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"Trampoline" mechanical resonators for ultrasensitive force detection and optomechanics (plus some spin transfer)

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Mechanical systems are ubiquitous throughout society, from oscillators in timekeeping devices to accelerometers and electronic filters in automobiles and cell phones. They also comprise an indispensable set of tools for fundamental and applied science: using tiny mechanical elements, for example, it is possible to "feel around" surfaces at the atomic scale, and using human-scale masses, LIGO currently "listens" to gravitational waves emitted by violent events across the universe. In the field of optomechanics, we have exploited the forces exerted by radiation to gain a new level of control over these systems at all size scales.

In this talk I will discuss our recent efforts to create pristine mechanical sensors and manipulate/enhance them with laser light. We have fabricated nanogram-scale "trampolines" having extremely low damping parameters (ringing for six minutes when struck) and record low force sensitivities (below 20 attonewtons at room temperature). These trampolines also have excellent optical properties and are well-suited for optomechanical applications. Of note, the combined mechanical and optical parameters will provide access to a regime in which an extraordinarily small amount of light – at the level of a single photon – exerts a profound influence over the trampoline's trajectory. I will discuss progress toward optically levitating these (and related) devices to further improve their performance, discuss progress toward realizing a new and weird type of optomechanical interaction wherein light strongly influences the geometry and mass of a mechanical mode.

I will finish by briefly discussing an unrelated project to couple spin-transfer-controlled nanoscale magnetic circuits to atom-like defects in single-crystal diamond.

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