A Book Review for At Home in the Universe – The Search for the Laws of Self-Organization and Complexity

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Upon reading a book such as At Home in the Universe, one can only gasp in awe the genuine novelty of the ideas presented and the vastness of the intellectual interests covered in this book. Indeed, this ground-breaking work by Dr. Kauffman on self-organization, explained brilliantly using Complex Adaptive Systems (CAS) approach, ventures into every conceivable corner of modern-day science, from the origin of life to foundation of democracy, bridging all traditional scientific disciplines such as chemistry, biology, physics and socio-economics as well as religion. The CAS approach employed in this work examines properties of complex systems (organism, ecosystems, society) across disciplinary boundaries. However, not to be confused and lost in the vast amount of ideas conveyed by the author in this book is his cornerstone line of argument, that in complexity there lies natural order. This "natural order" is generated spontaneously due to laws of complexity. It is only then the natural selection, long thought in biology as the sole source of order, comes into play. The author further suggests that all complex adapting systems (CAS), be them single cells or economies, evolve to a natural state between order and chaos, a compromise between structure and surprise. This is the famous "at the edge of chaos" theory proposed by the Santa Fe Institute, whose members pioneered the CAS approach.

In my opinion, what truly sets this book apart from the rest in its class is the author's ability in convincingly conveying to the readers how his ideas of self-organization, backed up with detailed mathematical explanation and computer modeling, can shine light on the understanding of the origin of life. This new postulate proposed by

Kauffman nicely complements with rather than rivals against the century-old belief in Darwinian Evolutionary Theory. The major difference between Darwinism and Self-Organization Theory using Complex Adaptive System Approach lies in the fact that the former explains only how complex life emerged from simple life, whereas the latter addresses the very issue of origin of life. If Kauffman's theory can be adopted and embraced by the general scientific community, the historical significance of this work is unparalleled throughout mankind's history. For now, we might be able to understand the fundamental reason why and how life began in the first place. According to Kauffman, life was bound to rise, not as "an incalculably improbable accident [as suggested by Darwinian Evolutionary Theory], but as an expected fulfillment of the natural order;" thus, "we truly are at [our] home in universe." As the author so concisely and brilliantly put it, "not we [all life forms including humans] the accidental, but we the expected." For the past 150 years, the scientific communities, particularly biology, have embraced the Darwinian Doctrine of "random variation, selection sifting" in explaining the origin of life. Adherents of this Doctrine believe life began with the simplest building block, ribonucleic acid (RNA). It has been discovered by Cech, undoubtedly to his own astonishment, that some RNA molecules are capable of self-replicating and of themselves acting as catalysts. Hence, argued by the mainstream biological community, life can occur from the very simple to more complex. However, the inevitable question arises: why all living things seem to have a minimal complexity requirement below which it is impossible for them to survive, sustain and reproduce themselves. The simplest free-living cells, pleuromona, are consisted of cell membranes, genes, RNA, proteins, etc. Nothing simpler can exist in the world, or can be found to exist in the world. One then must ask himself/herself how pleuromona could be formed from the building blocks of RNA, when RNA themselves alone cannot survive in the first place. Simply put, RNA alone is just not complex enough to exist. Thus, Darwinian Evolutionary Theory is crippled in explaining the very origin of life.

Realizing the limitations of Darwinism in explaining origin of life, Kauffman sets out to argue his own version of how life began using self-organization theory. What he found is truly amazing and, to me, the finding of "autocatalytic sets" is the most significant and

profound one of all ideas presented in this book. Opposed to the Darwinian Evolution theory that all life evolved from single-cell organisms via natural selection applied to variation; Kauffman, however, focuses his attention on the source of variation. He argues that "autocatalytic sets" spontaneously emerge "fully-grown." Kauffman further points out that these "sets" are self-organizing, stable and can vary as a reflex to external stimuli. Thus, these "sets" are truly Complex Adaptive Systems.

However, even for a book as brilliantly written as this one and contain as many groundbreaking ideas as this one, one will still find some rather unsettling questions and unsatisfying feeling of not being answered. For example, the author goes on to extraordinary mathematical detail and computational simulation in elucidating his ideas of "autocatalytic sets", "order for free", "ontogeny" and so on, there lacks an experimental approach that will bolster and prove his postulates. A postulate unfortunately cannot be acknowledged as the "rule" in science until proven. This leaves me to wonder, in a deeper level, if life is such a necessary result of "natural order", why then has it proven to be so difficult in synthesizing anything remotely resembles the very initial life (a life so complex below which it cannot survive) in the controlled environment of a laboratory. To think along the line of complex system, are there forces or interactions that cannot be reproduced in the experimental settings? Or other components/factors (for example, 'God's hand') are not considered in the experiment. In addition, the author tried diligently to avoid bring in the religion during the deduction of his postulate. However, what he found indeed resembles more with the Creation Science than the Neo-Darwinian Theory. One is left to wonder why matters in nature over a certain complexity tend to show "natural order." This question is far more profound and far-reaching than asking why an oil droplet shows "natural order" in water by not diffusing everywhere. This example, however, is the exact example Kauffman used in explaining the laws of thermodynamics and statistical mechanics. These examples are situated on rather weak grounds. Nonetheless, these questions cannot possibly eclipse the significance of Kauffman's theory in this book, for it freed minds of people from the Darwinian Doctrine, which, although still just an unproven theory, is being taught as a religion in the classrooms.