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University of Miami, Physics Department Colloquium

Date: Wednesday, Feb 7, 2024
Time: 4:00 pm – 5:00 pm
Location: Wilder Auditorium – Rm 112, Knight Physics Building

Extreme Manipulation of Light with Structured Surfaces: Highly Resonant Optical Materials and Mechanical Manipulation Techniques

Dr. Claudio Hail
California Institute of Technology

Abstract

Nanotechnology has enabled engineering the interaction of light and matter at a subwavelength scale, leading to numerous scientific and technological breakthroughs such as label-free optical detection of single biomolecules, or the demonstration of efficient flat optical elements. In this talk, I will introduce three distinct approaches that leverage micro- and nanostructures to manipulate light-matter interaction at an extreme, facilitating the creation of novel optical devices and techniques for mechanical manipulation. First, I will discuss the design of highly resonant flat optical elements that show a strong interaction with light and, as a result, exhibit enhanced optical nonlinearity and characteristics that are highly sensitive to external stimuli for active reconfiguration. This design concept is illustrated with the experimental realization of beam deflectors and radial lenses with resonant quality factors of up to 1472, and nanostructures for third harmonic generation with a record conversion efficiency of 3×10-5. Next, I will show how the extraordinary optical properties of transition metal dichalcogenides can be employed to dynamically modulate visible light by electrically tuning excitonic material resonances. Specifically, I will present experimental results of active beam steering of light in reflection at the material exciton wavelength obtained by electrically gating a single atomic layer of MoSe2. Finally, I will introduce a powerful method for the remote mechanical manipulation of an object by light that leverages the object's nanostructuring. The advancements presented here have the potential for a profound impact on the development of light-based propulsion, chip-based hardware for quantum technology, and compact imaging and sensing devices for consumer electronics.

Biography

Dr. Claudio Hail is a postdoctoral fellow at Caltech's Department of Applied Physics and Materials Science under the guidance of Prof. Harry Atwater. Claudio's research centers around highly resonant dielectric optical nanostructures and optomechanics. Prior to joining Caltech, he earned his PhD at ETH Zurich in 2020 in the group of Prof. Dimos Poulikakos, where he developed a technique for the on-demand nanoprinting of single fluorescent molecules and optical materials for structural coloring. Claudio has been honored with the Fulbright Fellowship, the ETH silver medal, and is a Postdoctoral Fellow of the Swiss National Science Foundation.