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Dual-wavelength laser frequency stabilization on a single ULE cavity for strontium Rydberg experiments[1] YI LU, JOSEPH WHALEN, SOUMYA KANUNGO, F. BARRY DUNNING, THOMAS KILLIAN, Rice University — A narrow-linewidth stable laser is crucial for both laser cooling and Rydberg-atom creation in cold atomic gases. Here we present a dual-wavelength laser frequency stabilization system based on a single ultra low expansion (ULE) reference cavity that is suitable for laser cooling on the strontium $^1S_0$-$^3P_1$ intercombination line and exciting atoms to the triplet Rydberg series. The standard Pound-Drever-Hall (PDH) technique is used to lock a 689nm diode laser and a 640nm optical parametric oscillator seeded by a 1064nm fiber laser. The 689nm laser is used for laser cooling on the $^1S_0$-$^3P_1$ line and also provides the first photon in the two-photon Rydberg excitation. The 640nm light is frequency doubled to excite the $^3P_1$ state to a Rydberg level. The frequencies of both lasers are tunable while locked by adjusting the offset frequencies (provided by electro-optic modulators) between the lasers and the cavity modes. A servo bandwidth of 1.2MHz is achieved for the 689nm system while the 640nm laser has a target lock bandwidth of 30kHz due to the slower response of the fiber master. Long-term drift of the ULE cavity is measured to be $\sim$25kHz/day and is compensated by continual offset-frequency adjustment.

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