Light propagation beyond standard optics in a uniform-density polarizable medium

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Host: Associate Professor David Wilkowski

Abstract

The interaction of light with ensembles of resonant emitters is becoming increasingly important for both fundamental research and technological applications as experimentalists realize a growing number of such systems. We perform microscopic numerical simulations of light propagation in a uniform-density polarizable medium on an atom-by-atom basis. Comparisons between these essentially exact simulations for cold and dense atomic ensembles and the predictions obtained from the standard electrodynamics of a polarizable medium (EDPM) reveal that the more than a century-old wisdom of conventional textbook optics can dramatically and qualitatively fail. The failure of EDPM is not due to quantum effects, but reflects emergent cooperative phenomena and strong light-induced correlations between the atoms. However, incorporating the effects of thermal motion in hot atom vapours or inhomogeneous resonance broadening restores the usual phenomenology of effective continuous medium electrodynamics. These strong cooperative interactions can be utilized in arrays of atoms and other dipolar emitters, e.g., in preparation of giant subradiant states.

Short Biography

Janne Ruostekoski currently holds a UK Research Council research fellowship and has been a professor at the Lancaster University since 2017, and previously at the University of Southampton. He received his first degree at the Helsinki University of Technology (now Aalto University) and completed a PhD at the University of Connecticut.