Fundamental Asymmetries and the Origin of Homochiral Order

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Two important contributors to our limited understanding of the origin of biochirality are: (a) poor integration of chirality in system analysis; and (b) the largely symmetric behavior of the physical laws. Many examples of chirality exist outside chemistry that may help formulate a generalization of chirality. Can the postulates of such generalization be used to integrate chirality in the evolution of dynamic systems? Will they allow formalizing the role of physical attractors in the origin of order, and assess the "biogenic potential" of different environments? A Theory of Generalized Chirality should include: chemical and non-chemical structures; chiral behavior and multiple dimensionality. Two non-conventional types of chirality are presented: enantiomers in a 2D-world and spin chirality.

Symmetry violation is an important premise for the origin of biochirality. Evidence is presented of Symmetry Violation in Spin Enantiomers (SVSE) in magnetic fields (B). At B = 0.6 T the calculated spin-chiral p:a disequilibrium is ~$3x10^{-7}$ in $H_2{}^{17}O$, ~$1.5x10^{-7}$ in $-{}^{14}NH_2$ and ~$2.1x10^{-7}$ in $-{}^{15}NH_2$, while the measured differences in proton exchange reactivity ($\Delta\Delta G^o$) with water between enantiomers are of ~1.58 kcal/mole in ribose and ~0.59 kcal/mole in glucose.

The SVSE helped organize prebiotic systems by biasing chemical interactions involving spin-enantiomers. Because spin-chiral disequilibrium at B=0.5T and 20°C is ~10^9 times larger than the effect of Parity Non Conservation, the surface of magnetite crystals (B=~0.5 T within 1 μm) is one of the most likely environments to explain the origin of biochirality and life. The Magneto-Chiral Stereo-Chemical effects reported here are also significant for exploratory Astrobiology, may help explain specific instances of mass independent isotopic fractionation, and may help the development of new technologies for chiral and isotopic separation.