ANALYSIS OF OH^+, H_2O^+, AND H_3^+ IN A DIFFUSE MOLECULAR CLOUD TOWARD W51

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Absorption lines from the molecules OH^+, H_2O^+, and H_3^+ have all been observed in a diffuse molecular cloud along a line of sight near W51 IRS2. We present the first chemical analysis that combines the information provided by all three of these species. Together, OH^+ and H_2O^+ are used to determine the molecular hydrogen fraction ($f_{\rm H_2}$) in the outskirts of the observed cloud, as well as the product of the cosmic-ray ionization rate of atomic hydrogen and an efficiency factor ($\epsilon\zeta_{\rm H}$). The efficiency factor (ϵ) describes what fraction of the time ionization of H by cosmic rays eventually leads to OH^+. H_3^+ is used to infer the cosmic-ray ionization rate of H_2 (ζ_2) in the molecular interior of the cloud. By demanding that the two ionization rates are equal, and taking the value inferred from H_3^+ to be correct, we determine ϵ. This is an important step in the future use of OH^+ and H_2O^+ on their own as tracers of the cosmic-ray ionization rate.