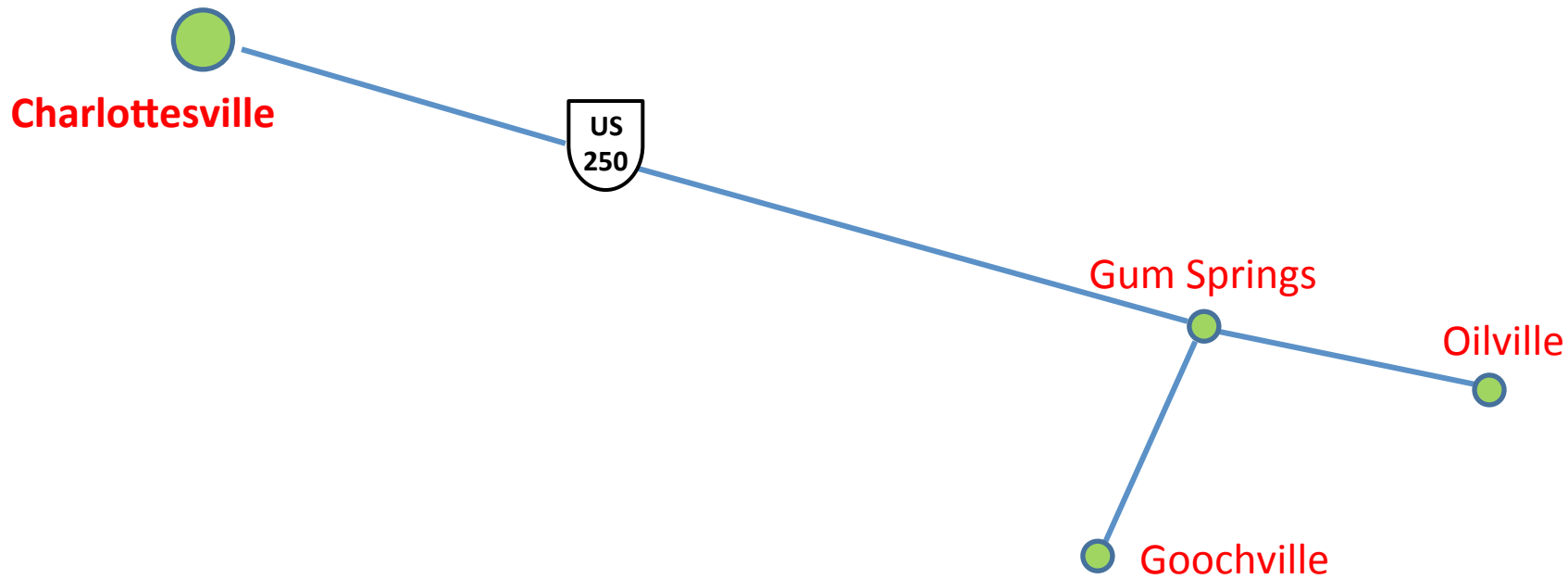


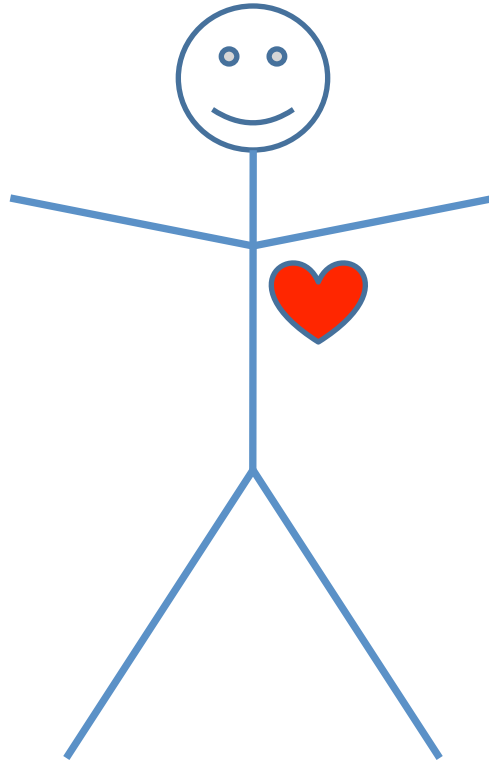


# Electron Circular Dichroism and the Origin of Life on Earth

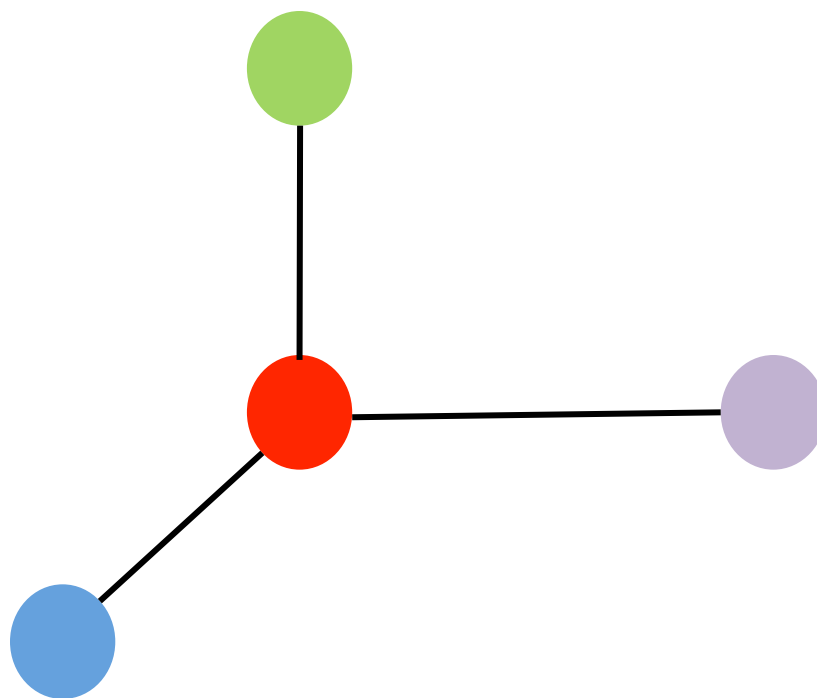
*Timothy Gay*  
*University of Nebraska*



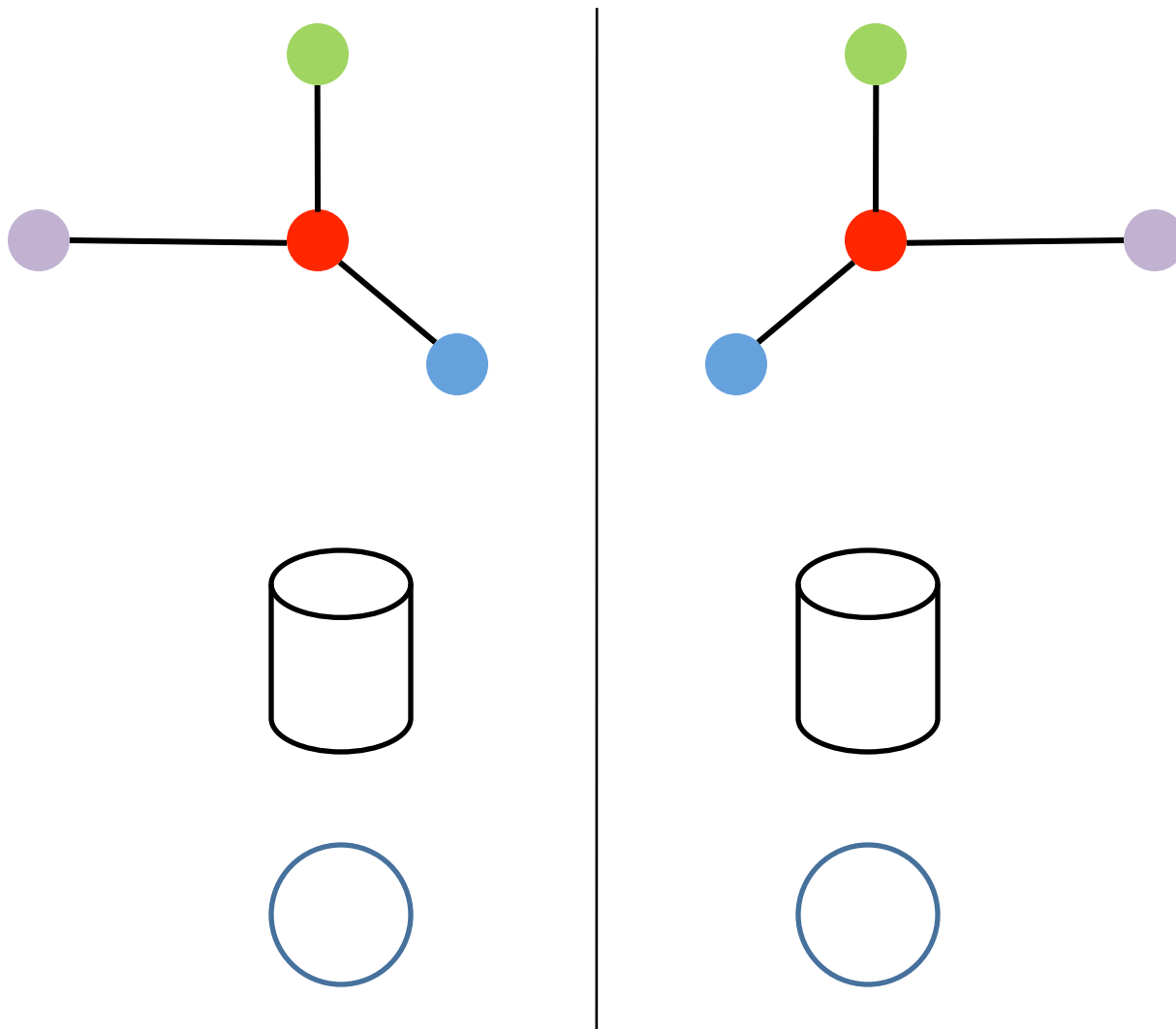




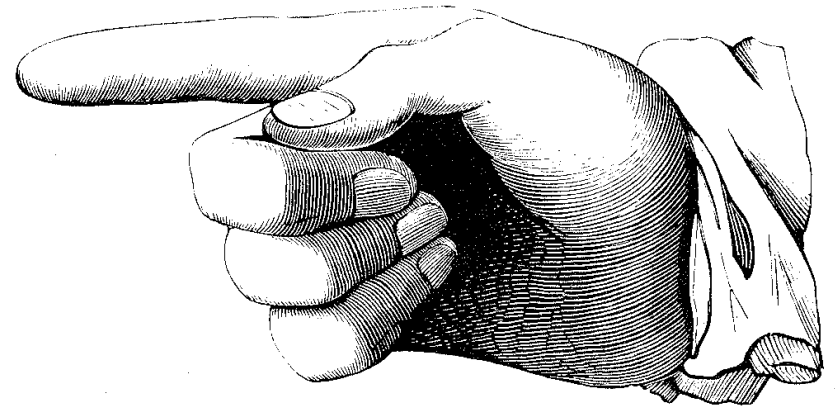
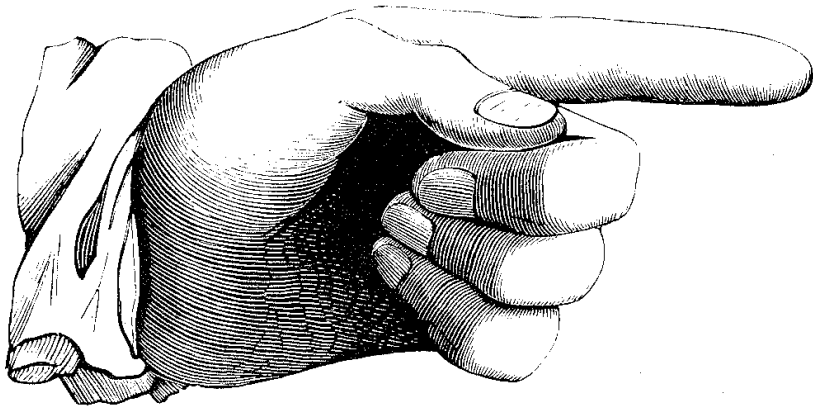
“Put the heart on the right!”



Prototypical “Handed” Molecule



Plane of Mirror Symmetry

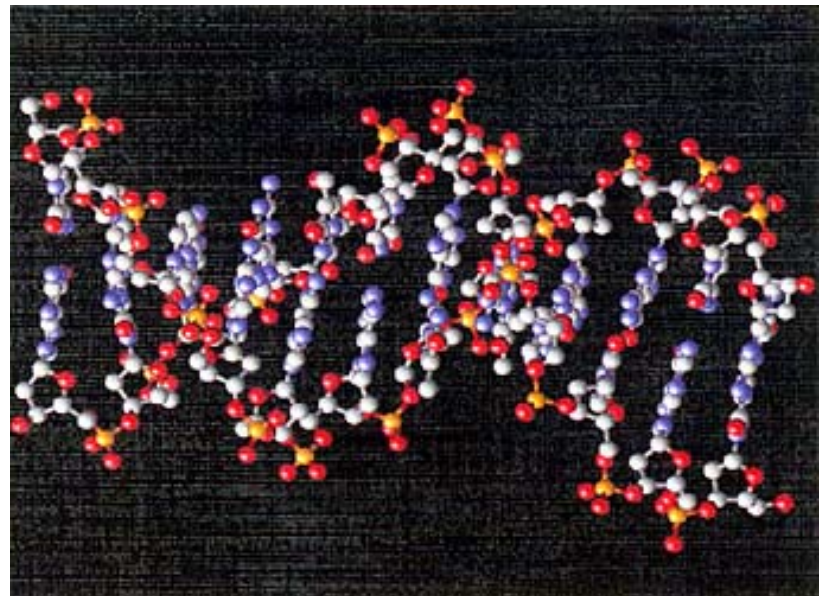


Plane of Mirror Symmetry

χειρ



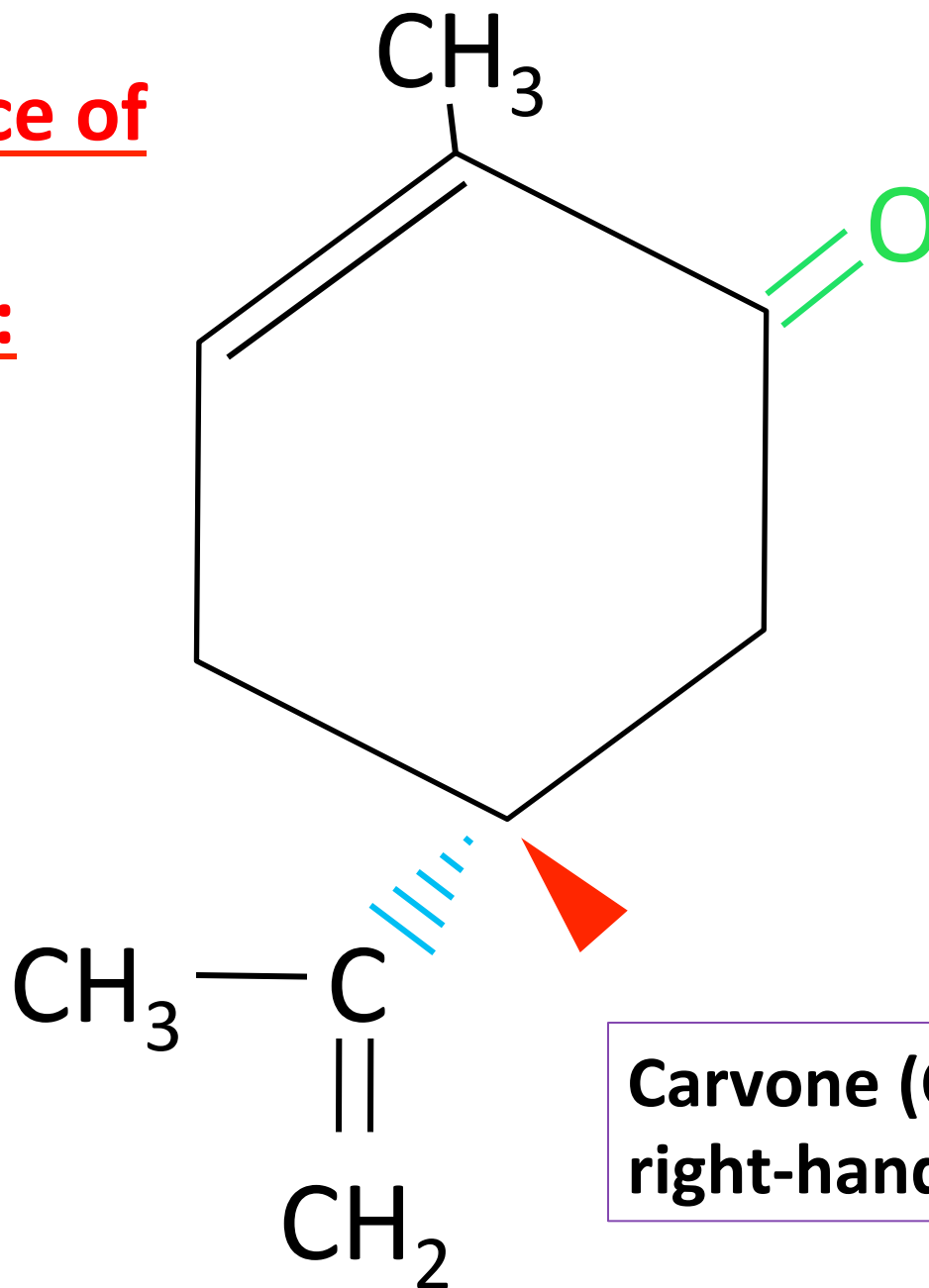
# Chirality in Nature





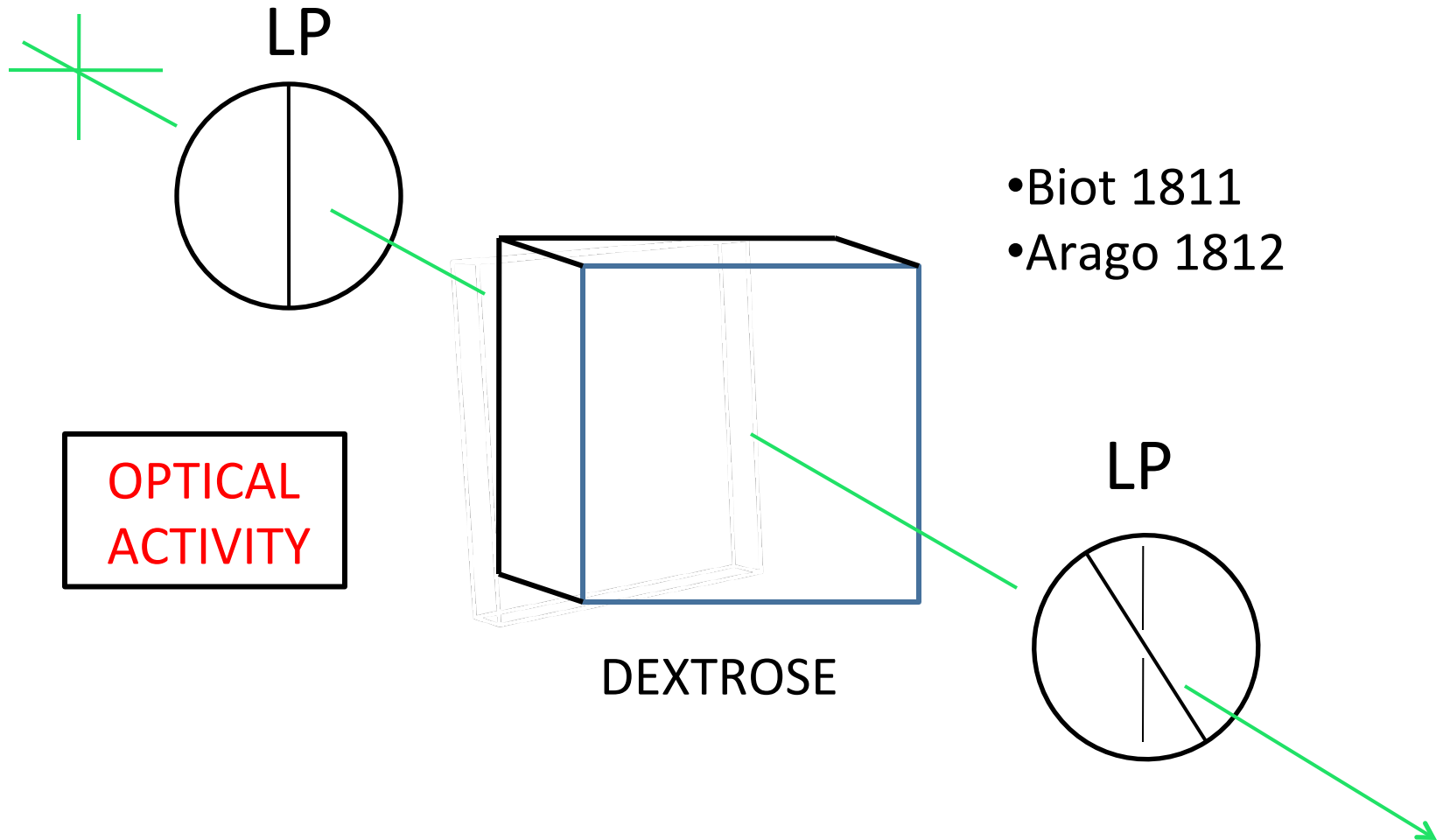
<u>Molecule</u>	<u>Left-handed enantiomer</u>	<u>Right-handed enantiomer</u>
Heroin	<i>antitussive</i>	<i>addictive narcotic</i>
Thalidomide	<i>relieves morning sickness</i>	<i>causes birth defects</i>
Ritalin	<i>reduces hyperactivity</i>	<i>ineffective (may have side effects?)</i>
Ibuprofen	<i>ineffective</i>	<i>effective pain reliever</i>
Pyrethroids	<i>kills bugs; biodegradable</i>	<i>doesn't kill bugs non-biodegradable</i>

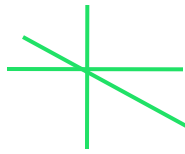
A amusing  
consequence of  
inversion  
asymmetry:



Carvone (C<sub>10</sub>H<sub>14</sub>O) –  
right-handed

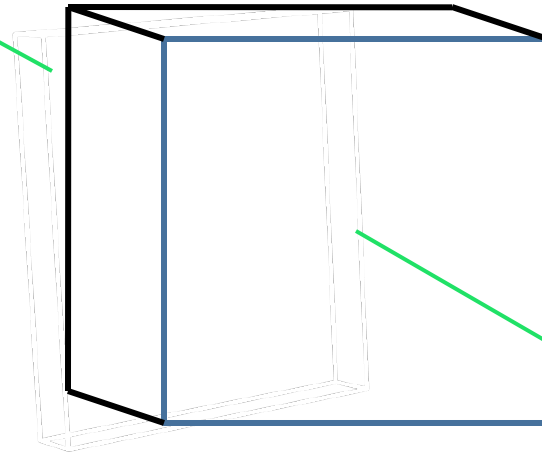
# Macroscopic Chiral Effects





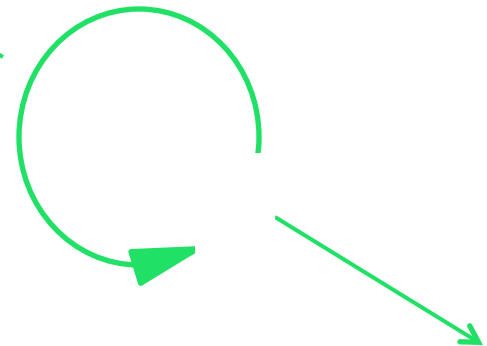
• Fresnel 1835

CIRCULAR  
DICHROISM

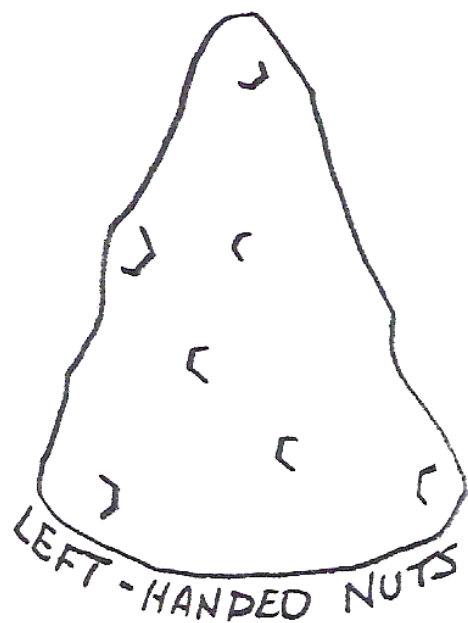
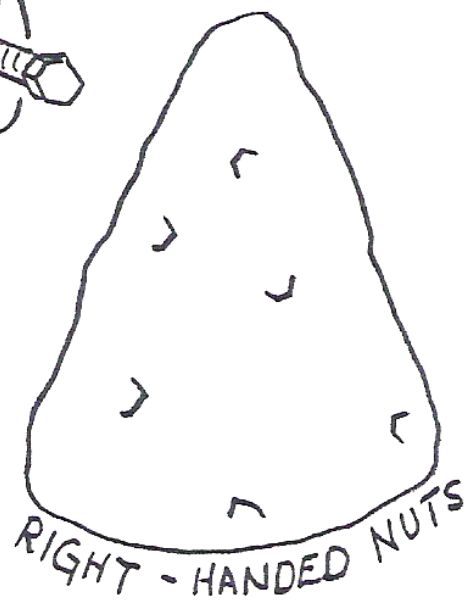
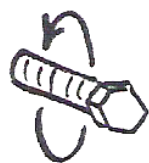


DEXTROSE

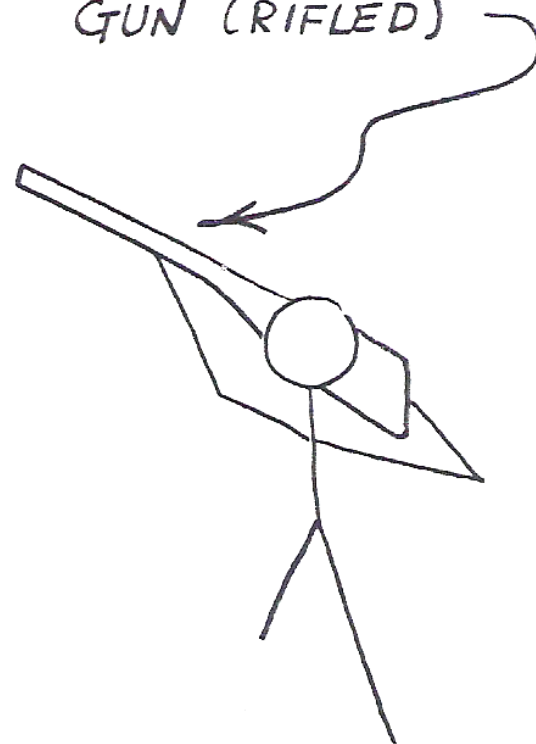
RHC



i 3D Dalton Particles !

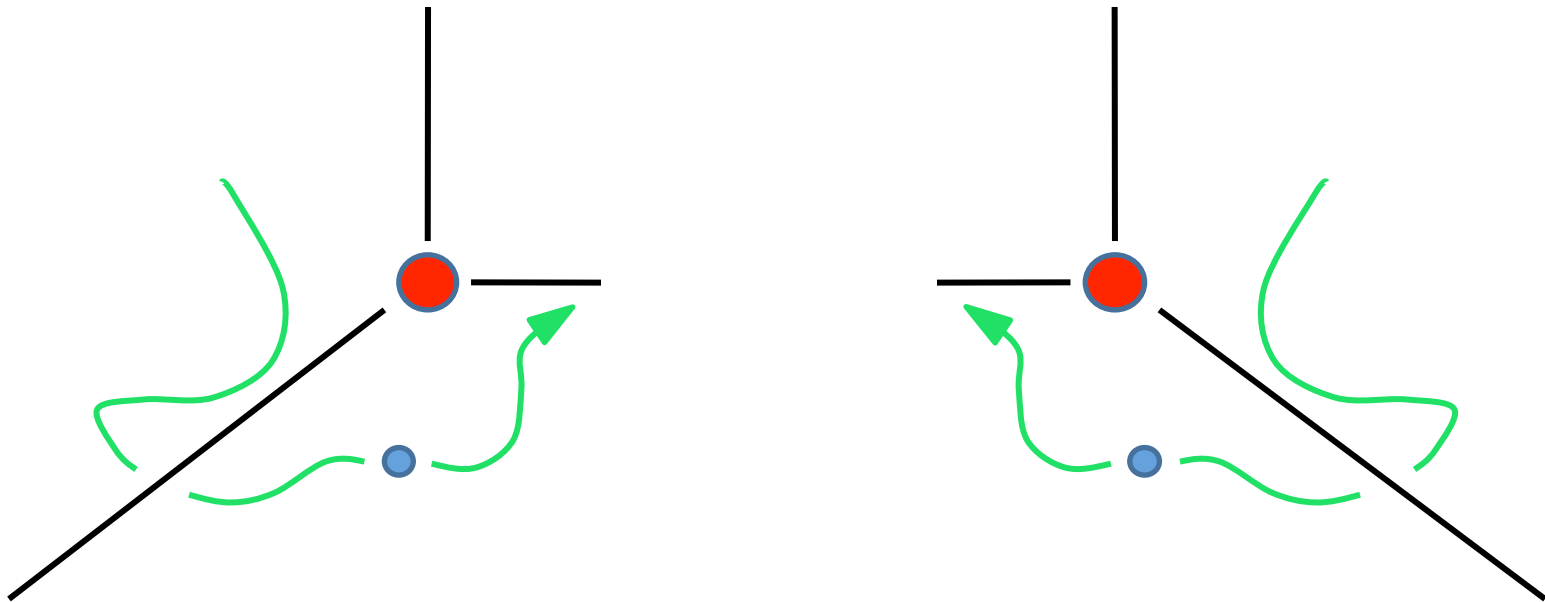


LEFT-HANDED BOLT  
GUN (RIFLED)



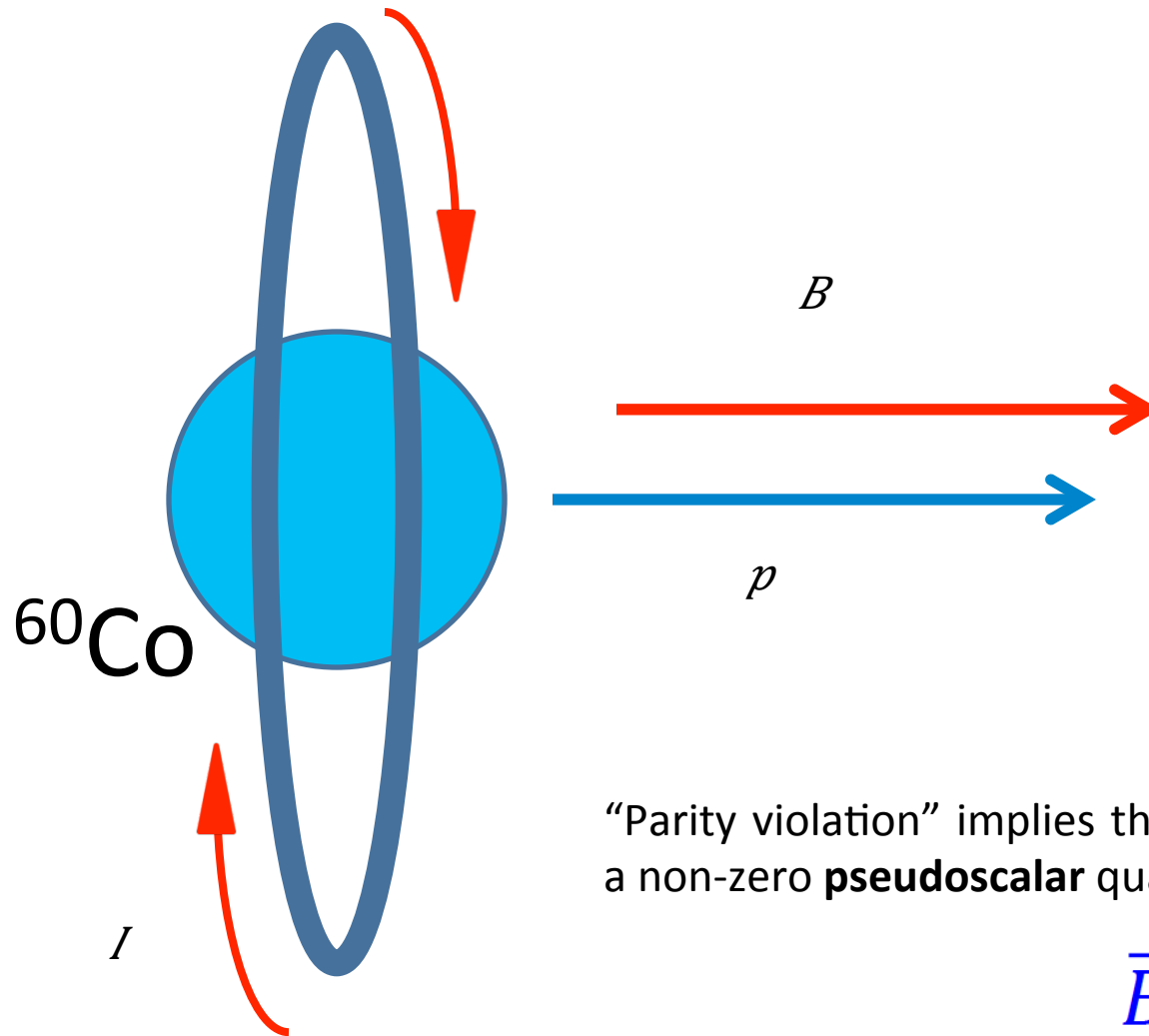


## ¿ What does inversion invariance (“parity conservation”) imply ?

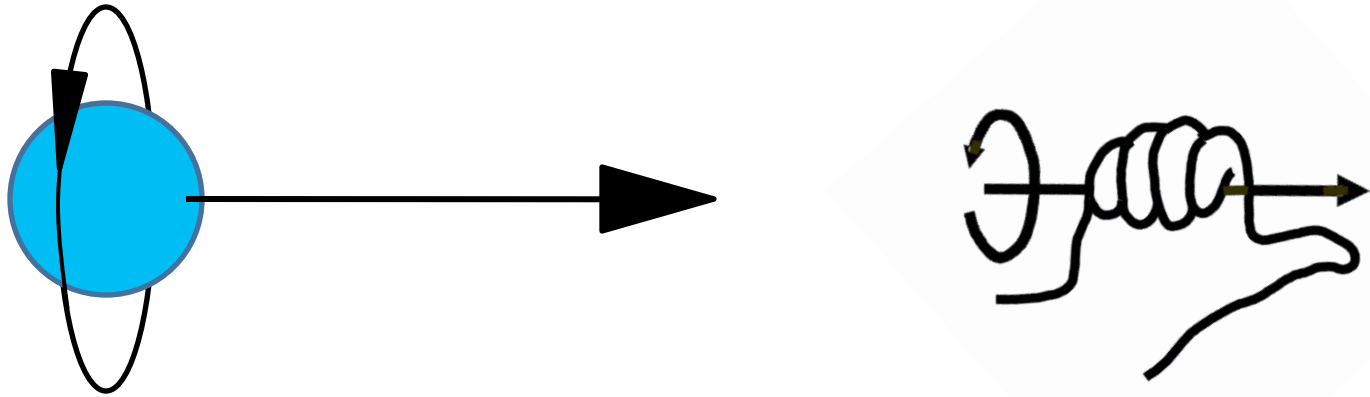


- Melting point
- Vapor pressure
- Electronic properties
- Color
- ....etc...

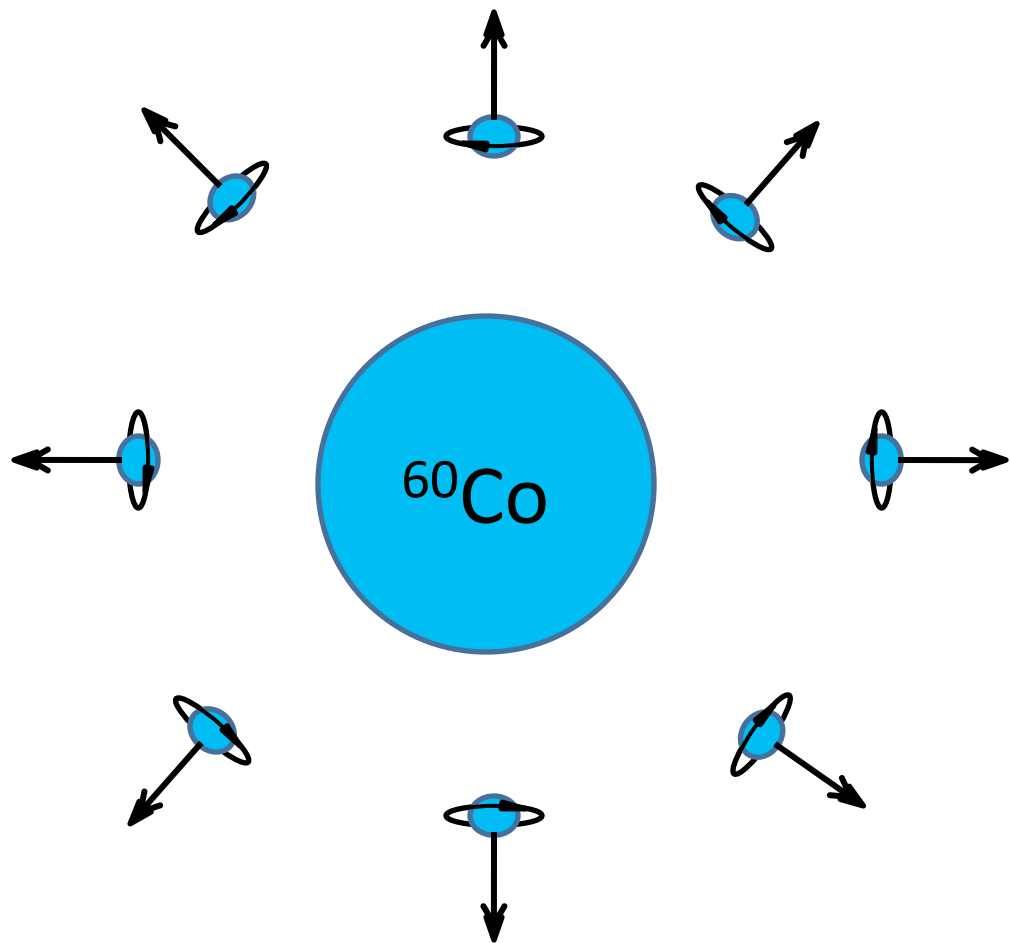
# Wu & Ambler (NBS, 1957)

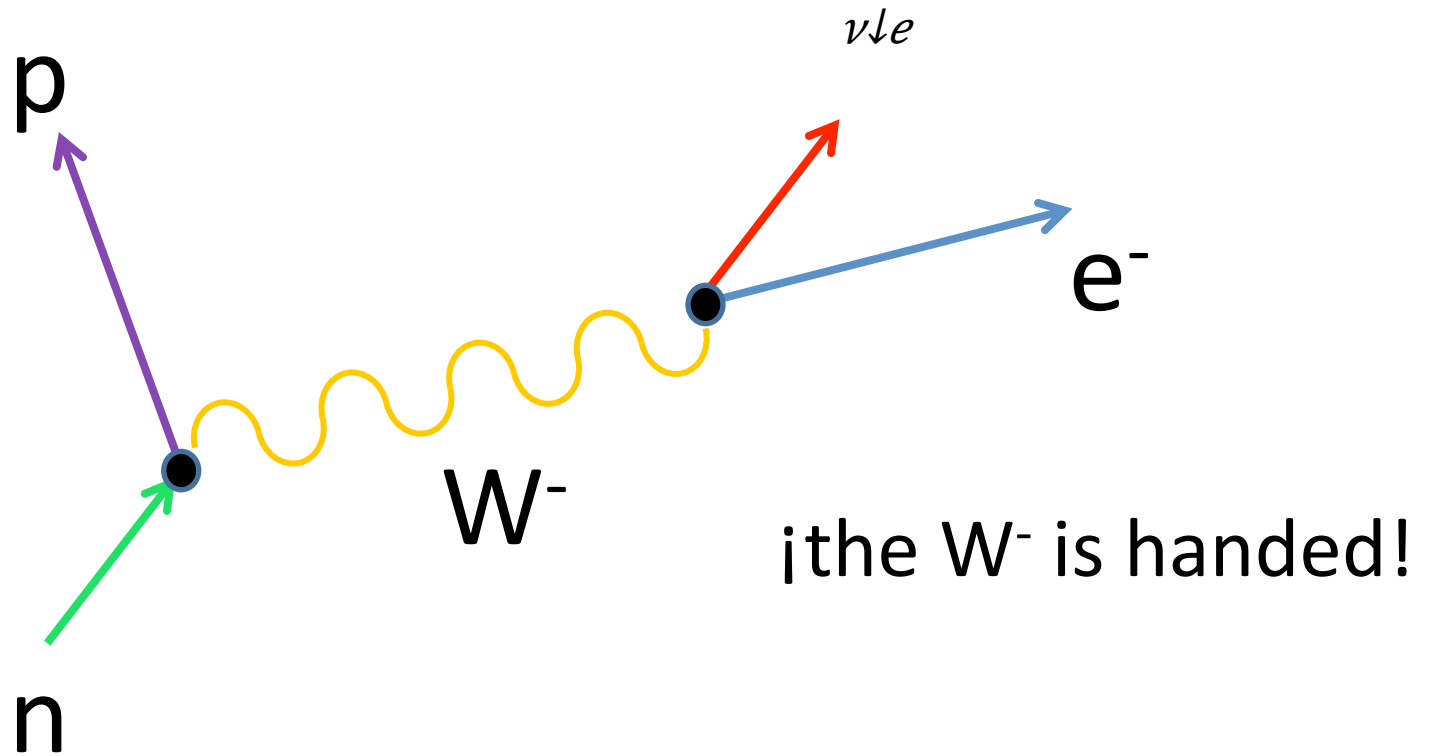


...alien problem solved...



ielectrons can be chiral!





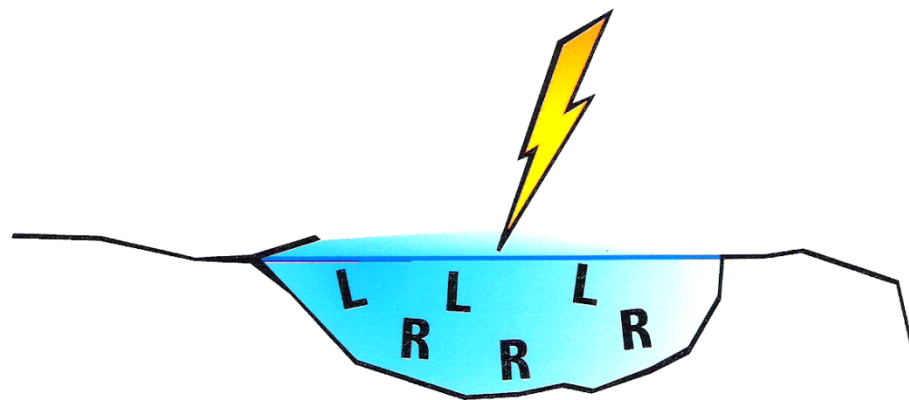
Interaction

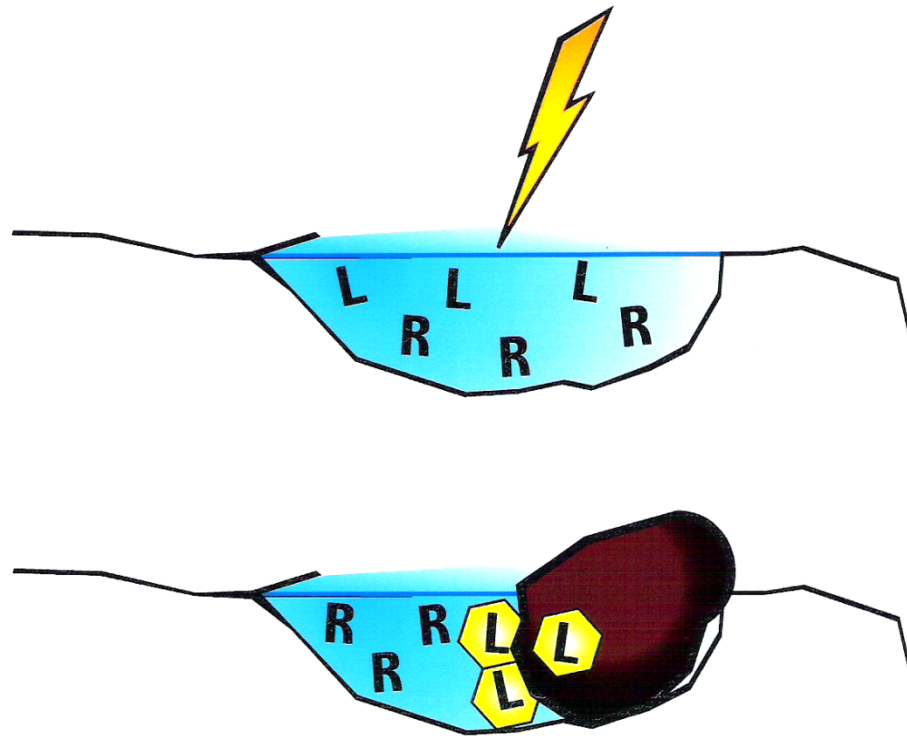
Strong  
Electromagnetic  
Weak  
Gravitational

¿Parity conserved?

Yes  
Yes  
No  
?





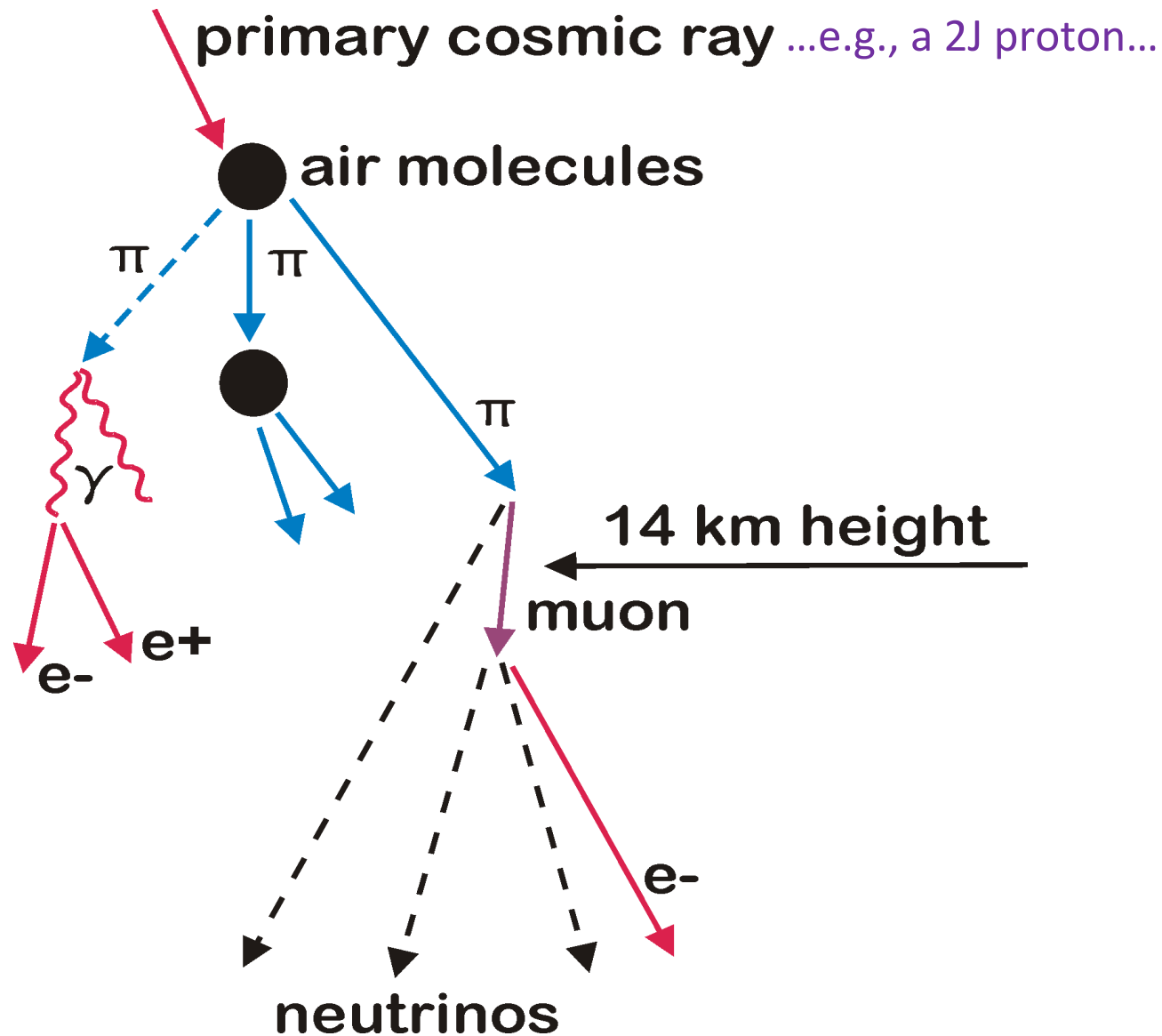


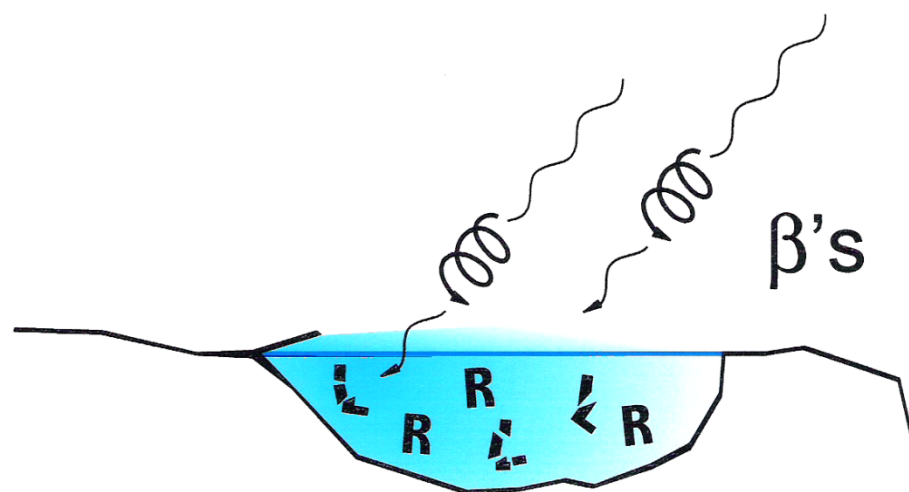
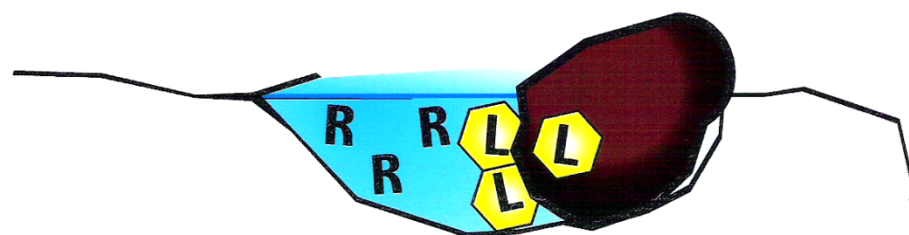
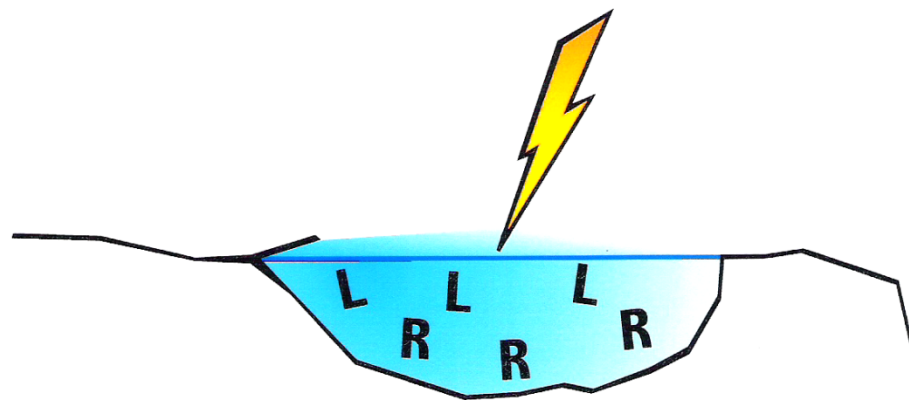
L. Pasteur *ca.* 1847

# The Vester-Ulbricht Hypothesis

- Lee and Yang propose that parity is violated in nature (1956)
- The Wu-Ambler experiment (1957)
- Vester in a seminar at Yale proposes that beta-ray-induced *bremsstrahlung* photolysis is responsible for biological homochirality (1957)
- Goldhaber shows that *bremsstrahlung* from beta rays is circularly-polarized (1957)

# Cosmic Rays







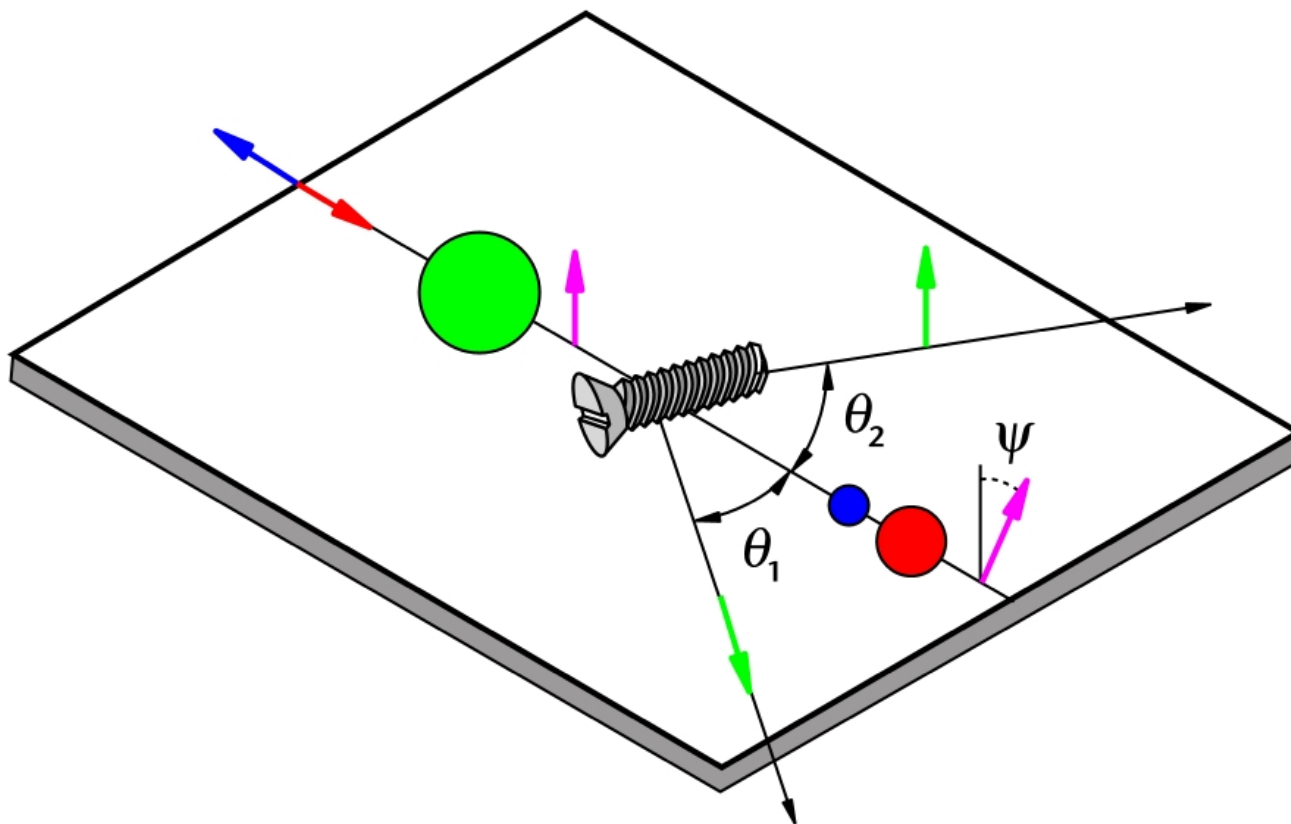
# Attempts to Verify the Vester-Ulbricht Hypothesis

- 1) Ulbricht and Vester bombard various organic substances with a variety of beta radiation. No effect on optical activity seen (1959).
- 2) Garay bombards tyrosine with betas from  $^{90}\text{Sr}$ . Reports a positive result (1968).
- 3) Bonner *et al.* fail to reproduce Garay's results (1974).
- 4) Calvin *et al.* attempt to preferentially destroy amino acids with betas from  $^{14}\text{C}$ . No effect is seen (1972).
- 5) Bonner *et al.* also fail to see a positive  $^{14}\text{C}$  effect (1974).
- 6) Darge *et al.* report large effect with  $^{32}\text{P}$  beta radiation on tryptophan (1976).
- 7) Bonner *et al.* repeat the Darge experiment, see no effect (1979).
- 8) Keszthelyi and Vincze use bremsstrahlung from  $^{57}\text{Fe}$  betas to photolyze tyrosine and tryptophan. No effect seen (1975).

## Attempts to Verify the Vester-Ulbricht Hypothesis (...the saga continues...)

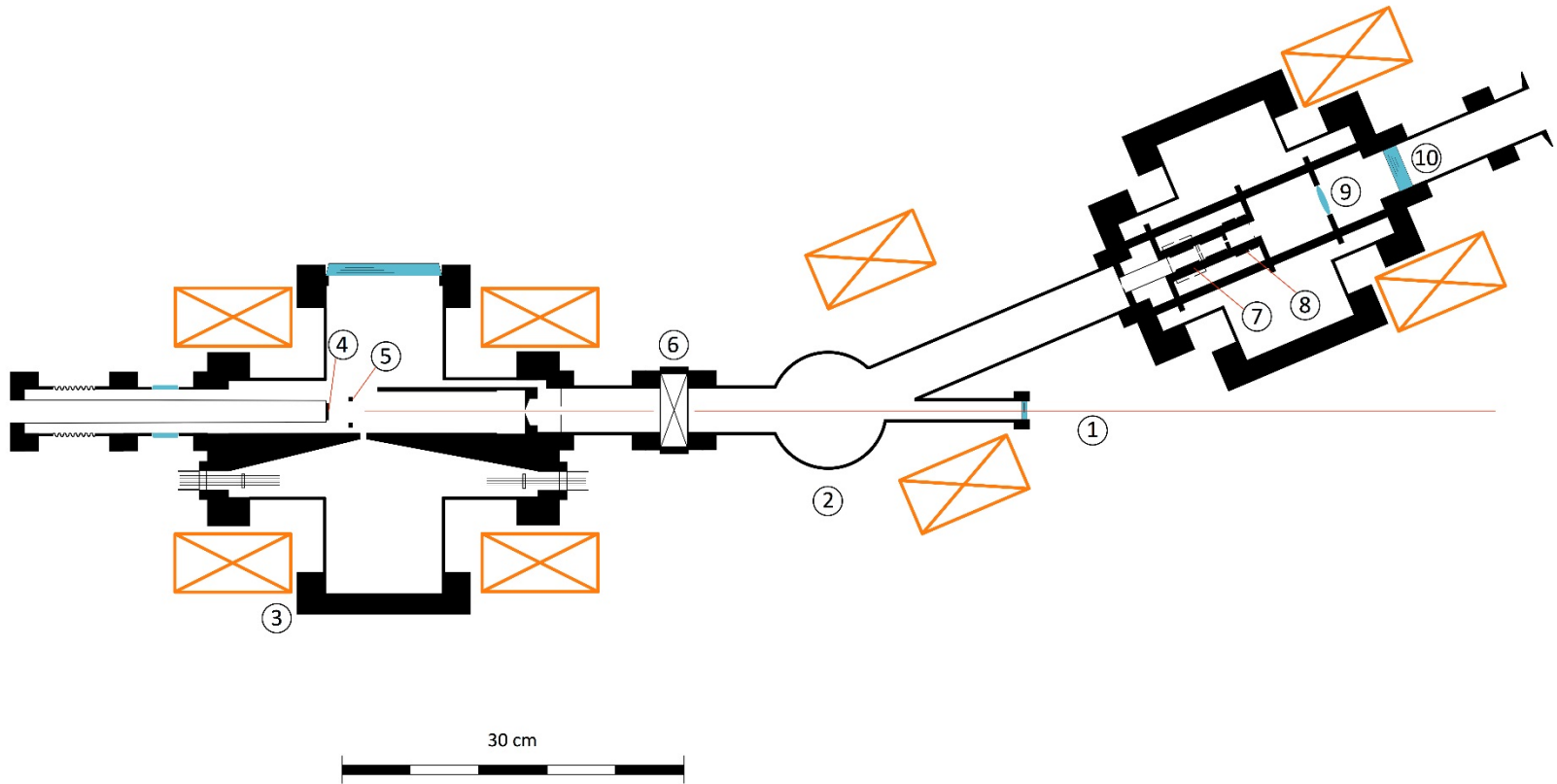
- 9) Bonner *et al.* observe *radioracemization* of various amino acids (1978).
- 10) Norden *et al.* observe preferential radiolysis of leucine with *unpolarized* gamma radiation (1985). ?
- 11) Tokay *et al.* observe a nonzero result in leucine labeled with  $^{14}\text{C}$  (1986).
- 12) Garay and Ahlgren-Beckendorf observe that betas from  $^{32}\text{P}$  emit different levels of Cerenkov radiation from 2-phenylbuteric acid (1990).
- 13) Bonner *et al.* bombard leucine with 120 keV polarized electrons, and report significant effects (1975).
- 14) Hodge *et al.* fail to reproduce Bonner's results (1979).
- 15) Naaman *et al.* and Rosenberg *et al.* find significant effects in the transmission of polarized electrons through ordered layers of chiral molecules on surfaces, both in terms of chemistry and in transmission (2000s).

# Electron Scattering from Chiral Molecules



Dissociative Attachment:  $e^- + AB \rightarrow A^- + B$

# Our Apparatus

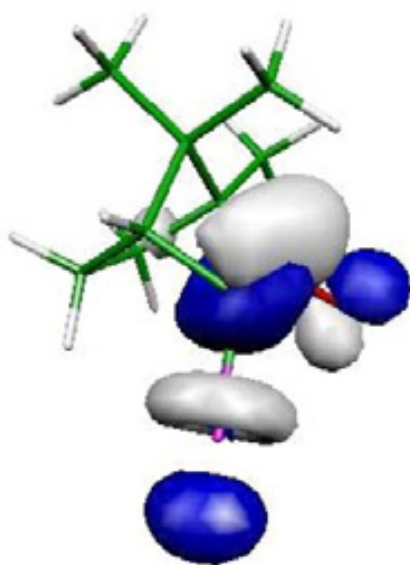


- 1) laser beam; 2) differential pumping chamber; 3) guiding magnets;  
4) GaAs photocathode; 5) cesiators; 6) gate valve; 7) chiral target cell;  
8) optical polarimeter target cell; 9) collimating lens; 10) window to optical polarimeter

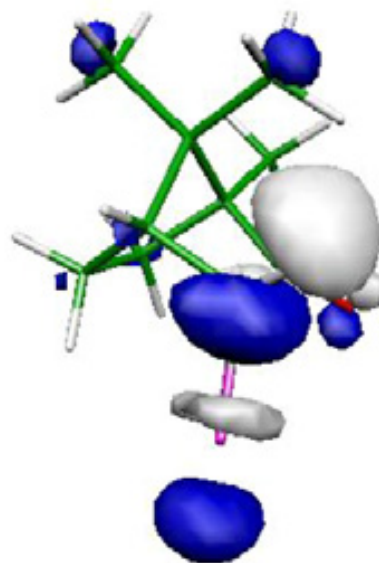




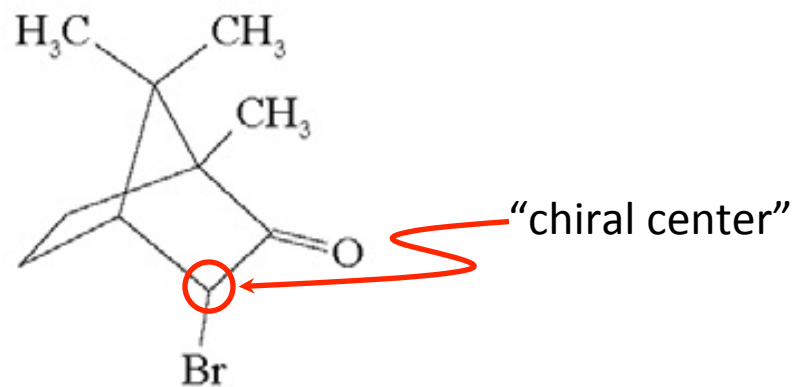
# Bromocamphor



LUMO ( $\sigma_1^*$ )

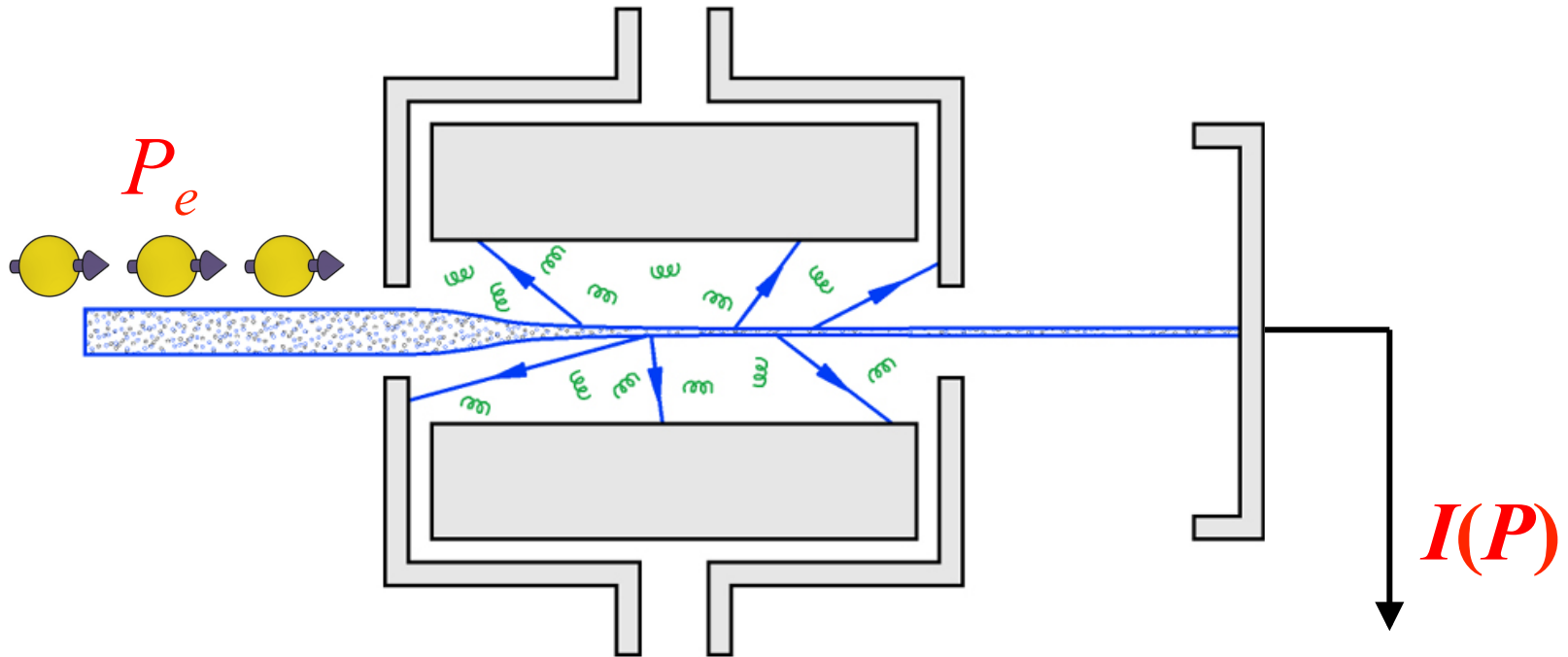


LUMO + 1 ( $\sigma_2^*$ )



# Electron Circular Dichroism

Dissociative Attachment:  $e^- + AB \rightarrow A^- + B$

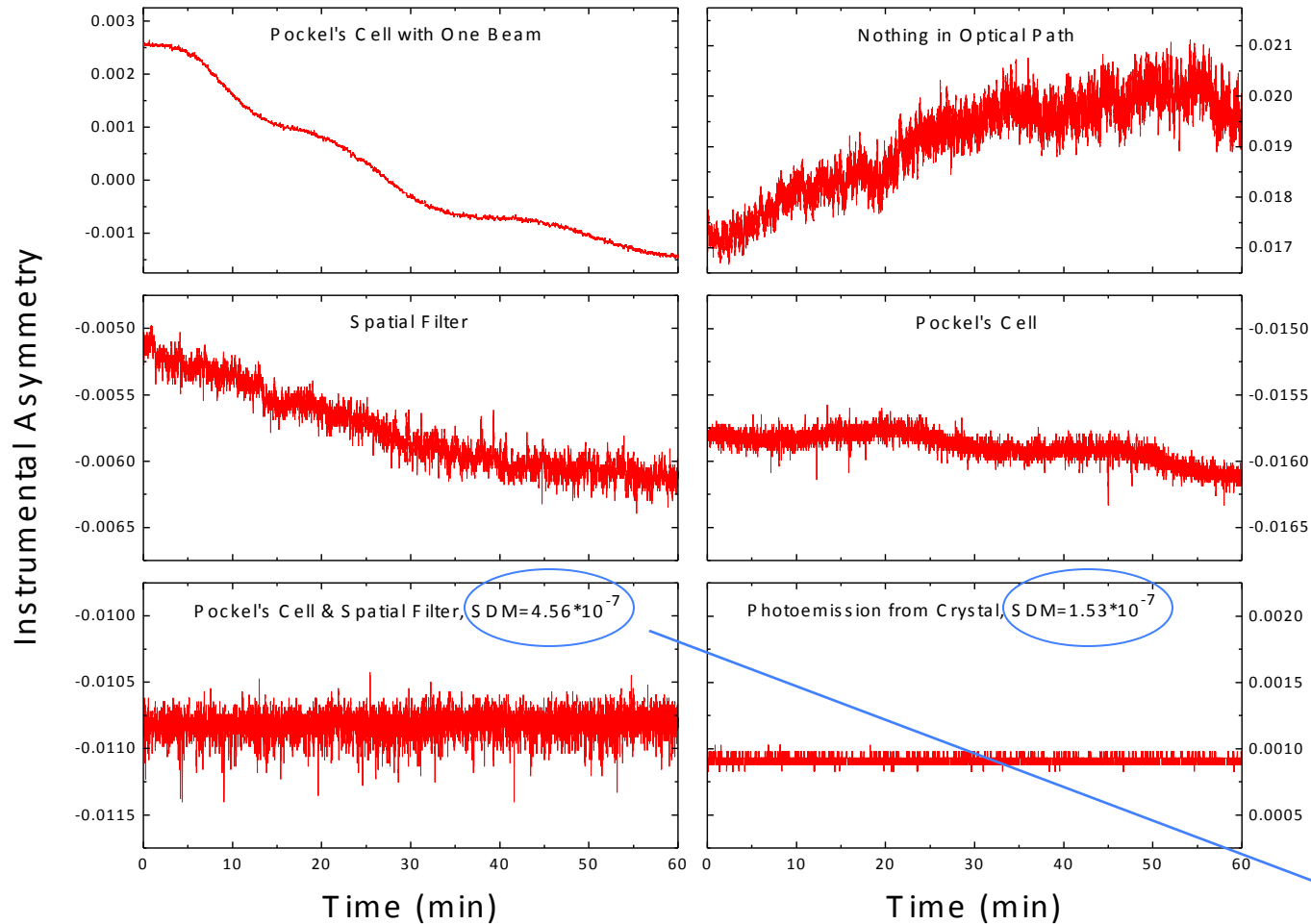
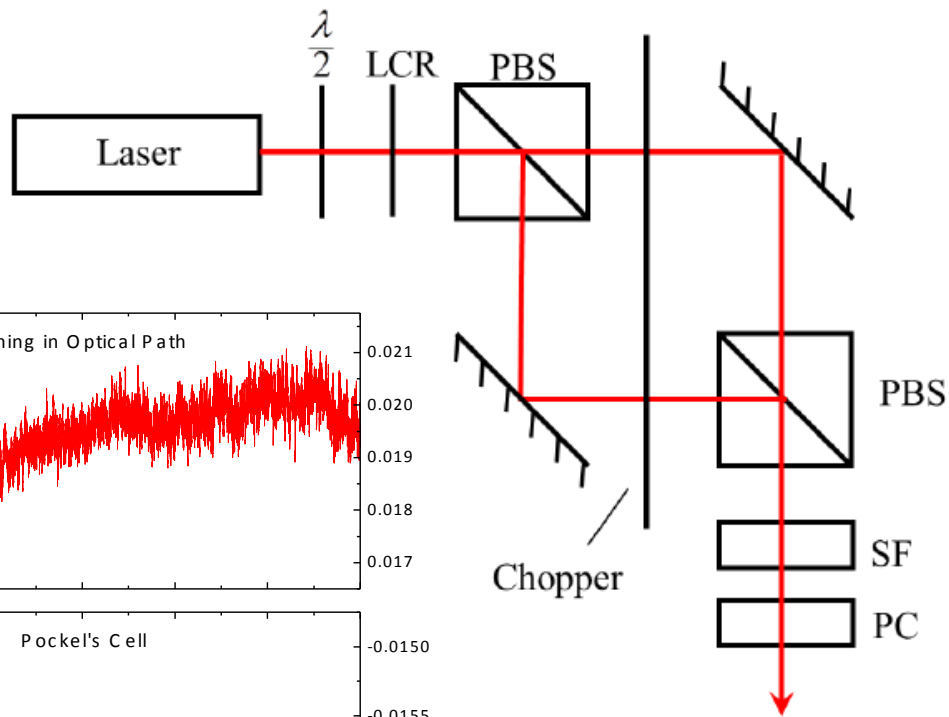


Transmission Asymmetry: 
$$A = \frac{I(P) - I(-P)}{I(P) + I(-P)}$$

# The Problem

On theoretical grounds, we expect  $A$  to be of order  $10^{-4}$ . Such a small asymmetry can be easily mimicked by correlations in the incident electron beam between its spin and its intensity...

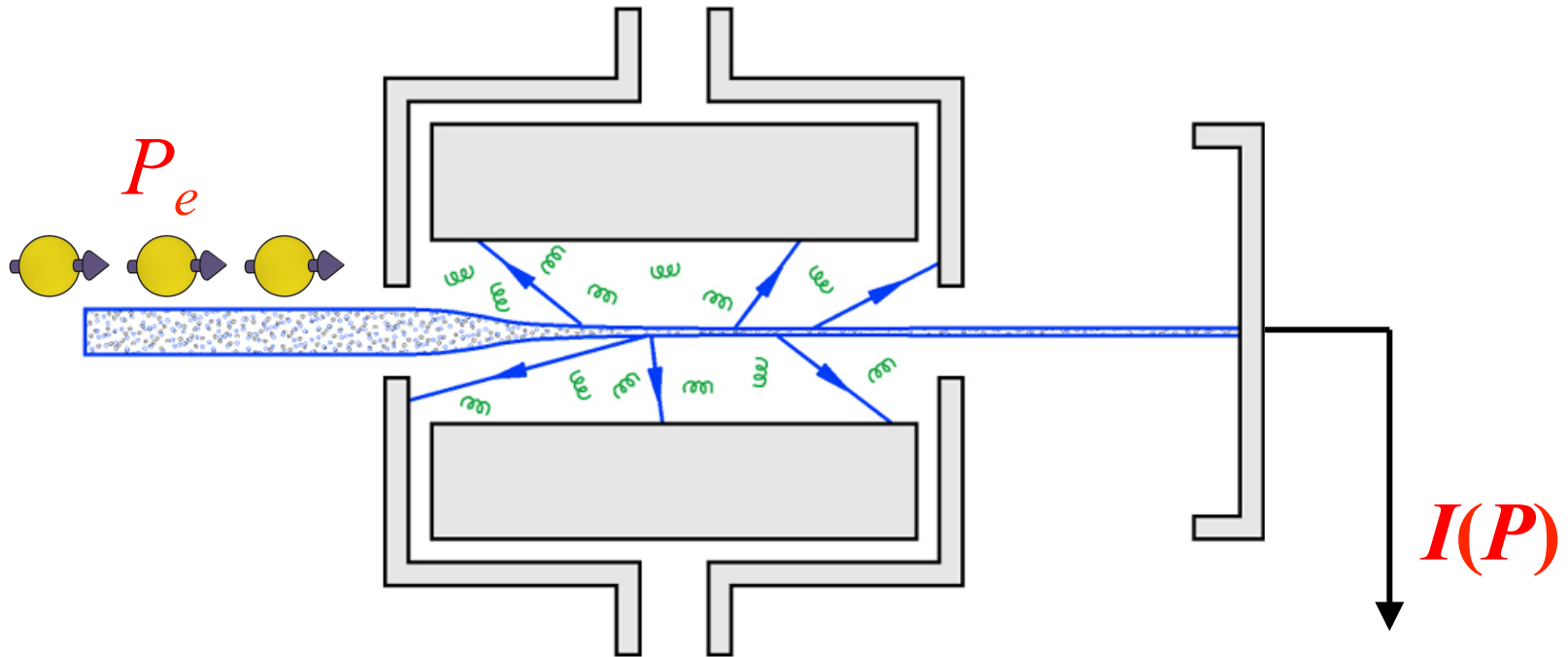
# OPTICAL SYSTEM



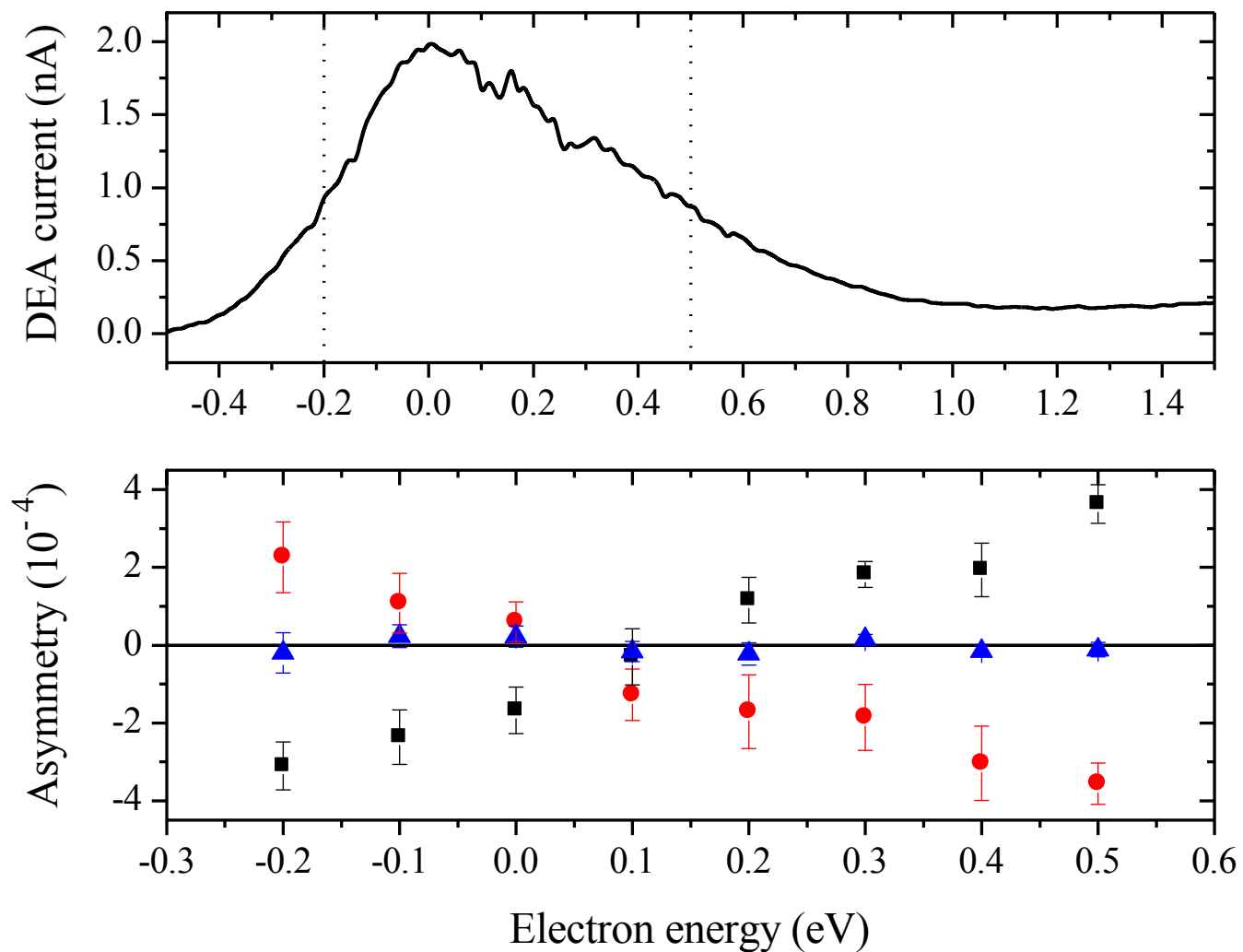
~ SLAC E158

# Electron Circular Dichroism

Dissociative Attachment:  $e^- + AB \rightarrow A^- + B$

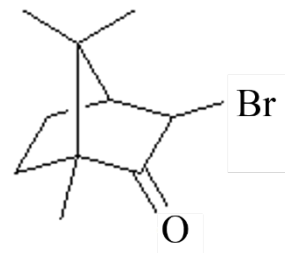


Transmission Asymmetry: 
$$A = \frac{I(P) - I(-P)}{I(P) + I(-P)}$$

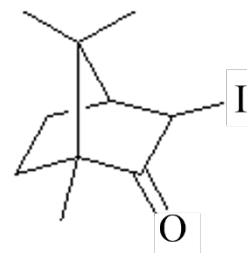


# Our results are permitted by symmetry, but what are the dynamics responsible?

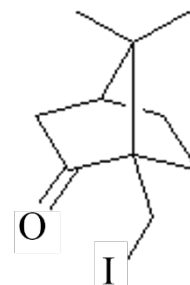
- Theories explaining asymmetry disagree on  $Z$  dependence
- Vary  $Z$ 
  - Bromocamphor,  $Z_{\text{Br}} = 35$
  - Iodocamphor,  $Z_{\text{I}} = 53$
- Vary location of highest  $Z$ 
  - 3-Iodocamphor
  - 10-Iodocamphor



3-Bromocamphor



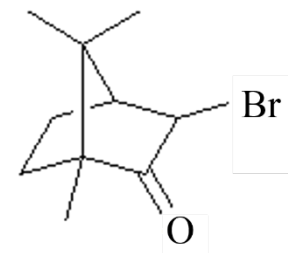
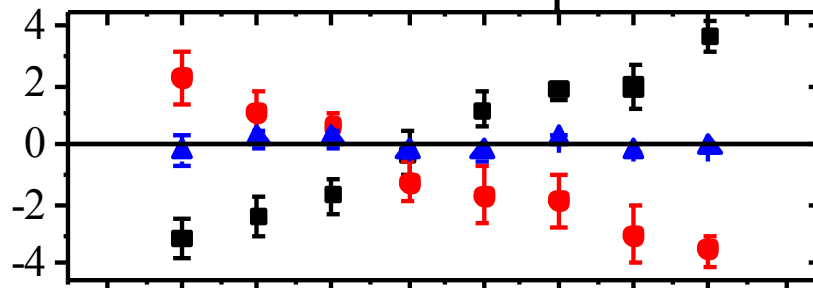
3-Iodocamphor



10-Iodocamphor

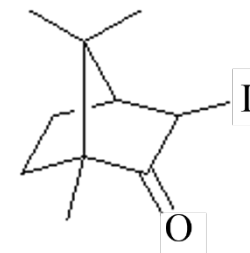
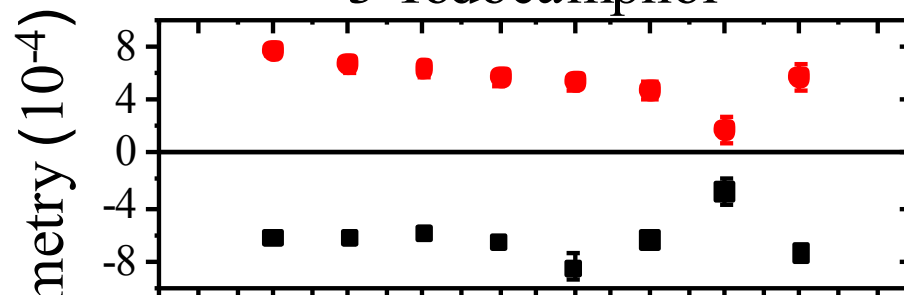
# DEA Asymmetry Data

## 3-Bromocamphor



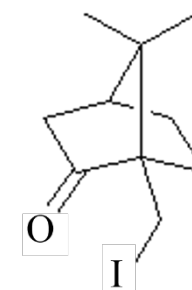
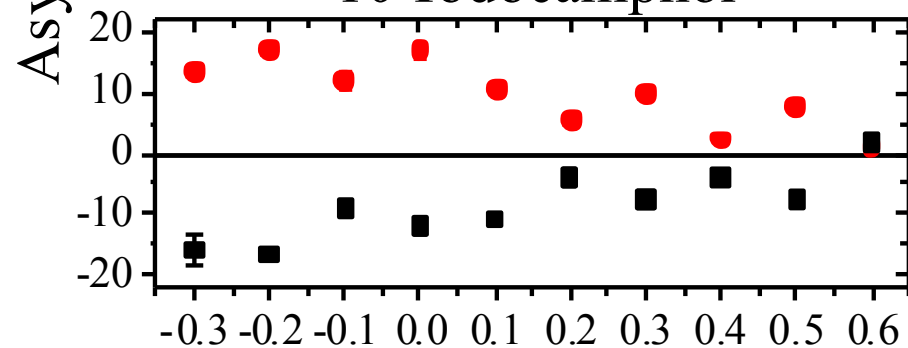
3-Bromocamphor

## 3-Iodocamphor



3-Iodocamphor

## 10-Iodocamphor



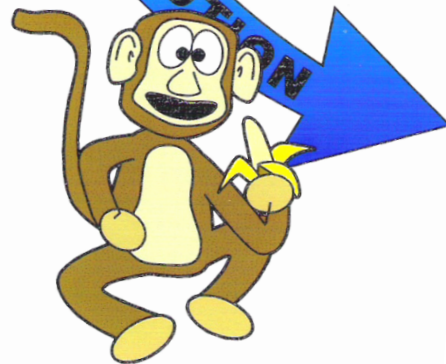
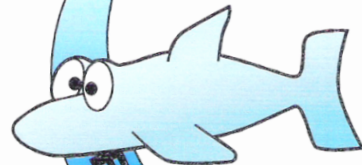
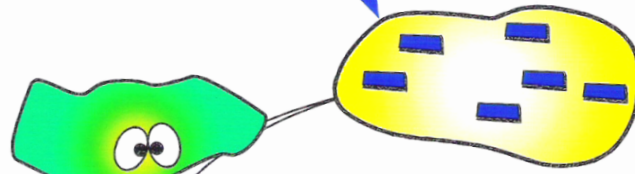
10-Iodocamphor

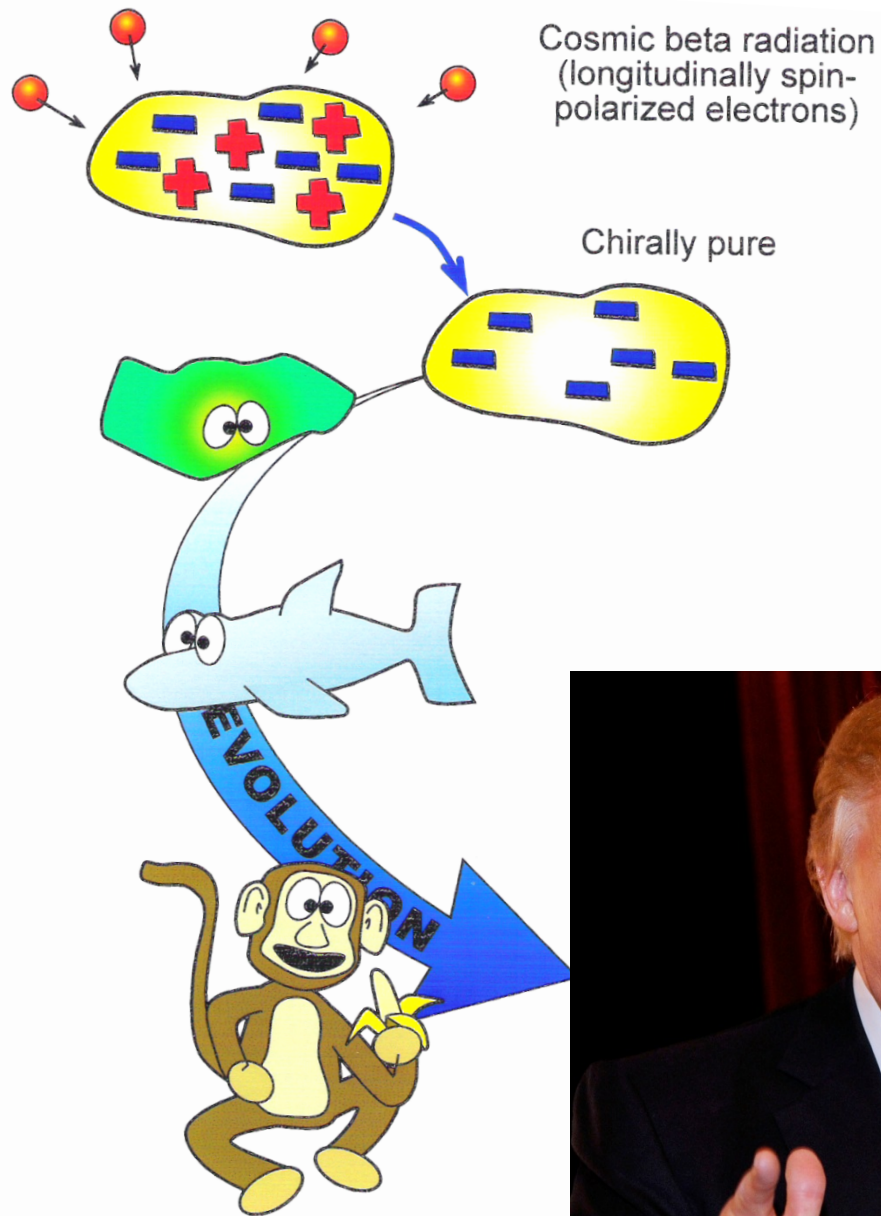
Electron Energy (eV)



Cosmic beta radiation  
(longitudinally spin-  
polarized electrons)

Chirally pure







One problem is that an electron is like a flea on an elephant compared to an amino acid. Its mass is so low, it seems inconceivable it could have any effect. The [Nature](#) article explains how Timothy Gay and Joan Dreiling (U of Nebraska-Lincoln) have been trying for 13 years to get a measurable result out of electron spin. Only with a highly-contrived setup, in which the electron energies were tightly controlled, could they see an excess in bromocamphor molecules (unrelated to amino acids). Even then, the excess was only 3 out of 20,000 molecules—about .015 of 1%, far too low when the requirement is 100% purity of one hand.

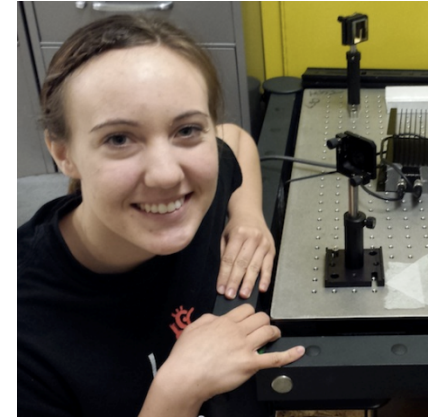
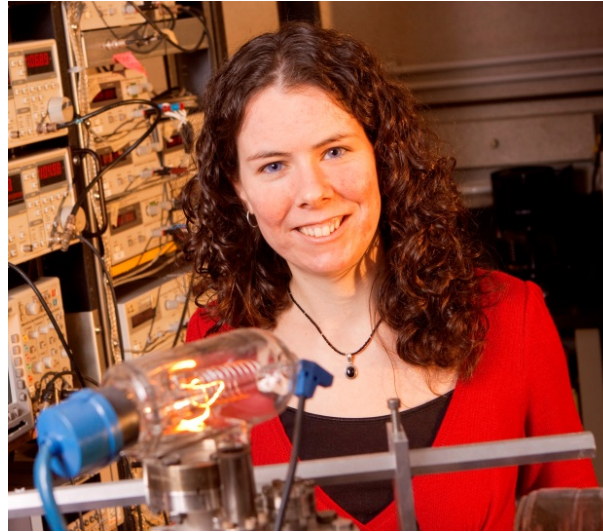
Got evidence?

Look, those of you who respect science, and who criticize creationists for trusting “religion” over “science” ([false dichotomy](#), [loaded words](#), [glittering generalities](#)). Here’s evidence! Here is math. Here is the law of probability. Here is *prima facie* evidence for design, but these secular materialists do not want to face the music. They have been trying since Pasteur discovered chiral molecules in 1860 (a year after Darwin’s little black book) to get around this “little problem” that Dr. Coppedge calculated. A single protein has 1 chance in  $8.7 \times 10^{34}$  of being all left-handed, but the smallest known living cell has 239 proteins. The chance of all of those being left-handed in the simplest conceivable living cell is 1 in  $10^{8295}$ . This is clearly impossible. Are you going to follow the evidence where it leads, or continue to hope against hope that materialistic science will find an answer, when they’ve been trying for over 150 years, and are no nearer a solution now than they were then? *What does evidence mean to you?*



# Perpetrators

Joan Dreiling



Samantha  
Burtwistle



Paul Burrow



Ken Trantham



Eric Litaker



Nick Ryan





