N_2 ROTATIONAL TEMPERATURE ANALYSIS BY LASER INDUCED FLUORESCENCE FOLLOWING RESONANT ENHANCED MULTIPHOTON IONIZATION *

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It has been demonstrated that the rotational temperature of molecular nitrogen at atmospheric pressure can be determined by direct optical probing of the N_2 (X,v=0) ground state with subsequent analysis of the rotational state distribution. A tunable probe laser was scanned over resonant enhanced multi-photon ionization transitions initiating from various N_2 (X,v=0, J) states. At atmospheric pressure, the laser photo-ionization also induced nitrogen fluorescence bands. Analysis of the relative fluorescence as a function of laser wavelength produced a calculated N_2 (X,v=0, J) rotation state distribution and the assignment of a rotational temperature.

This laser-based temperature probe may be more accurate and applicable in more environments than optical emission spectroscopy (OES), which is commonly applied as a passive remote temperature measurement technique. OES most often involves the analysis of the N_2 (C–B) emission bands, or the second positive system, where the rotational temperature is typically determined from a contour analysis of the unresolved rotational structure. OES analysis can be acceptable, but requires that (*i*) the nitrogen gas is electronically excited so that optical emission is observable and (*ii*) the rotational distribution of the N_2 (C) state is a Boltzmann distribution and it has the same distribution as the N_2 (X,v=0) ground state. The rotational temperature measurement technique introduced in this work involves remote sensing with a laser probe and can be applied to a more broad variety of nitrogen systems in thermal equilibrium or non-equilibrium, such as hot gases, flames, or atmospheric plasmas.

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