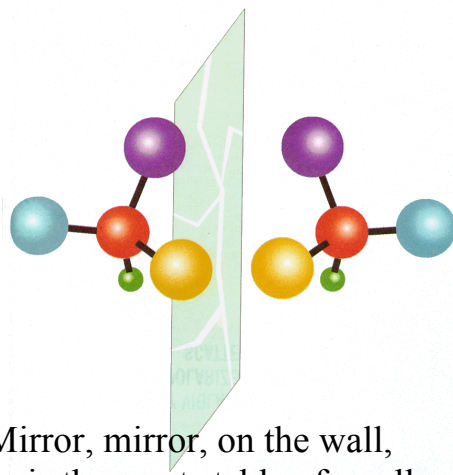


The Quest for Absolute Chirality

Peter Schwerdtfeger

Centre for Theoretical Chemistry and Physics, The New Zealand Institute for Advanced Study, Massey University Albany, Auckland, New Zealand

Emil Fischer's studies of peptides and sugars led to chiral molecules (D-sugars and L-amino acids) and to the confirmation of Pasteur's conjecture that the universe is disymmetric. Friedrich Hund regarded the existence of stable chiral molecules as paradoxical (the Hund Dilemma). A fundamental discovery of this century is that our Universe is "left" handed (Weinberg-Salam-Glashow theory), the electro-weak interaction (parity-odd) gives rise to primarily left-spinning electrons during beta decay. In 1957 Lee and Yang discovered parity violation (PV) in the K^+ decay, which was confirmed shortly after by Wu *et al.* for the β -decay. In the last decade PV effects in atomic transitions have been measured and calculated to high accuracy confirming the so-called *standard model* in particle physics. PV through Z-boson exchange between electrons and nucleons, leads to a small energy difference between enantiomers of chiral molecules although there is no experimental verification yet of this distinct symmetry breaking effect despite many attempts. Current high resolution optical spectroscopy carried out in the CO₂ laser frequency range (878-1108 cm⁻¹) in Christian Chardonnet's group in Paris achieves resolutions of about 1 Hz. Recent calculations in our group applying the standard model show that PV effects in vibrational transitions of chiral methane derivatives CFXYZ (X,Y,Z= H, Cl, Br, I) are in the mHz range and below the detection limit. Our research group is therefore searching for molecules including heavy elements (because of the PV Z^5 -scaling) to achieve enhanced PV effects in the Hz range. New promising candidates are presented in collaboration with the French PV initiative, which aims at a 100 mHz resolution in Ramsay-Fringes experiments using quantum cascade lasers. Another future alternative is single-molecule spectroscopy in traps at ultra-cold temperatures. Shot discussion on the Yamagata hypothesis is provided, which states that one chiral form is stabilized by PV giving rise to biomolecular homochirality in nature.



Mirror, mirror, on the wall,
who is the most stable of us all.