“The Ultimate Limits to Optical Refractive Index”

Abstract:
It is interesting to observe that all optical materials we know of have a refractive index of order unity at telecom or visible wavelengths. Yet we seem to lack any deep understanding of this seemingly universal phenomenon. Furthermore, this observation is difficult to reconcile with the well-known fact that a single isolated atom can have a giant response to near-resonant light, as characterized by a scattering cross-section much larger than its physical size. Indeed, according to conventional formulas, this would lead to an index of order 10^4 for materials at solid densities. Here, we take a bottom-up approach to this question, investigating how the refractive index of an atomic medium evolves as a function of density, starting from the well-understood regime of dilute, isolated atoms. We explore the roles that different mechanisms, such as non-perturbative multiple scattering of light and quantum chemistry, can have in limiting the index, what the ultimate limits of index might be, and why our conventional textbook descriptions are insufficient.

Bio:
Darrick Chang is an ICREA Research Professor at ICFO, where he has led the Theoretical Quantum Nanophotonics Group since 2011. He obtained his Bachelor's degree and PhD in physics from Stanford and Harvard, respectively, and was a prize postdoctoral fellow at Caltech. Among his recognitions, he has been awarded both the Starting and Consolidator Grants from the European Research Council. His group explores quantum light-matter interactions in diverse platforms, including atomic arrays, atom-nanophotonics interfaces, optomechanical systems, and low-dimensional materials, and collaborates with leading experimental groups to bring their theoretical ideas toward reality.