Cold Rydberg Atoms near an Optical Nanofiber

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Optical nanofibers (ONF) are used to radially confine light in subwavelength dimensions. In ONFs, a large evanescent field extends beyond the fiber surface into the surrounding medium. These ONFs also have the distinct advantage of being readily integrable into experimental setups. One of the attractions of these fibers is their sensitivity to very low atom numbers within the evanescent field and hence the ability to use them as wavelength-dependent "detectors" for atoms or molecules.

Cold atomic gases are suited for exploring the quantum physics of many-body systems and for investigating quantum matter and exotic quantum phenomena. Here we will discuss advances in our current work on using cold Rydberg atoms trapped next to an optical nanofiber. Non-destructive detection methods via nonlinear processes, such as electromagnetically induced transparency (EIT), are used to detect the presence of the Rydberg states. The high polarizability of Rydberg states gives rise to stronger optical nonlinearities. We can make use of the extraordinary properties of Rydberg atoms in dense atomic gases to explore the realm of strongly-correlated, many-body physics. By combining laser cooling and trapping of atoms with the coherent excitation of Rydberg atoms from dense atomic gases, and interfacing the system using an ONF, we will be able to explore new aspects of Rydberg physics heretofore experimentally inaccessible. To date, effort on creating highly excited Rydberg atoms in the vicinity of a dielectric surface has been very limited, despite the advantages such a system can have in developing neutral atom-based quantum networks. Here we present our experimental result on creation of Rydberg atoms next to an ONF. A ladder type EIT [3] scheme is used for the creation and detection of the Rydberg atoms.

References

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