C_3 EXCITATION PROFILES IN DIFFUSE INTERSTELLAR CLOUDS

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The very high-resolution ($R > 80,000$), very high signal-to-noise ($S/N > 1000$), optical (4051Å) spectrum of the carbon-chain molecule C_3 is reported for 10 diffuse interstellar clouds, demonstrating the possibility for detailed study of polyatomic molecules in the diffuse interstellar medium (ISM). Thus far, C_3 is the largest identified molecular species to be observed in absorption in the diffuse ISM. The first detection of C_3 toward three stars (Maier et al., 2001) contained a single spectrum of sufficient quality to show a non-thermal equilibrium rotational excitation profile. This data was adequately modeled with a two-temperature thermal distribution. Rotationally resolved C_3 was then measured in one additional source, and a detailed radiative balance model was used to analyze the data (Roueff et al., 2002). A low resolution survey (Oka et al., 2002) has measured the column densities of C_3 in roughly 30 targets, laying the groundwork for high resolution observations. We present rotationally resolved and very high signal-to-noise spectra taken with the HIRES spectrometer on the 10-m Keck telescope and with the Hamilton echelle spectrometer on the Shane 3-m Lick Observatory telescope. The measurements allow for a detailed analysis of the C_3 molecular excitation in a variety of diffuse interstellar environments. The observed excitation profiles are modeled using 1) thermal distributions incorporating either one or two kinetic temperatures and 2) a new technique involving a least squares fit of the entire spectrum using the population in each rotational level as a fit parameter. We discuss how these observations constrain our understanding of the various environments in these sightlines, correlation between C_2 and C_3, and the prospects for the study of larger polyatomic molecules in the diffuse ISM.