THE CHINESE UNIVERSITY OF HONG KONG

Department of Physics

SEMINAR

Optically Active Metal Nanoparticles with Atomically Chiral Lattices

by

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Time: 11:30 a.m. - 12:30 p.m.
Place: Rm. G25, Science Centre North Block, CUHK
Join ZOOM Meeting: https://qrgo.page.link/FV35F

ALL INTERESTED ARE WELCOME
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Abstract

Chirality denotes an asymmetric configurational property whereby an object cannot be superimposed on its mirror image. Homochirality overwhelmingly occurs in biosystems, where almost all biological building blocks being preferentially composed of one stereoisomeric configuration over another. Biological homochirality has raised an unsolved question about the mystical origin of molecular enantiopreference on Earth, that is, the origin of life. Understanding of essential chiral forces to manipulate molecular chirality is a key to answer this question. It is well-known that a clockwise/counterclockwise rotation accompanied with a translation along the rotational axis (i.e., macroscopic shear force) enables the generation of chiral matter, such as springs and winding stairs. Hence, the unidirectional rotation/revolution of the Earth has been long proposed to be one of important homochiral forces. However, it is unclear how such a macroscopic movement can manipulate molecular chirality, considering the dramatic dimensional difference between them.

In this seminar, I will present an unprecedented demonstration of chirality transmission from macroscopic rotation to molecules. We used glancing angle deposition (GLAD) to apply macroscopic shear force and produce metal chiral nanoparticles (CNPs), on which photoinduced cyclodimerization was asymmetrically performed: clockwise/counterclockwise substrate rotation -> right/left-handed CNPs -> preferential synthesis of (-)/(+)-cycloadducts, respectively. The macroscopic manipulation of molecular chirality can be effectively mediated with silver and copper CNPs, which have optical activity owing to the formation of atomically chiral lattices in the cores and at the surfaces. However, the enantiomeric excess was less than 10%, mainly ascribed to small surface density of chiral lattices and small differential surface energies of the dimer precursors adsorbed at the chiral surfaces. These two key parameters can be increased via the fabrication of alloy CNPs, to potentially enhance the macroscopic-to-molecular chirality transmission. Two fabrication methodologies, including layer-by-layer GLAD and galvanic replacement reactions, will be introduced to produce binary, ternary, and even denary (10 elements) CNPs. Polyelemental CNPs are also optically active, composed of atomically chiral lattices, and, importantly, made of a wide range of metallic elements that have catalytic activity.

These works pave the way toward significant enhancement of chirality transfer from macroscopic rotation to molecules and will provide an insight into the homochirality-related origin of life via applying polyelemental CNPs to study molecular symmetry breaking, heterogeneous asymmetric synthesis, an enhancement of electromagnetic optical chirality and molecular optical activity, and circularly polarized luminescence.