The ORFEUS Survey of Interstellar Molecular Hydrogen

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The hydrogen molecule plays a central role in a variety of processes that significantly influence the chemical and physical state of the interstellar medium. The EUV/FUV Berkeley spectrometer on the ORFEUS I/II mission is used to survey the column densities of interstellar H2 in the J = 0-5 rotational levels of the v″ = 0 vibrational state toward 67 early-type stars. High-resolution optical observations of Na I are used to constrain the distribution and velocity of molecular clouds along each line of sight. In most cases, the H2 lines exhibit strong absorption damping wings; and column densities are derived by fitting damping profiles to the observed spectra. For stars with N(H2) larger than 1018 atoms cm-2, the N(1)/N(0) population ratio provides a direct measure of cloud kinetic temperature T01. The value of T01 ranges from 21K to 232K, with an average over 44 stars of 89±22 (rms) K. It is found that the fraction of H2, f = 2N(H2)/[2N(H2)+N(H I)], is correlated with E(B-V), the optical reddening, as well as with N(H I + H2), the total hydrogen column density, confirming the previous results of Savage et al. by the Copernicus survey measurements. There is a trend that disk stars, of which galactic height z is smaller than 500 pc, have more uniform and higher values (~ 0.1) of f than halo stars. When N(4)/N(0) is dominated by UV photon pumping in the clouds, it is expected that N(4)/N(0) is anticorrelated with f for most stars. Considering the self-shielding effect per each cloud, the UV photon density outside the clouds can be obtained. We will also discuss CO abundance ratio to molecular hydrogen, which is a key to understand the mass, size and evolution of molecular clouds in the ISM.