NMMU Inaugural lecture - Prof. David Bell

NATURAL SYSTEMS AND HUMAN AFFAIRS

Summary

The presumption that Nature obeys deterministic laws and that an understanding of Nature is best arrived at by delving ever more deeply into the character and interactions of its fundamental constituents have dominated modern science. Nevertheless, many of science's discoveries now point to a world underpinned by chance and uncertainty, with fundamental materials and behaviours incomprehensible in familiar physical terms. The study of complex systems narrows the gap between these profound but confusing implications of fundamental physics and world of everyday human experience. In doing so, it reopens ancient philosophical debates about the character of existence, the relationship of parts to the whole, and admits worldviews of diverse human societies thrust into contact by globalization. Complex systems from the purely physical, through the biological to the human world display common features implying governing principles of wide transdisciplinary applicability and potential for transcultural consilience, i.e. "decolonization". The systems approach may suit a South Africa pursuing new identity.

The complexity of Earth systems is revealed in time series of geochemical indicators in the carbon cycle and climate system that are critically relevant to our present global environmental crisis. Phase changes between homeostatic quasi-steady states of the system and their prediction from time series analysis are noted, and implications for ecological and climatic resilience and the evolutionary theory of punctuated equilibrium discussed. The phenomenon of complex system evolution is further illustrated by rivers, leading to the assertion that evolution is a fundamental physical phenomenon not restricted to biological organisms and notably applicable to human social systems without the offensive determinacy of other physical analogies. Analysis of financial markets in statistical econophysics terms highlights inadequacies of mainstream economics developed along analytical equilibrium lines. Emergence of hierarchy and social inequality may be inferred from evolutionary principles of self-organizing flow systems.

The above examples reflect the following principles: 1. The workings of the world around us, and of ourselves, can be usefully analyzed and understood (in some cases may be best understood) in collective rather than individual terms, 2. System properties originate in the indeterminate contingency of individual interactions, but are predictable in a statistical sense. This analogy to materials suggests utility of powerful analytical tools derived from statistical physics, 3. Systems are characterized by flow of some description and may be said to exist in order to enable and optimize that flow. 4. Complex systems appear to adapt and evolve ("self-organize") according to a universal governing principle allied to macroscopic thermodynamics. The identity of this principle has been a subject of debate since at least the early 1920s.