The Superposition Principle of Optics and Cavity Ring Down Spectroscopy

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Cavity Ring Down Spectroscopy is an important new spectroscopic tool that promises to be widely useful to gas phase spectroscopists. Unfortunately, the literature is rife with misstatements about spectrum of light inside the ring down cavity. These have arose from the belief that excitation of an optical resonator with a pulse of short coherence length is inherently a complex physical process that is difficult to describe. In this talk, we will demonstrate that the ring down cavity cell can be viewed as a high finesse etalon, and the spectrum of light that enters the cavity is confined to narrow Lorentzian lines near each cavity resonance. This result follows naturally from the superposition principle of optics, and is independent of the coherence properties of the input light, which only effect the distribution of cavity modes which are excited. A consequence of the strong filtering of light that enters the ring down cavity is that it should be possible, using a conventional single mode pulsed laser of a few nsec duration (and thus $\sim$ 300 MHz linewidth) to obtain spectra with much high resolution, limited only by the time of flight of molecules through the focus of the laser beam, which will be $\sim$ 1 MHz in most cases. In order to realize this advantage of cavity ring down, one will need to carefully control the matching of both the spatial and spectral modes of the cavity with the excitation laser. Expressions have been derived that allow the straightforward calculation of the excitation intensity of each cavity mode.