Ultra-Sensitive Force Measurements and Searches for New Physics with Laser-Trapped Dielectric Particles

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Despite the many successes of the Standard Model of particle physics, basic phenomena surrounding us remain without any satisfactory explanation, including the nature of Dark Matter and Dark Energy, which together make up 95 percent of the matter-energy content of our universe. Ultra-sensitive tabletop experiments are well suited to discover a wide range of new phenomena beyond the Standard Model, where feeble interactions require precision measurements rather than high energies. In high vacuum, optically levitated dielectric nanospheres can achieve excellent decoupling from their environment, making force sensing at the zeptonewton level (10^{-21} N) achievable.

In this talk I will describe our experimental efforts using dielectric objects supported by radiation pressure as precision sensors to search for quantum effects related to gravity, high-frequency gravitational waves and Dark Matter.