

# Light induced magnetization using chiral molecules

Xuanyuan jiang

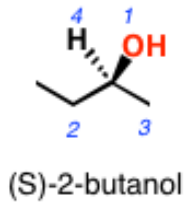
2019-02-01

# Chiral molecules

**chiral molecules** commonly comprise a carbon atom attached to four different substituents. Only two geometry is allowed by swapping components.

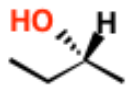
The Single Swap Rule:

6 different ways to swap two functional groups about the stereocenter:

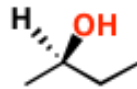


single swap

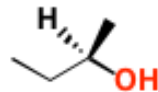
OH and H



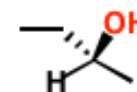
C<sub>2</sub>H<sub>5</sub> and CH<sub>3</sub>



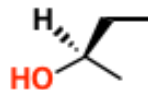
OH and CH<sub>3</sub>



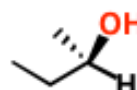
C<sub>2</sub>H<sub>5</sub> and H



OH and C<sub>2</sub>H<sub>5</sub>

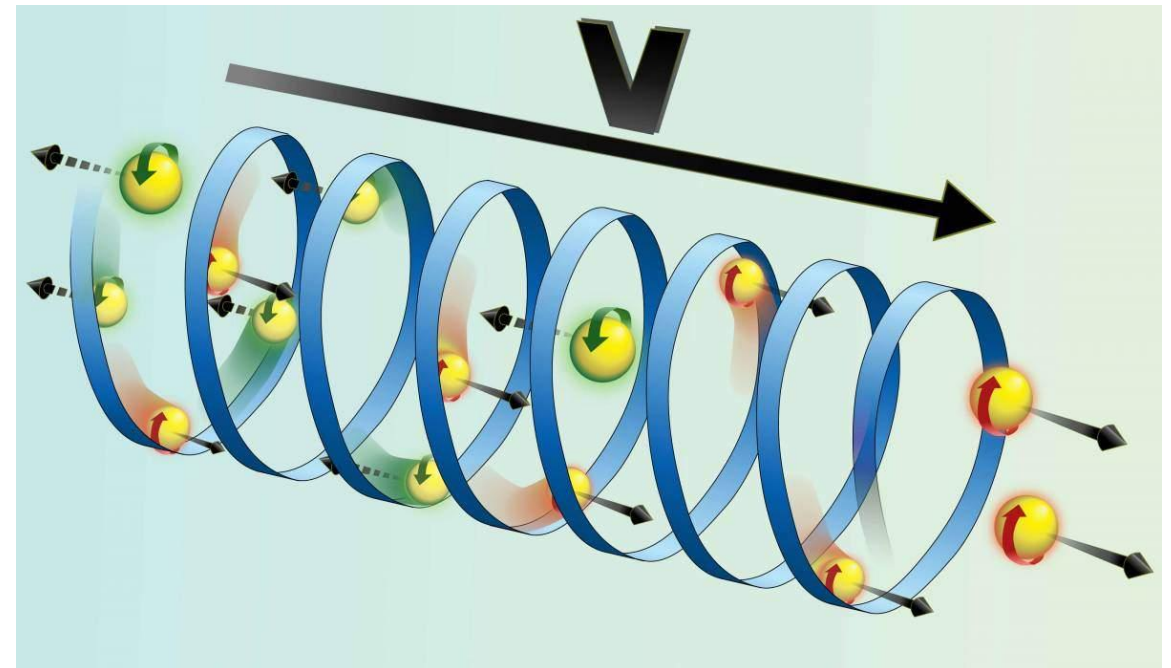
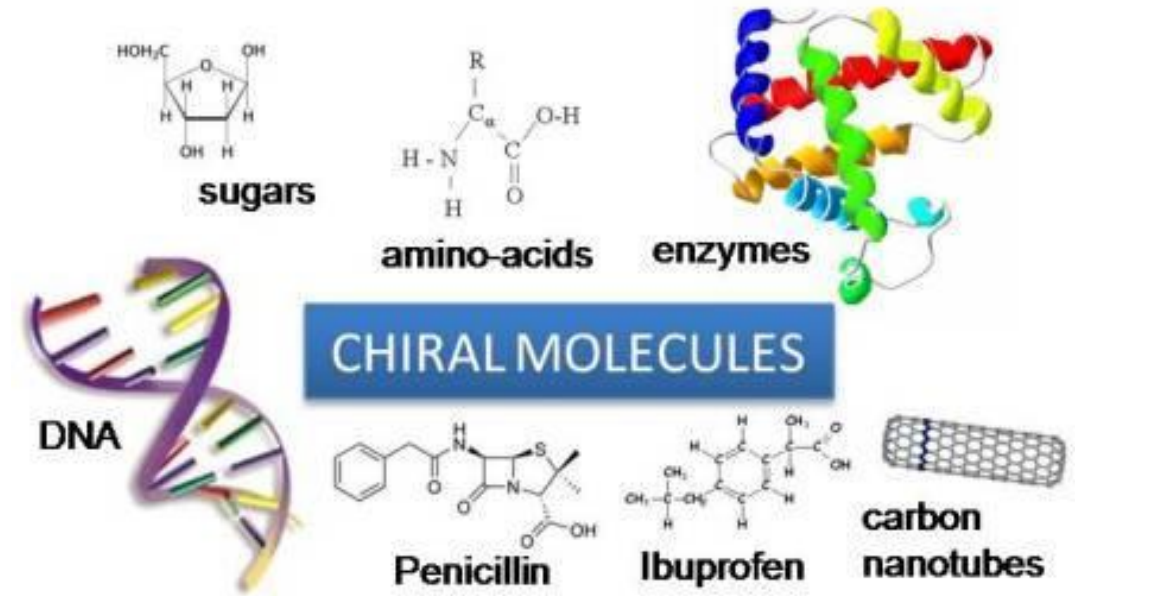


CH<sub>3</sub> and H

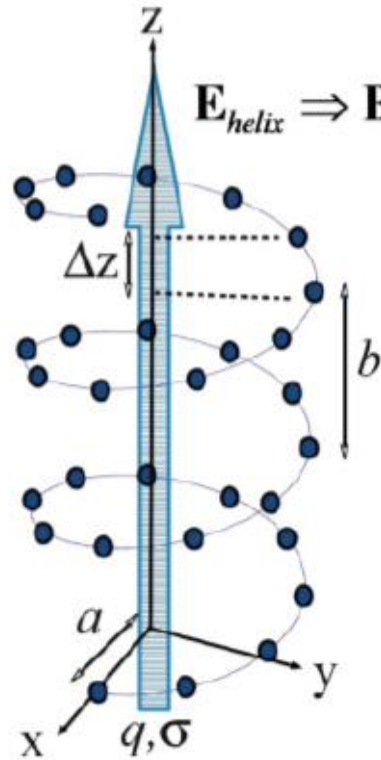


These are ALL (R)-2-butanol !

Swapping ANY TWO substituents inverts the stereocenter!



# Spin selection in Chiral molecules



$$\mathbf{E}_{helix} \Rightarrow \mathbf{B} = \frac{\mathbf{v}}{c^2} \times \mathbf{E}_{helix}$$

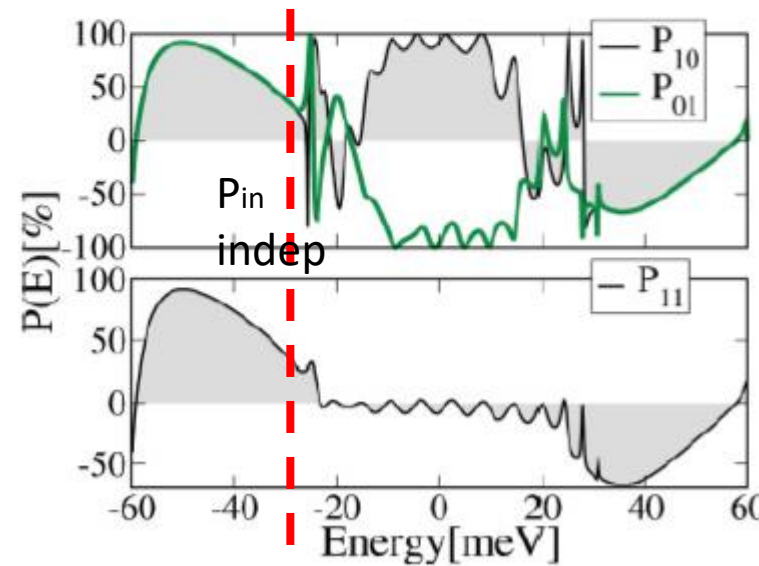
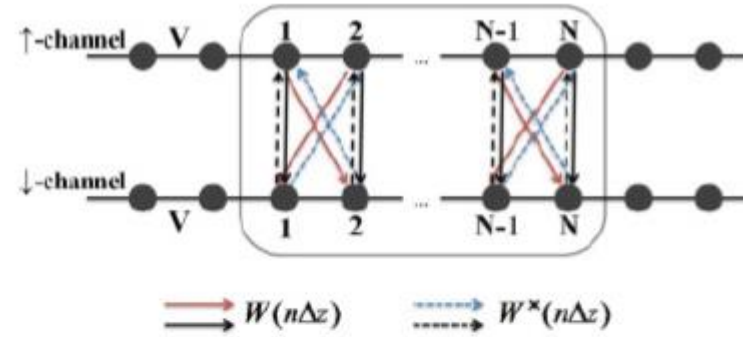
medium. The potential for a single point charge located at  $\mathbf{x}' = (a, \phi', z')$  in a uniform dielectric medium is just

$$\begin{aligned} \Phi(\mathbf{x}) &= \frac{q}{\epsilon} \frac{1}{|\mathbf{x} - \mathbf{x}'|} \\ &= \frac{q}{\epsilon} \frac{1}{(\rho^2 + a^2 - 2a\rho \cos(\phi - \phi') + (z - z')^2)^{1/2}}. \end{aligned} \quad (25)$$

A textbook calculation yields the electric field on the central axis:

$$\begin{aligned} E_\rho(0, \phi, z) &= -\frac{q}{\epsilon_{n,s}} \sum \frac{a \cos\left(\phi - \frac{2\pi s \Delta z}{P}\right)}{(a^2 + (z - nP - s\Delta z)^2)^{3/2}}, \\ E_\phi(0, \phi, z) &= \frac{q}{\epsilon_{n,s}} \sum \frac{a \sin\left(\phi - \frac{2\pi s \Delta z}{P}\right)}{(a^2 + (z - nP - s\Delta z)^2)^{3/2}}, \\ E_z(0, \phi, z) &= \frac{q}{\epsilon_{n,s}} \sum \frac{(z - nP - s\Delta z)}{(a^2 + (z - nP - s\Delta z)^2)^{3/2}}. \end{aligned} \quad (26)$$

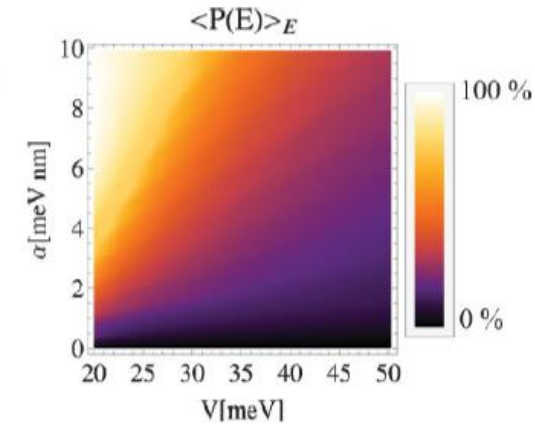
D. Hochberg, G. Edwards, and Th. W. Kephart,  
Phys. Rev. E 55, 3765 (1997).



Band edge

$$\begin{aligned} H &= \sum_{\sigma=\uparrow,\downarrow} \sum_{n=1}^N U_n c_{n,\sigma}^\dagger c_{n,\sigma} + V \sum_{\sigma=\uparrow,\downarrow} \sum_{n=1}^{N-1} (c_{n,\sigma}^\dagger c_{n+1,\sigma} + \text{H.c.}) \\ &+ \sum_{n,m=1}^N (c_{n,\uparrow}^\dagger W_{n,m} c_{m,\downarrow} + c_{m,\downarrow}^\dagger W_{m,n}^\times c_{n,\uparrow}) + H_{\text{leads}}. \end{aligned} \quad (2)$$

R. Gutierrez, etc.,  
Phys. Rev. B 85,  
081404(R), 2012

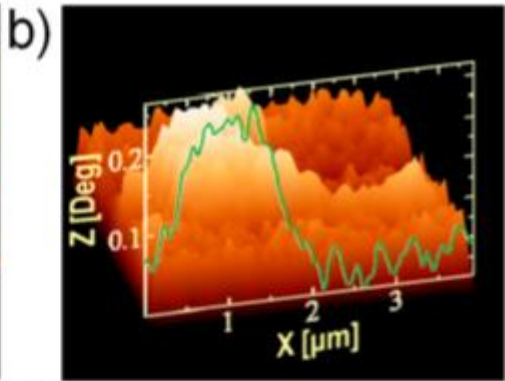
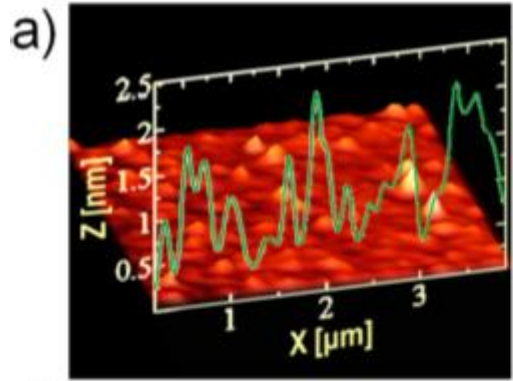


# Light induced magnetization

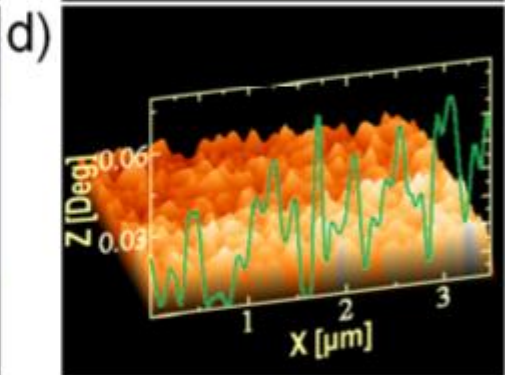
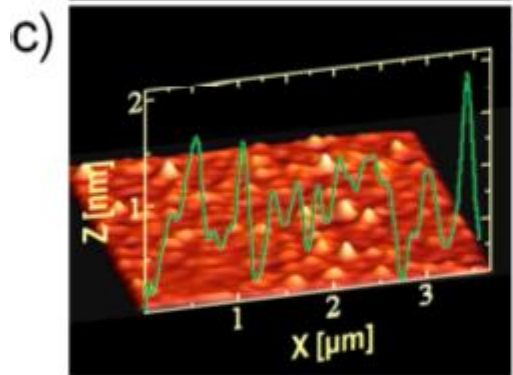
O. Dor, etc.,  
 Nano let. 2014, 14,  
 6042-6049

AFM

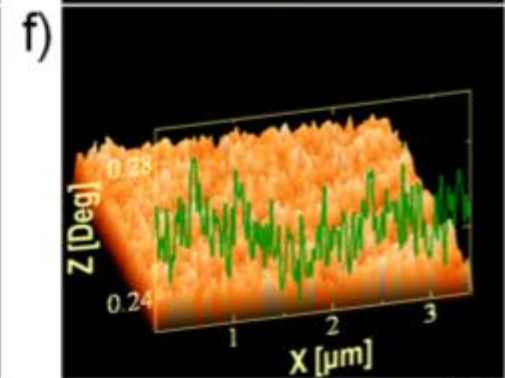
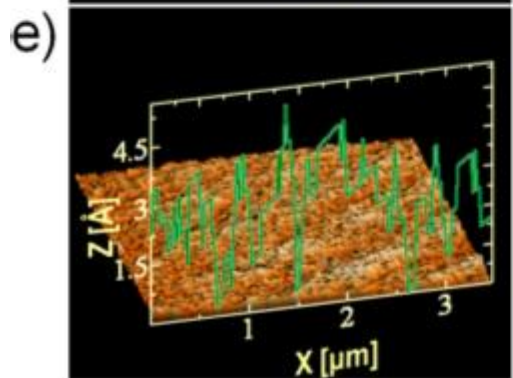
MFM



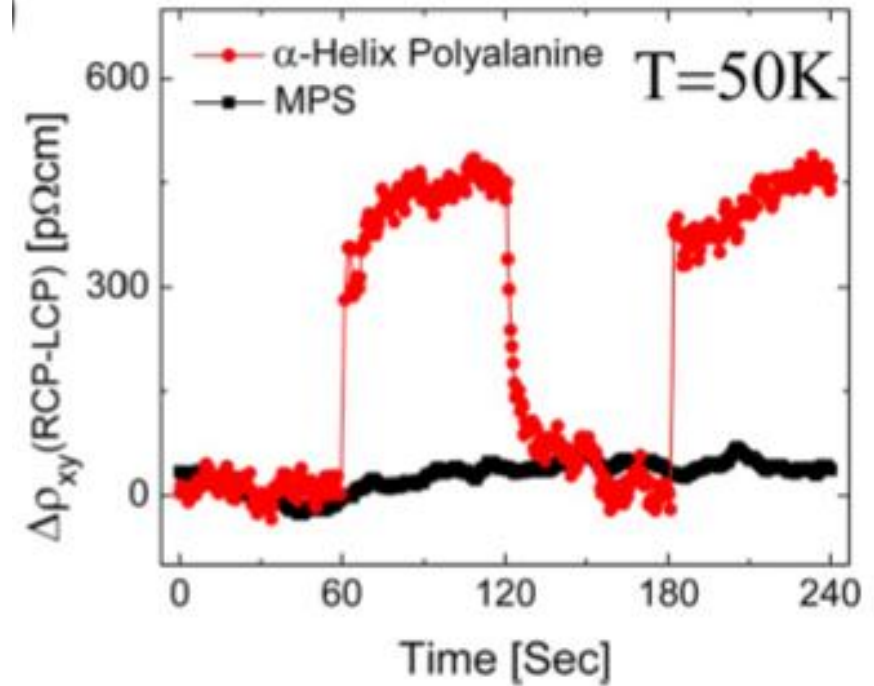
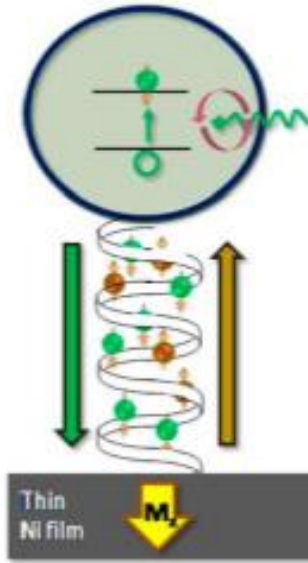
with  
light



no  
light



Without  
chiral  
molecule



AHE under  
circular  
light with  
and  
without  
chiral  
molecule