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CHAOTIC OPTOMECHANICAL RESONATORS

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Background: Chaos is considered hypersensitive to conditions of a system and is often thought to be unpredictable and difficult to explain. However, recent work has shown that chaos can be added as noise to improve amplification of weak signals through stochastic resonance. Stochastic resonance has been shown to occur in many physical and biological systems including electronics, sensory neurons, and nanomechanical oscillators. However, stochastic resonance has not been previously reported in optomechanical systems.

Technology Description: A novel method for generating chaotic weak optical fields through transfer of chaos from a strong optical field inside a microtoroid optomechanical resonator. In this pump (strong optical field) to probe (weak optical field) system, as the pump power increases, the signal-to-noise ratio of the probe first increased then decreased after a critical value. Below this critical value, increasing pump power results in an increase in the signal-to-noise ratio of both pump and probe fields (Figure a). A conceptual diagram of the mechanism for chaos-mediated stochastic resonance in our optomechanical system is shown in Figure b. To our knowledge, this is the first time that stochastic resonance has been demonstrated in an optomechanical system. In addition to signal enhancement, this technology may be useful for the secure transfer of quantum signals. When the pump power is increased to high levels (in blue, Figure c) the resonator chaotically vibrates and imprints the chaotic signal as an intensity modulation on the probe (Figure c). Since the probe signal (key) is a stream of entangled photons, one copy of the key can be kept locally while the other is distributed securely.