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Sensitive Detection of Molecules by Sub-Doppler Nonlinear Laser Wave-Mixing Spectroscopy JORGE JIMENEZ, MARC GREGERSON, TIFFANY NEARY, MARCEL HETU, MANNA IWABUCHI, WIILIAM G. TONG

— Nonlinear multi-photon laser wave-mixing spectroscopy is presented as a sensitive optical detection method for trace-concentration analysis of liquid- and solid-phase chemicals using simple capillary flow cells and glass slides as sample holders. Wave mixing offers inherent advantages over other detection methods including excellent detection sensitivity levels even when using micrometer thin analyte cells and high spatial resolution levels suitable for capillary flow cells and microfluidic systems and single bio-cell analyses. In a typical wave-mixing setup, two excitation laser beams are focused and mixed to create dynamic gratings inside the analyte. The incoming photons are then scattered off these gratings to create a signal beam that is characteristic of the analyte. Since the signal beam is a coherent laser-like beam, the optical detection efficiency is very high and the signal-to-noise ratio is excellent. By using counter-propagating input beams, wave mixing offers sub-Doppler spectral resolution that is suitable for isotope analysis. The wave-mixing signal has a cubic dependence on laser power, and hence, one can efficiently use low laser power levels available from compact solid-state lasers.

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