FINALLY – A CONVENTIONAL CONFOCAL FABRY-PÉROT AT SUB-THz FREQUENCIES

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Confocal Fabry-Pérot resonators are ubiquitous in spectroscopy throughout the optical region of the electromagnetic spectrum and are often used for cavity ring down or Cavity Enhanced Absorption Spectroscopy (CEAS). Their use in the sub-THz region, however, is uncommon due to the lack of spherical dichroic mirrors at these wavelengths. To get around this, sub-THz spectroscopists often employ multi-pass or unconventional cavity geometries. Some of these, use planar free-standing wire-grid polarizers to couple radiation into and/or out of the cavity. A few years ago, we demonstrated that it is simple to fabricate a concave wire-grid polarizer by lithographically patterning and etching copper that is adhered to the concave surface of a spherical plastic blank. By placing a matching pair of these spherical mirror/polarizers in a confocal geometry, we demonstrate cavity Qs on the order of 100,000. This simple open-resonator geometry favors the TEM_{00} mode of the field and allows us to pass a molecular beam directly through the cavity beam waste. Underscoring the increased sensitivity of this molecular beam setup, we readily observe the weak fine-structure band near 60 GHz from the magnetic dipole allowed transitions of molecular oxygen and their splitting in the earth's magnetic field. While the setup is simple, the resulting saturated absorption/dispersion signals are surprisingly complex. At molecular beam temperatures and densities, sub-THz CEAS signals display comparable Doppler, pressure, and transit-time broadening effects. This is complicated further by the dramatic dispersion effects the molecular beam has on the cavity mode resonance. This talk will give a brief overview of the cavity and then focus on the theory for modelling and fitting the sub-THz CEAS signals.