THE ROTATIONAL SPECTRUM OF HCl^+

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The rotational spectrum of the radical ion HCl^+ has been detected at high resolution in the laboratory, supporting conclusively the identification of this ion with the *Herschel Space Observatory's* Heterodyne Instrument for the Far-Infrared (HIFI) in diffuse clouds toward the Galactic star-forming regions W31C and W49N. Three rotational transitions, one in the ground state $^2\Pi_{3/2}$ ladder and two in the $^2\Pi_{1/2}$ ladder (643 cm^{-1} above ground), were observed in a microwave discharge of He and HCl. Well-resolved chlorine hyperfine structure and Λ-doubling, and the detection of lines of $H^{37}Cl^+$ at precisely the expected isotopic shift, provide conclusive evidence for the laboratory identification. The detection of rotational transitions in the $^2\Pi_{1/2}$ ladder of HCl^+ for the first time allows an experimental determination of the individual hyperfine coupling constants of chlorine, and yields a precise value of eQq_2. The spectroscopic constants determined by fitting a Hamiltonian simultaneously to our data and more than 8000 optical transitions are so precise, that they allow calculation of the frequencies of $^2\Pi_{3/2}$ $J = 5/2 - 3/2$ transition observed by HIFI to within 0.2 km s^{-1}, and indeed, those of the strongest rotational transitions of HCl^+ below 7.5 THz to better than 1 km s^{-1}.

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