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Molecular optomechanics with atomic antennas

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A typical surface-enhanced Raman scattering (SERS) system relies on deeply subwavelength field localization in nanoscale plasmonic cavities to enhance both the excitation and emission of Raman-active molecules [1,2]. Here, we demonstrate that a germanium-vacancy (GeV) defect in diamond can efficiently mediate the excitation process, by acting as a bright atomic antenna [3]. At low temperatures, the GeV's low dissipation allows it to be efficiently populated by the incident field, resulting in a thousand-fold increase in the efficiency of Raman scattering in the hybrid system comprising a GeV atomic antenna and a plasmonic nanoparticle [4]. Additionally, we show that atomic antenna-enhanced Raman scattering can be distinguished from conventional SERS by tracing the dependence of Stokes intensity on input power, and the pronounced antibunching of the Raman emission.

We also discuss a simpler setup, in which GeV atomic antennas localize light in diamond, driving and enhancing the Raman response of the diamond lattice, in what would be a solid-state analogue of the canonical experiment demonstrating plasmon-enhanced Raman scattering from a solution of molecules [5].

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Author: SCHMIDT, Mikolaj (Macquarie University)

Co-authors: Prof. HIGH, Alexander (University of Chicago); STEEL, Michael (Macquarie University)

Presenter: SCHMIDT, Mikolaj (Macquarie University)

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