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Compact High Sensitivity Optomechanical Inertial Sensors

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The Laboratory of Space Systems and Optomechanics (LASSO) at Texas A&M University is working to create novel, highly sensitive inertial sensors by combining our fused-silica optomechanical resonators with compact, high-precision interferometers. Our resonators have high mechanical quality factors and low thermal acceleration noise. Q's of 2.45 x 10^5 were previously achieved at mTorr pressures. This corresponds to an estimated thermal acceleration noise floor of 10^-10 m s^-2/√Hz at frequencies greater than 30 mHz. However, gas damping dominates losses at this pressure. We expect mechanical quality factors on the order of 10^6 and thermal acceleration noise levels of 10^-11 m s^-2/√Hz at lower pressures where gas damping is negligible. We are currently creating a vacuum set up to take Q measurements at these lower pressure ranges. These resonators will be incorporated with our compact high sensitivity displacement interferometer design, with the aim to read out test mass oscillations at picometer sensitivities. Current sensitivities at the sub-nm/√Hz level for sub-Hz frequencies are possible. By subtracting individual noise sources from our heterodyne interferometer bench-top prototype, sensitivities at the picometer level were reached for frequencies above 100 mHz. A compact mount that will hold the combined resonator and interferometer sensor system is being designed, and we hope to have a mount prototype to test with our fused-silica resonators by summer.

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