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Parallelism between Ruelle–Takens Scenario on Turbulence and Ancient Chinese Philosophy of Lao Tzu

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Abstract

Similarity between Ruelle–Takens scenario on turbulence (chaos) and the cosmogony by Lao Tzu is pointed out.

In recent years, there has been increasing interest in the chaotic motions in deterministic systems.[1] The existence of the chaotic motions implies that Laplace's determinism[2] does not practically hold in the systems. In the chaotic systems, the distance between two orbits, whose initial conditions are chosen almost the same values, becomes exponentially large in time. Therefore we can not predict the future state because there are inevitable small errors for the observation of the inital conditions. In general models that describe nature are nonlinear systems, and chaotic motions frequently appear in the nonliear systems when the control parameters (e. g., Reynolds number) are taken some values. There are some scenarios leading to chaos.[3] Ruelle–Takens[4] have proposed a scenario which gives a new picture on the occurrence of turbulence.

Recently, the parallels between elementary particle physics and ancient Chinese philosophy of Tao was discussed by Capra[5]. In this note, we point out that Ruelle–Takens scenario[4] on turbulence (chaos) is similar to the scenario by Lao Tzu.[6] He said "Tao (way)" generates "one", the "one" generates "two", the "two" generates "three" and the "three" generates "all things". (Chap.42.) Namely the parallelism between the two scenarios is expressed by

Ruelle Takens :	no flow	→	steady flow	→	periodic flow	→	quasi–periodic flow	→ turbulence (chaos)
	‖		‖		‖		‖	‖
Lao Tzu :	"Tao"	→	"one"	→	"two"	→	"three"	→ "all things"

where "Tao" is interpreted by Non–being.[7] The "one" here corresponds to Being of one mode which expresses a steady flow. "Tao" generates "one" is the same as Non–being generates Being.[7] This part of the statement can be interpreted as: "From no flow there comes steady flow." The "two" here corresponds to Being of two excited modes where the steady mode is counted. The "three" can be considered as the same way as "two". In a fully developed turbulence, all modes are excited which correspond to "all things".

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The steady flow can be characterized by the velocity of the steady flow mode, therefore, the flow has one degree of freedom where the direction of the velocity is disregarded for simplicity. Higher stage of the flow has more degrees of freedom and at the ultimate stage an infinitely different types of turbulence have possibility of realization. The original word of Lao Tzu's ultimate stage is "wànwù" which literally means the ten thousand things. The number in Lao Tzu's statement may be interpreted also as the number of the degrees of freedom in the world of the stage. It is worth while noting that the numeral ("one", "two" or "three") doesn't mean a cardinal number in the strict sence of the word but it reads *an order of generousness and complexity.*

In a common story on the creation of the world it is said: "From chaos there comes cosmos." Where chaos is considered as a primitive disorder and cosmos is conceived as an orderly and harmonious system. Contrary to the case of Ruelle–Takens, chaos is set at the beginning of the scenario. However, the meaning of chaos in Ruelle–Takens's case (or a deterministic dynamical system) is different from that of this cosmogony. The chaos of Ruelle–Takens has rich structure, which involves order, therefore, the scenario leading to chaos can be shortly interpreted as "from simple structure there comes rich structure". This interpretation also apply to Lao Tzu's statement. In this sense, the chaos in Ruelle–Takens's scenario corresponds to the cosmos in the cosmogony.

It may be noted that only a few steps are required to reach the ultimate stage in both Ruelle–Takens and Lao Tzu. On the other hand, Landau consider that successive appearances of many new modes leads to turbulence, namely many steps are required.[8] Landau's conjecture accords with our ordinary sence. However, recent experiments[9] support Ruelle–Takens scenario. We consider that the last steps in the scenarios of Ruelle–Takens (quasi–periodic → turbulence) and Lao Tzu ("three" → "all things") have an extraordinary meaning.

In a separate paper[10], we have studied scenarios leading to chaos in an ecosystem model. The model has some basins, which are determined by deterministic laws. In this case, the laws are described by a set of equations and one of the basins is chosen accidentally by its initial condition. This situation gives a metaphor that rich structures of nature are produced by necessity (simple deterministic laws) and chance (accidental chosen).[10]

In this note, we only treat on "geneses of chaos" (i. e. scenario of chaos) but study on "logos of chaos" (i. e. order in chaos) is indispensable to total understanding of chaos.

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