RING DOWN SPECTROSCOPY WITH A BREWSTER'S ANGLE PRISM RESONATOR

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Cavity Ring Down Spectroscopy (CRDS) is an important spectroscopic technique with applications to science, industrial process control, and atmospheric trace gas detection. At present, this method is limited to spectral regions where one can obtain high reflectivity dielectric mirrors and there only over spectral tuning ranges of a few percent for a single set of mirrors. To overcome these limitations, we have designed, constructed, and tested an astigmatic prism ring resonator which utilizes total internal reflection to achieve high reflectivity, a curved prism face for optical stability, and reflective coupling near Brewster's angle to provide controlled finesse of the resonator. The resonator was excited with tunable 2 ps radiation from an optical parametric generator (OPG). The laser system produces nearly transform limited, 10 microJoule pulses at a 1 kHz repetition rate. In the range between 470 nm to 1.6 micrometers with a nitrogen purged air path of 1 meter, decay times of 10 - 23 microseconds were measured corresponding to as much as a 7 kilometer mean photon path length through the cavity. Atmospheric spectroscopy of weakly absorbing lines of oxygen and water vapor was demonstrated by allowing the OPG output, transmitted through the unpurged resonator, to fall on a CCD array in the focal plane of a 1 meter spectrograph. Additionally, the principal loss mechanisms that limit the radiative decay time for the prisms and their spectral dependence were measured. These include: scattering, stress induced birefringence, diffraction, and partial frustration of internal reflection.