*HERSCHEL*/HIFI IDENTIFICATION OF $HCl^+$ IN THE INTERSTELLAR MEDIUM

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The radical ion $HCl^+$, a key intermediate in the chlorine chemistry of the interstellar gas, has been identified for the first time in the interstellar medium with the *Herschel Space Observatory's* Heterodyne Instrument for the Far-Infrared. The ground state rotational transition of $H^{35}Cl^+$, $^2\Pi_{3/2}$ $J = 5/2 - 3/2$, showing $\Lambda$-doubling and hyperfine structure, is detected in absorption toward the bright Galactic submillimeter-wave continuum regions, W31C (G10.6-0.4) and W49N. The complex interstellar absorption features are modeled by convolving in velocity space the opacity profiles of other molecular tracers of the same sources with the fine and hyperfine structure of $HCl^+$ derived from a combined analysis of recent high-resolution submillimeter-wave measurements and optical data from the literature. The models reproduce well the interstellar absorption, and the frequencies inferred from the astronomical observations are in exact agreement with those calculated from spectroscopic constants derived from the laboratory data. The detection of $H^{37}Cl^+$ toward W31C, with a column density consistent with the expected $^{37}Cl$ abundance, provides additional evidence for the identification. These observations also yield the surprising result that $HCl^+$ accounts for nearly $3 - 5\%$ of the gas-phase chlorine toward W31C and W49N, values several times higher than the maximum fraction ($\sim 1\%$) predicted by chemical models.

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