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Investigation of difference between the rotational temperatures of ground and excited electronic states in a recombining nitrogen plasma at atmospheric pressure AUGUSTIN TIBERE-INGLESSE, SEAN MCGUIRE, CHRISTOPHE LAUX, Laboratoire EM2C, CentraleSupelec — We report on a fundamental study of a recombining nitrogen plasma at atmospheric pressure, evidencing strong differences between the rotational temperatures of the ground and excited electronic states. The experiments were conducted using the CentraleSupélec 50-kW plasma torch to provide an equilibrium nitrogen plasma at about 7000 K and 1 atm. The plasma was then forced to recombine rapidly by flowing through a water-cooled tube. At the exit of the tube, we performed Raman and Optical Emission Spectroscopy measurements of the ground and excited electronic states of N_2. The rotational temperature of $N_2(X)$, is found to be 3200 K. The rotational temperature of $N_2(C)$ agrees with this temperature. In contrast, the rotational temperature of $N_2^+(B)$ is higher, at 4600 K. The density of ground state atomic nitrogen was also indirectly measured and found to be nearly frozen in the tube. Therefore, it is strongly overpopulated with respect to its density at 3200 K at the exit of the tube. A clear relation is established between the overpopulation of atomic nitrogen and the difference between the rotational temperatures of $N_2(X)$ and $N_2^+(B)$. Comparisons with CFD code show that the simulations are unable to predict the measured temperature decrease in this nonequilibrium situation.

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