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The Physics, Chemical Physics, and Biological Physics of the Origin of Life on Earth

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This article illustrates the possible application of homeokinetics to the constructive process of the origin of life. The homeokinetic strategy is to seek out cycles at all time scales in a system where they can be discovered (spectroscopy) and to show how interacting cyclic processes can account for historical emergence of new entities, many of which also are cyclic processes. The full story of emergence necessarily begins with cosmology, which eventually results in an earth that can support geological processes, which form the matrix for life.

Biology and chemistry might be viewed as dominating the discussion about the origin of life. However, physics also has very useful insights to share. The intent of this article is—given the evolution and development of "purpose" in life systems wherein they can persist for a great number of generations—to determine the physical processes that can account for how the origin and evolution of many disparate species emerge as a regular procession of processes and events that began with the physics of the Big Bang.

Actually, four topics—physics, chemistry, geology, and biology—are part of a continuum that flows from physical processes and from the way humans process information. Physical science was born in the Enlightenment of the 17th century, and leads from Copernicus (ca 1500) to Newton (ca 1700; Randall, 1940; Wills, 1975). This new age of science led to the development of chemistry, geology, and biology. Chemical science began in the 18th century with Lavoisier. The coupling of ideas from these disparate fields led to an age of mechanism and machinery, and to an industrial revolution for engineering processes—civil (physical), mechanical,

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able physical model for the terrestrial planets? If only H were available as H clouds in the galaxy, the condensed planetary density would be too low. SiO_2 is so abundant that Si and SiO atoms and molecules need to be added to the list. For life, H and HOH atoms and molecules, C and CO, and N and NO are needed. Add some near pure Fe compounds, and Cu at atomic number 29 is about the upper limit for required elements. What is so interesting about the H, C, and Si elements is that they can be thought of as hermaphroditic. That is, they can either be electron donors or acceptors. These have electrodynamic exchange valence electron bonding as well as electrostatic bonding. The elements CHON are sufficient for life (Morowitz, 1973, 1987), and the more exotic catalysts based on P and S probably were not that essential at the beginning of life's operation. With these six to eight nuclear elements and a few heavy radioactive ones, it is possible to provide an Earth model of the proper density, internal pressure distribution, internal temperature, internal viscosity, internal heat transport, and internal angular momentum distribution (Iberall et al., 1993).

Morowitz (1973, 1987) showed in a CHON reaction graph under reducing conditions that the rules of chemistry lead to the predominance of a small group of compounds. From his analysis, he noted that free radical reactions can dominate to form lipids through methane and toward amino acids through the reactants for the Strecker synthesis: cyanide, ammonia, and an aldehyde. This has seemed to be a very impressive thought for the past 15 years or so. However, now as a chemist, M. Sato (personal communication, 2000) considered that the Strecker synthesis, although interesting, requires temperatures too high to consider it as an important reaction in the origin of life.

PALEONTOLOGICAL RECORD

The paleontological record is the place to start looking for evidence that only six to eight elements were involved with life's origin. The next question is where to begin the search, and using homeokinetic physics thought processes, it is important to first lay out the timing of various important processes.

Assuming that there is a physical foundation for the creation of sedimentary rock materials on Earth at 3.8 billion years ago (Gya), what is the evidence for water? Bedding and other sedimentary structures of microbially derived stromatolites in the Belt Series in Montana and the Swaziland System appear to be associated with lunar developed tides and have been dated (Glaessner, as cited in Cloud, 1970), which means that lunar capture goes back as early as 3 Gya. The association with tidal water processes indicates surface temperatures as low as a few hundreds of Kelvins. The limit for the end of meteoritic infall is 3.9 billion years ago (Iberall et al., 1993), which also suggests liquifaction of the surface until that time (Iberall et al., 1993, chap. 11).

It is important to recognize that almost as soon as the surface cooled, life began. Robbins, LaBerge, and Schmidt (1987) showed the presence of microbial