COMPARISON OF TWO EXPERIMENTAL ARRANGEMENTS FOR INFRARED-MICROWAVE DOUBLE-RESONANCE SPECTROSCOPY IN ELECTRIC-RESONANCE OPTOTHERMAL SPECTROMETERS

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We have evaluated the infrared-microwave double-resonance capabilities for two experimental arrangements in electric-resonance optothermal spectrometers. In the method originally developed by A.S. Pine and G.T. Fraser at NIST, Gaithersburg, the infrared and microwave radiation is applied before the state-focusing device. In this configuration, the double-resonance mechanism is based on the spectroscopic and state-focusing properties of the dressed states of the molecule in the presence of a strong, resonant microwave field. Detection of double-resonance spectra in this configuration requires monitoring the total molecular beam flux exiting the state-focusing device. This detection requirement limits the general application of this technique to other spectroscopic detection methods such as fluorescence detection or direct absorption. Alternatively, the spectroscopy can be performed following the state-focusing device. In this configuration, the double-resonance mechanism is based on the alteration of rotational level populations in the usual "maser-like" manner. We find that this second arrangement achieves comparable sensitivity and maintains the double-resonance capabilities and the spectral resolution of the Pine-Fraser arrangement. This "post-quadrupole" arrangement has several advantages for molecular-beam spectroscopy and is compatible with other detection methods.