condition

$$x_5(t) = M_{d,F}(x_1(t), x_2(t), \cdots, x_{20}(t)) \geq x_6(t) = M_{d,C}(x_1(t), x_2(t), \cdots, x_{20}(t)) \tag{15b1}$$

The essential effect restriction condition

$$x_7(t) = M_{d,S}(x_1(t), x_2(t), \cdots, x_{20}(t)) \geq x_8(t) = M_{d,L}(x_1(t), x_2(t), \cdots, x_{20}(t)) \tag{15c1}$$

The environmental dynamical restriction condition

$$x_9(t) = M_{d,EF}(x_1(t), x_2(t), \cdots, x_{20}(t)) \geq x_{10}(t) = M_{d,EC}(x_1(t), x_2(t), \cdots, x_{20}(t)) \tag{15b2}$$

The environmental effect restriction condition

$$x_{11}(t) = M_{d,ES}(x_1(t), x_2(t), \cdots, x_{20}(t)) \geq x_{12}(t) = M_{d,L}(x_1(t), x_2(t), \cdots, x_{20}(t)) \tag{15c2}$$

The external dynamical equilibrium condition

$$x_{13}(t) = M_{SE,\Gamma}(x_1(t), x_2(t), \cdots, x_{20}(t)) = x_{14}(t) = M_{SE,L}(x_1(t), x_2(t), \cdots, x_{20}(t)) \tag{15d1}$$

The external cooperative restriction condition

$$x_{13}(t) = M_{SE,\Gamma}(x_1(t), x_2(t), \cdots, x_{20}(t)) > x_{14}(t) = M_{SE,L}(x_1(t), x_2(t), \cdots, x_{20}(t)) \tag{15d2}$$

The external competitive restriction condition

$$x_{13}(t) = M_{SE,\Gamma}(x_1(t), x_2(t), \cdots, x_{20}(t)) < x_{14}(t) = M_{SE,L}(x_1(t), x_2(t), \cdots, x_{20}(t)) \tag{15d3}$$

The external synergetic equilibrium condition

$$x_{15}(t) = M_{SE,\Lambda}(x_1(t), x_2(t), \cdots, x_{20}(t)) = x_{16}(t) = M_{SE,V}(x_1(t), x_2(t), \cdots, x_{20}(t)) \tag{15e1}$$

The external concentrative restriction condition

$$x_{15}(t) = M_{SE,\Lambda}(x_1(t), x_2(t), \cdots, x_{20}(t)) > x_{16}(t) = M_{SE,V}(x_1(t), x_2(t), \cdots, x_{20}(t)) \tag{15e2}$$

The external dispersive restriction condition

$$x_{15}(t) = M_{SE,\Lambda}(x_1(t), x_2(t), \cdots, x_{20}(t)) < x_{16}(t) = M_{SE,V}(x_1(t), x_2(t), \cdots, x_{20}(t)) \tag{15e3}$$

The internal dynamical equilibrium condition

$$x_{17}(t) = M_{S,\Gamma}(x_1(t), x_2(t), \cdots, x_{20}(t)) = x_{18}(t) = M_{S,L}(x_1(t), x_2(t), \cdots, x_{20}(t)) \tag{15f1}$$

The internal cooperative restriction condition

$$x_{17}(t) = M_{S,\Gamma}(x_1(t), x_2(t), \cdots, x_{20}(t)) > x_{18}(t) = M_{S,L}(x_1(t), x_2(t), \cdots, x_{20}(t)) \tag{15f2}$$

The internal competitive restriction condition

$$x_{17}(t) = M_{S,\Gamma}(x_1(t), x_2(t), \cdots, x_{20}(t)) < x_{18}(t) = M_{S,L}(x_1(t), x_2(t), \cdots, x_{20}(t)) \tag{15f3}$$

The internal synergetic equilibrium condition

$$x_{19}(t) = M_{S,\Lambda}(x_1(t), x_2(t), \cdots, x_{20}(t)) = x_{20}(t) = M_{S,V}(x_1(t), x_2(t), \cdots, x_{20}(t)) \tag{15g1}$$

The internal concentrative restriction condition

$$x_{19}(t) = M_{SE,\Lambda}(x_1(t), x_2(t), \cdots, x_{20}(t)) > x_{20}(t) = M_{S,V}(x_1(t), x_2(t), \cdots, x_{20}(t)) \tag{15g2}$$

The internal dispersive restriction condition

$$x_{19}(t) = M_{S,\Lambda}(x_1(t), x_2(t), \cdots, x_{20}(t)) < x_{20}(t) = M_{S,V}(x_1(t), x_2(t), \cdots, x_{20}(t)) \tag{15g3}$$

The constraint relation of essential dynamical factors

$$\frac{d}{dt}(x_5(t) - x_6(t)) \leq 0 \tag{15h}$$

The constraint relation of essential effect factors

$$\frac{d}{dt}(x_7(t) - x_8(t)) > 0 \tag{15i1}$$

The constraint relation of environmental dynamical factors

$$\frac{d}{dt}(x_9(t) - x_{10}(t)) \leq 0 \tag{15h2}$$

The constraint relation of environmental effect factors

$$\frac{d}{dt}(x_{11}(t) - x_{12}(t)) > 0 \tag{15i2}$$

The equilibrium constraint relation of external dynamical factors

$$\frac{d}{dt}(x_{13}(t) - x_{14}(t)) = 0 \qquad (15\,j1)$$

The cooperative constraint relation of external dynamical factors

$$\frac{d}{dt}(x_{13}(t) - x_{14}(t)) > 0 \qquad (15\,j2)$$

The competitive constraint relation of external dynamical factors

$$\frac{d}{dt}(x_{13}(t) - x_{14}(t)) < 0 \qquad (15\,j3)$$

The equilibrium constraint relation of external synergetic factors

$$\frac{d}{dt}(x_{15}(t) - x_{16}(t)) = 0 \qquad (15\,k1)$$

The concentrative constraint relation of external synergetic factors

$$\frac{d}{dt}(x_{15}(t) - x_{16}(t)) > 0 \qquad (15\,k2)$$

The dispersive constraint relation of external synergetic factors

$$\frac{d}{dt}(x_{15}(t) - x_{16}(t)) < 0 \qquad (15\,k3)$$

The equilibrium constraint relation of internal dynamical factors

$$\frac{d}{dt}(x_{17}(t) - x_{18}(t)) = 0 \qquad (15\,l1)$$

The cooperative constraint relation of internal dynamical factors

$$\frac{d}{dt}(x_{17}(t) - x_{18}(t)) > 0 \qquad (15\,l2)$$

The competitive constraint relation of internal dynamical factors

$$\frac{d}{dt}(x_{17}(t) - x_{18}(t)) < 0 \qquad (15\,l3)$$

The equilibrium constraint relation of internal synergetic factors

$$\frac{d}{dt}(x_{19}(t) - x_{20}(t)) = 0 \qquad (15\,m1)$$

The concentrative constraint relation of internal synergetic factors

$$\frac{d}{dt}(x_{19}(t) - x_{20}(t)) > 0 \qquad (15\,m2)$$

The dispersive constraint relation of internal synergetic factors

$$\frac{d}{dt}(x_{19}(t) - x_{20}(t)) < 0 \qquad (15\,m3)$$

The above system of equations (15a) - (15 m) should be called the basic system of the equations of complete factor synergetics, where the system of equations (15 a) should taken as Langevin equation with the form of the system of one order differential equations, and f_i is the stochastic fluctuating force, while F_i $(x_1, x_2, \cdots, x_{16})$ is generally the nonlinear function of variable $x_i(t)$.

V. CONCLUSION

The system of fundamental equations and model of complete factor synergetics is preliminarily approached for the general situation in this paper, to form the analytical base of complete factor synergetics. By the essential variables constituting this system of equations we should set twenty variables respectively with relation to the essential dynamical effect, external synergetic action and internal synergetic action of the system.

The new system of equations to be set in this paper is above all the combination and unity of the nonlinear stochastic differential equation and the determinant constraint condition, and then the combination and unity of the practical state function and reasonable state function (or non-reasonable state function) of the system on the basis of the basic system of equations of complete factor synergetics.

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Li Zong-Cheng was born in Laoyang, CHINA., May 1958. He first studied in Nankai University, CHINA and afterwards in Zhejiang University, CHINA. His major field of study is in mathematics, systems science and economics.

He became a professor in 1997. Since 1999 he has been with the RG of INTERDISCIPLINARY SCIENCE, Suzhou University. Information concerning previous publications: Fundamental equation and Function of Holo-synergetic Dynamics for Complex Systems, Systems Engineering —— Theory & Practice, Vol. 24, 2004, 4-13; Spatiotemporal Relation of Extendable General Relativity in the Irreversible Process of A Dissipative System, Acta Physics Sinica, 2003.4: 1-10; Gravitational Relation of Extendable General Relativity in the Irreversible Process of A Dissipative System, Acta Physics Sinica, 2003.4: 11-20. His current research interests are System Modelling and Identification, Adaptive Control, Stochastic Systems, Descriptor Systems, and Control Design and Analysis of Systems with Input Constraints.