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Rotational temperature measurements of the Princeton FRC using non-optical electron-impact excitation selection rules[1] D.R. FARLEY, Innovative Energy Concepts, S.A. COHEN, Princeton Plasma Physics Laboratory — Spectroscopic rotational temperature measurement techniques are often used in molecular gas dynamics and generally can be related to the gas translational temperature. Many authors assume a low-mass electron cannot significantly disturb the molecular rotational level distribution, enforcing a rotational selection rule $\Delta K = 0$. Others believe optical selection rules apply ($\Delta K = 0, \pm 1$). In either case, these selection rules allow for the use of simple Boltzmann plots to estimate the rotational temperature. However, rotational transitions for $\Delta K > 1$ are in fact allowed by molecular symmetries and dipole selection rules. It has been found through this study that these larger transitions ($\Delta K = \pm 2$) for the hydrogen Fulcher- α emission (H_2 $d^3\Pi_u \rightarrow a^3\Sigma_g^+$) can affect the rotational distributions by up to 40% for $K = 5$ upper rotational states and also results in inferred rotational temperatures about 30% lower than would be obtained with Boltzmann plots and optical selection rules. This broader use of non-optical selection rules is applied to measuring rotational temperatures radially across the plasma column of the Princeton Field-Reversed Configuration device at a variety of pressures.

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David Farley
Innovative Energy Concepts

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