Abstract Submitted
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**Sensitive photoacoustic trace gas detection with a moving optical grating**[1] WENYU BAI, LIAN XIONG, Brown Univ, FEIFEI CHEN, FAPENG YU, XIAN ZHAO, Shandong Univ, GERALD DIEBOLD, Brown Univ — Examination of the wave equation for the photoacoustic effect shows that photoacoustic waves can be excited by steady motion of a heating source. Compared with the traditional excitation methods such as the pulsed or amplitude-modulated laser excitation, photoacoustic waves launched by moving sources permits greater sound controllability, higher input radiation energy, and most importantly, the possibility of achieving optimal optical to acoustic energy conversion efficiency. In this talk, we first show that in the linear acoustic regime when a laser source moves at the sound speed in a one-dimensional geometry, the amplitude of the acoustic wave grows linearly in time without bound. Second, use of this principle is described for trace detection of gases using two frequency shifted beams from a $CO_2$ laser directed at an angle to each other to give optical fringes that move at the sound speed in a cavity with a longitudinal resonance. The photoacoustic signal is detected with a high $Q$, piezoelectric crystal with a resonance on the order of 443 kHz. As the grating frequency, the length of the resonator, and the crystal must all have matched frequencies, three resonances are used to advantage to produce sensitivity that extends to the parts-per-quadrillion level.

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