## SPONTANEOUS BREAKING OF THE L, D SYMMETRY IN PHOTOLYTIC PRODUCTION AND DEGRADATION OF AMINO ACIDS

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Abstract. The radiolysis experiments of amino acids have revealed the presence of bimolecular interaction between like enantiomers which suppress their photodegradation and between opposite enantiomers that enhance the photodegradation. Based on a mathematical model, it is suggested that this phenomenon could have given rise to chiral stereoselection in biochemical evolution.

## 1. Introduction

The possibility that chiral stereoselection in biochemical evolution is a result of spontaneous breaking of the L, D symmetry in parallel chemical reactions, have received much attention (Frank, 1956; Decker, 1974; Kondepudi and Nelson, 1983; Tennakone, 1984). All models of this type proposed, assumes autocatalytic production of L, D enantiomers, e.g. (Kondepudi and Nelson, 1983).

$$A + B \longrightarrow X_L$$
 [1]

$$A + B \longrightarrow X_D$$
 [2]

$$A + B + X_L \longrightarrow 2X_L \tag{3}$$

$$A + B + X_R \longrightarrow 2X_D.$$
<sup>[4]</sup>

Followed by an inhibitary interaction between L and D species, e.g.,

$$X_L + X_D \longrightarrow C, [5]$$

where the concentrations of the reactants A, B and C are assumed to be maintained constant. The rate equations for [1] – [5] have an unstable symmetric solution and a stable asymmetric solution. In the presence of even a minute, but universal, right-left asymmetric influence, the selection occurs in the same sense with a high probability (Kondepudi and Nelson, 1983; Mason, 1984). Thus a global symmetry breaking becomes possible. The external chiral factor needed for biasing the symmetry breaking is believed to be weak neutral currents (Letokhov, 1975; Hegstrom, 1985) or polarized radiation from betadecaying radio active materials (Garay, 1968;

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Bonner, 1974). Unfortunately the difficulty of the models of this type is that, the molecules likely to have occurred in the prebiotic medium, capable of participating in reactions of the required form are not identified. Self-replicating complex biomolecules will naturally fit into autocatalytic schemes with competitive interactions. However this necessitates simultaneous creation L and D enantiomers of complex biomolecules which is an highly improbable event.

Recently Akaboshi *et al.*, (1990) have observed that in  $\gamma$ -radiolysis of amino acid mixtures, the biomolecular intraction of like enantiomers (i.e. L, L or D, D) suppresses the rate of decomposition, whereas the interaction opposite species enhances each others decomposition rate. In other words, an asymmetric field is found to affect the photodecomposition rate of amino acids. Akaboshi *et al.* (1990) also have suggested that this mechanism could have operated in amplification of L, Dasymmetry in biochemical evolution. In this paper we present a mathematical model which illustrate that the effect observed by Akaboshi *et al.* (1990) could have resulted in biochemical stereoselection via spontaneous breaking of the chiral symmetry biased by parity violating interactions.

As is well known uv irradiation of relevant inorganic materials in aqueous medium generate amino acids. Amino acids also undergo photodecomposition and since the rate of decomposition depends on their concentration X, we have,

$$\frac{\mathrm{d}X}{\mathrm{d}t} = C - kX,\tag{1}$$

where C is the rate of production and k is a constant. Thus,

$$X = C/k + Ae^{-kt} \qquad (A = Constant)$$
<sup>(2)</sup>

and an equilibrium concentration X = C/k is reached in a theoretically infinite time. The condition (1) holds in absence of radiation induced bimolecular interactions between L and D enantiomers. The effect observed by Akaboshi *et al.* (1990), implies the presence of second order interactions of the form  $X_L^2(X_D^2)$  and  $X_LX_D$  of which the former suppresses and latter enhances decomposition rate of  $X_L(X_D)$ . In this situation, the rate equation for development of two species takes the form.

$$\frac{\mathrm{d}X_L}{\mathrm{d}t} = C - kX_L + aX_L^2 - bX_L X_D \tag{3}$$

$$\frac{\mathrm{d}X_D}{\mathrm{d}t} = C - kX_D + aX_D^2 - bX_D X_L, \qquad (4)$$

where a and b are constants and provided b > a, Equations (3) and (4) have a symmetric solution.

$$X_L = X_D = X_0 = \frac{-k + [k^2 + 4C(a-b)]^{\frac{1}{2}}}{2(b-a)}.$$
(5)

To investigate the stability of the equilibrium (5), we put,