THE TRANSITION FROM DIFFUSE ATOMIC GAS TO MOLECULAR CLOUD IN TAURUS

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We study four lines of sight that probe the transition from diffuse molecular gas to molecular cloud material in Taurus. Measurements of atomic and molecular absorption are used to infer the distribution of species and the physical conditions in the direction to stars behind the Taurus Molecular Cloud. New high-resolution spectra at visible and near infrared wavelengths of interstellar K I, CH, CH^+, C_2, CN, and CO toward HD 28975 and HD 29647 are combined with published results for HD 27778 and HD 30122. Gas densities and temperatures are inferred from analyses of C_2, CN, and CO excitation. Our results for HD 29647 are noteworthy in that the CO column density is 10^{18} cm^{-2}, our analysis of CO and C_2 excitation reveal a temperature of 10 K and densities of about 1000 cm^{-3}, and the CO excitation and radiation temperatures are the same, more like emission-line studies of dark molecular clouds. Similar results arise from our chemical analysis leading to CN through reactions involving the observed species CH and C_2. The other directions are typical of molecule-rich diffuse clouds and can be considered CO-dark gas.