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Assignment of resonances in dissociative recombination of HD+ ions: high-resolution measurements compared with accurate computations

F. O. Waffeu Tamo (1,2,3), H. Buhr (4,5), O. Motapon (6), S. Altevogt (4), V. M. Andrianarijaona (4), M. Grieser (4), L. Lammich (4), M. Lestinsky (4), M. Motsch (4), I. Nevo (5), S. Novotny (4), D. A. Orlov (4), H. B. Pedersen (4), D. Schwalm (4), F. Sprenger (4), X. Urbain (7), U. Weigel (4), A. Wolf (4), I. F. Schneider (1) ((1) Université du Havre, France, (2) CEPAMOQ, University of Douala, Cameroon, (3) Observatoire de Paris, France, (4) Max-Planck-Institut für Kernphysik, Heidelberg, Germany, (5) Weizmann Institute of Science, Rehovot, Israel, (6) LPF, University of Douala, Cameroon, (7) Université catholique de Louvain, Belgium)

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The collision-energy resolved rate coefficient for dissociative recombination of HD+ ions in the vibrational ground state is measured using the photocathode electron target at the heavy-ion storage ring TSR. Rydberg resonances associated with ro-vibrational excitation of the HD+ core are scanned as a function of the electron collision energy with an instrumental broadening below 1 meV in the low-energy limit. The measurement is compared to calculations using multichannel quantum defect theory, accounting for rotational structure and interactions and considering the six lowest rotational energy levels as initial ionic states. Using thermal equilibrium level populations at 300 K to approximate the experimental conditions, close correspondence between calculated and measured structures is found up to the first vibrational excitation threshold of the cations near 0.24 eV. Detailed assignments, including naturally broadened and overlapping Rydberg resonances, are performed for all structures up to 0.024 eV. Resonances from purely rotational excitation of the ion core are found to have similar strengths as those involving vibrational excitation. A dominant low-energy resonance is assigned to contributions from excited rotational states only. The results indicate strong

modifications in the energy dependence of the dissociative recombination rate coefficient through the rotational excitation of the parent ions, and underline the need for studies with rotationally cold species to obtain results reflecting low-temperature ionized media.

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