Enhancing Selective Absorption in Chiral Molecules Using Dielectric Nanospheres

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Separation of chiral molecules is important for the pharmaceutical industry due to the differing biological functions of opposite enantiomers. While separation via chemical means can be time-consuming and prohibitively expensive, selective photoionization or photolysis via circularly polarized light (CPL) has been proposed as a promising all-optical scheme to separate enantiomers. Unfortunately, CPL alone can only achieve enantiomeric excesses up to 2% with substantial yield. The speaker and her research group propose a system to increase separation efficiencies above CPL using magnetically excited Mie resonances in achiral dielectric nanoparticles.

As a model system, they consider silicon nanospheres illuminated by CPL. These particles support strong magnetic and electric Mie resonances from UV to IR frequencies, allowing a variety of molecular resonances to be targeted. Optimizing over nanosphere size and excitation wavelength, they find local enhancements in the differential rate of absorption between enantiomers of up to 7x as well as local enhancements in the circular dichroism signal of up to 170x. Importantly, these local enhancements maintain electromagnetic field strengths equal to or greater than that of the illuminating field, enabling efficient molecular absorption. The enhancements can be correlated with excitation of magnetic Mie resonances within the nanosphere. Finally, they determine design parameters for achieving maximal differential absorption rates between enantiomers, paving the route towards full optical separation of enantiomers.