Title: Controlling the charge state of color centers at the nanoscale: Challenges and opportunities.

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Abstract: Charge control of color centers in semiconductors promises opportunities for novel forms of sensing and quantum information processing. This presentation discusses recent experiments combining confocal fluorescence microscopy and magnetic resonance protocols to induce and probe charge transport between discrete sets of engineered nitrogen-vacancy (NV) centers in diamond, down to the level of individual defects. Our observations reveal giant capture cross-sections exceeding typical values by two or three orders of magnitude, a result we attribute to the high sample purity (and, correspondingly, the lack of screening effects). Building on a theoretical framework and numerical simulations, we will also discuss the impact of external electric fields, as well as the formation of Rydberg states bound to color centers but extended over macroscopic distances. Finally, we will present recent results demonstrating NV charge state control with sub-diffraction resolution, and briefly discuss potential applications to high-density optical data storage in three dimensions.