Chiral Forces and Molecular Dissymmetry

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Introduction: Chiral molecules leading to helical macromolecules seem to preserve information and extend it better. In the biological world RNA is the very paradigm for self-replication, elongation and autocatalytic editing. The nucleic acid itself is not chiral. It acquires its chirality by association with D-sugars. Although the chiral information or selectivity put in by the unit momomer is no longer of much interest to the biologists - they tend to leave it to the Darwinian selection principle to take care of it as illustrated by Frank's model - it is vital to understand the origin of chirality .

There are three different approaches for the chiral origin of life: (1) Phenomenological, (2) Electromagnetic molecular and Coriolis forces and (3) atomic or or nuclear force, the neutral weak current(NWC).

The phenomenological approach involves spontaneous symmetry breaking fluctuations in far from equilibrium systems(Prigogine,Goldanskii) or nucleation and crystallization(Kondepudi). Chance plays a major role in the chiral molecule selected.

New Chemistry: Recently, within the past few years alone, there is a spurt of new activity in chemistry towards asymmetric synthesis, autocatalytic synthesis of lipids(Leng) and oligomerization and autocatalytic (self-replicating) synthesis of nucleic acids (Rebecke, von Kidrowski,Ferris) without any enzyme or template as it should be in the prebiotic stage. Also a variety of helical molecules with heavy metal atoms including knotted helice (Sauvage) are synthesised bearing resemblance to a variety of DNA and RNA structures. The most exciting event for us is the recent successful preparation of chiral molecules from achiral precursors in good amount, purity and time. These are hit and run experimets involving very selective metal ions(Mn^{2+},Pb^{2+} etc), cocatalysts of diverse origins (one includes chinchona bark) in addition to proper temperature, pH and solvent. There is a single unifying theme in all these syntheses: Chiral molecule production from racemic mixture, its polymerization and autocatalytic behaviour all involve organo-metallic chemistry. It is different from the early solution-in-flask experiments with nothing more than external electromagnetic or gravitational fields for induced chirality.

Intrinsic chiral Bias: Quantum chemical calculations (Mason and Collegues) showing the parity violating energy difference(PVED) is higher for L amino-acids and D-sugars is of significant importance. We simply have to construct viable amplification scheme although a larger PVED would help. However, in addition to improved calculations, the relation between spin-orbit coupling and bond length(Pitzer),oriented systems and the Born-Oppenheimer approximation should be considered. Simple calculations show that highly excited molecules and multiply charged ionic systems have a larger PVED. And since complexes of these are the ones involved in the new chemical synthesis of chiral molecules, the way is open for testing the theory.

Experiments:The PVED could be only of the order of 1Hz. Attempts to improve NMR and IR spectroscopy for this measurement is improving (Weisenfeld, Quack). High resolution heterodyning or Fabry-Perot or nonlinear optics as inverse optical Faraday effect could be possible experimental methods It would be interesting also to check if localisation of circularly polarized on surfaces could occur.

Epilogue:It is clear that chemists could produce pure chiral molecules and also self-replicating polymers.There is no need to invoke Darwinian principle. The influence of PVED on the reactioon dynamics should be investigated involving transition state of the two antipodes. Also, the possibility of time reversal symmetry violation should be looked into.

Chemistry is a fascinating science with frontiers at both ends. At one end it tamed the violent particles into chemical bonds while at the other end spawned the macromolecules and let them go in search of life on the Darwinian fitness landscape. Surely, it knows our ancestral chiral molecule, but did it endow those macromolcules with information coding capacity also? The experimental chemists should be able to give the answer.