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Selection of Amino Acid Chirality Via Weak Interactions in External Fields

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Introduction: An astro-biological model has been developed in which the selective destruction of chiral states in high magnetic fields can create enantiomeric excesses (*ee*s) of about 1 part in 10^6. These excesses may be subsequently auto-catalyzed into the large excesses observed on the earth today. In the present model, atomic nuclei bound in amino acids are destroyed via the weak interaction in stellar environments [1-3]. Nuclei are preferentially oriented in high magnetic fields of certain stellar environments and the molecular interaction couples the nuclear magnetic moment to the chirality through simultaneous orientations of the nuclear magnetic moment in the external field and the molecular electric dipole moment via the Stark Effect. The coupling of atomic nuclei with non-zero magnetic moments to the molecular orbitals via the interaction of the magnetic shielding tensor and the electric dipole moment creates additional energy splittings which depend on the molecular chirality [2]. This effect is exploited in this model to create a chirality-dependent asymmetry in molecular states. An enantiomeric excess is subsequently created via the selective destruction and subsequent amplification of nuclei oriented in strong fields. Possible sites in which this model may exist are proposed.

Results: Initial evaluations of L- and D-alanine indicate that three things are necessary for this model to result in *ee*s sufficient for subsequent autocatalysis to take place. An external electric and magnetic field provide the coupling of the molecular chirality to the nuclear spin. Even modest magnetic fields of ~10 T have been found to be sufficient enough in this model to produce *ee*s on the order of 10^{-6}. The external electric field is produced in the reference frame of the molecule via the motion of the molecular substrate through the magnetic field. Weak interactions then provide an asymmetric mechanism to selectively destroy one chirality over another. It is possible that the combination of strong stellar magnetic fields and destruction of the atomic nuclei in amino acids by a strong neutrino burst in the vicinity of collapsing stars may produce such an effect while still allowing the surrounding environment to survive.

References:

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