Nature, Earth & Life: A Lecture Series by Alder Stone Fuller (PhD)

Lincoln Street Center Auditorium, 24 Lincoln St, Rockland ME

Introduction

This integrated set of six lectures explores the complexity or system sciences. The first lecture offers an overview of the series. Subsequent lectures examine topics in greater depth and detail, building on topics explained in previous lectures. The series tells a story of Earth and life, and is, therefore, best engaged as a whole. **All lectures begin at 6 pm**. The first two lectures are two hours long; the remaining four are 1.5 hours each. Lectures are $10 each; $5 for students and seniors (65+) with ID. Full series prepaid: $50.

10.21.14: How the Universe Works: An Introductory Overview of the Complexity Sciences

Have you ever wished that there was a set of easy-to-understand principles that could lead anyone - with any background, including no science - to a rational and intuitive understanding of virtually everything in the universe ranging in scale from quantum to cosmos? This lecture slideshow - and the lecture series that it introduces - will offer a glimpse into such a set of principles from the complexity (or system) sciences. Those are as different from the mechanistic sciences as day from night. They have been called both a revolution and a renaissance in science on par with quantum theory, yet far more applicable to everyday reality and - fortunately - far more comprehensible. Indeed, for most, the principles are intuitive. Knowledge of them is crucially important for our future, including successfully addressing planetary challenges. Topics include dis-equilibrium, fractal geometry, the edge of chaos, self-organization, emergence and geophysiology, the study of our self-regulating planet. Examples include whirlpools, chemical clocks, homeostasis, cells, organisms, ecosystems, and climate. The remaining lectures in the series will examine these topics and examples more closely.

10.28.14: *Abrupt* Climate Change, What To Do About It, and Why the Media is Not Telling the Whole Story

The climate change event that has begun and will accelerate is likely to be the greatest challenge that our species has ever faced. This lecture will help you understand why using principles from the complexity sciences. It will address the status of Earth's climate with respect to temperatures, greenhouse gas concentrations, rates of increase, ice caps, oceans, changes in atmospheric circulation, CO_2 residence time, and multiple positive feedback processes that are accelerating change. It will compare current trends with the geologic past, focusing on the last three million years. Complexity principles employed include nonlinearity, system (attractor) states, and rapid transitions at tipping points (critical thresholds). It will explain why almost all contemporary climate models - including those used by the Intergovernmental Panel on Climate Change (IPCC) for their analyses and predictions - *significantly* underestimate the scale and speed of change. Therefore, in addition to mitigation efforts, we must *immediately* begin preparations for the inevitable large, abrupt changes, including dealing with our fear and denial (*), and replacement of world views and cultural maps based in obsolete, mechanistic models with the more accurate sciences of complexity and geophysiology. Strategies that fail to incorporate the latter changes will not adequately prepare us for the future. (* Carmine Leo will lecture on Thursday, 10.30.14 about how we can address fear, despair and denial, a first step in preparations. See the lecture schedule for details.)

11.04.14: Networks, Tipping Points, Fractals & the Edges of Chaos: The Mathematics of Nature

A visually-stunning introduction to several new (since the 1960s) branches of mathematics that serve as a foundation for the complexity sciences. They should be taught in schools as part of the core curriculum because they are not only intellectually fascinating, but lead to radical new understandings about nature, Earth and life that are crucially important for humans in this century and beyond. They are more useful than calculus and analytic geometry for modeling important aspects of nature and *far* easier to understand. The basic concepts are comprehensible by any adult with any background, including those with a fear of mathematics; they can be introduced as early as grammar and middle school. Topics will include fractal geometry, chaos theory (AKA non-linear dynamics), and a new kind of visual mathematics (no equations!) called computational systems (Stephen Wolfram's new kind of science). The latter include virtual oddities like cellular automata and Turing machines.

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11.11.14: Self-Organization & Emergence: Why the Universe Is Complex, Lumpy & Somewhat Orderly

Why is the universe so complex? That is, why are high levels of organization present in the universe instead of total chaos? And especially, how can we explain the existence of life, the most complex phenomenon that we know? Is life a highly-improbable accident that may exist on only one or a few planets, or a highly-probable process, driven by the 2nd law of thermodynamics that exists on billions of planets with the proper elements and energy sources? Two new sciences are offering new, exciting, even awe-inspiring answers to these ancient questions. One is informally called self-organization science or, in academic circles, non-equilibrium thermodynamics (NET); understanding its principles is easier than pronouncing its name. Second, the science of emergence, which expands and explores the ancient adage that "a whole is greater than the sum of its parts". This lecture will address the principles of NET and emergence with examples including whirlpools, tornadoes, hurricanes, convection cells (in the lab and Earth's mantle and atmosphere), chemical clocks (like your heart's natural pacemaker), dancing cornstarch, photosynthesis, homeostasis, life and consciousness. Without these new concepts, biology is an incomplete science that cannot even define life, let alone adequately explain it. Thus, these concepts will be employed in the next lecture in the series.

11.18.14: Cells, Symbiosis & Organisms: A Systems View of Life & Evolution

This is the biology that you wish you'd had in school. Biology from the perspective of the complexity sciences is *vastly* different from the mechanistic, reductionist models currently taught in high schools and colleges. It is far more intuitive, and often leads to "AHA! moments" because it offers a profoundly-meaningful and awe-inspiring new understanding of the phenomenon of life: what it is, how it works, and even why it exists. (The latter part - why - has formerly been the exclusive domain of philosophy and religion.) These ideas should be integrated into all school curricula. This lecture will address additions to biology and evolution that *significantly* expand Darwin's theory of natural selection acting on genetic variation, which are necessary but not sufficient components of a theory of evolution. A complete understanding of evolution - including the origins of life and intelligence - must also include non-linear dynamics, self-organization, emergence, and a phenomenon called symbiogenesis, the origin of new tissues, organs and species via symbiosis among existing species. A new scientific definition of life will be offered in terms of concepts explained in this and previous lectures.

11.25.14: Geophysiology & Earth System Sciences: Studies of Earth as a Self-Regulating System

In the 1970's, British atmospheric scientist James Lovelock and American microbiologist and evolutionist Lynn Margulis - Alder's most influential mentor - proposed a hypothesis that Earth is not merely a rock coated with water, air and life, but a planetary-scale entity with a metabolism (complex chemical cycles) and homeostasis (self-regulation) similar to ours, but vastly more complex. Yet it is not conscious like us. Instead, self-regulation is cybernetic or automatic, just as your homeostasis. (Your temperature, chemistry, pressure, and breathing are automatically regulated, even in your sleep.) A new science, geo-physiology or planetary physiology, has emerged to test the hypothesis, because physiology is the proper study of metabolism and homeostasis. (Geophysiology is often called Earth System Science, which is subtly different.) The hypothesis has withstood decades of criticism fueled by misunderstanding because the concept cannot be understood from the perspective of mechanistic sciences, only from a systems perspective. However, numerous predictions that followed from the hypothesis have been supported, and a sophisticated computer model explaining planetary self-regulation has evolved. Thus, the hypothesis has been elevated to a theory: Gaia theory. This is one of the most important ideas of our time. It carries profound implications for our understanding of and existence on Earth. For example, from a perspective of geophysiology, global heating is seen as a planetary "fever", and climate change is but one symptom of a much greater problem: disruption of Earth's metabolism and homeostasis, which in organisms we would call "disease". To successfully navigate the planetary challenges ahead, we must deeply understand that we don't merely live in "the environment", but inside an entity upon which we are totally dependent.