Ultra-stable optical cavities in KL FAMO for metrology and fundamental physics

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Ultra-stable optical laser cavities are among the most precise measuring instruments. Currently, they are indispensable components of atomic clocks and devices used in fundamental physics experiments, including searches for dark matter, tests of Lorentz invariance violation, constraints on quantum fluctuation amplitudes, gravitational wave detection, and searches for exotic particles beyond the Standard Model. Over the years, significant efforts have been made to improve the performance of ultra-stable cavities, including changing and optimizing the resonator's geometry, choosing less dissipative and noisy materials, and lowering and stabilizing the operating temperature. In my presentation, I will discuss the design of a room-temperature cavity with AlGaAs/GaAs mirror coatings and the approach to increase the short-term and long-term cavity stability. Moreover, I will present the idea of using ultra-stable cavities for gravitational wave detection and probing space-time fluctuations in the so-called space-time "foam" model.