THEORY OF DISPERSION EFFECTS IN CAVITY RING-DOWN SPECTROSCOPY

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We have recently published a formalism for the complete theory for linear cavity ring-down spectroscopy (CRDS). In this work, we use that formalism to investigate the effects of dispersion in CRDS. Previously, it has been assumed that dispersion effects are negligible in this spectroscopy for realistic levels of dispersion, given the small absorption coefficients of samples studied by CRDS. The present work confirms this assumption *if* one restricts detection to the decay of the intensity envelope of the cavity. However, if one want to properly model the changes in pulse shape of the pulse as it propagates inside the cavity, one must include not only the loss of cavity modes due to sample absorption but also the small shifts in cavity resonances due to dispersion. If the later effects are included, the time dependent output pulse in CRDS can be shown to reduce to a discrete Fourier Transform approximation of the familiar free space propagation equations of a linear absorber. Numerically calculations indicate that one can detect these pulse reshaping effects with high signal to noise. While in principle such experiments do not yield any information not available from the frequency resolved version of CRDS, there may be situations where such a detection method could be preferred for practical reasons. For example one can use the observed pulse reshaping determine the shape of a molecular absorption line from a single cavity decay, which could be useful in the study of flames and other highly unstable samples.