AU Neau, A, Al Khalili, A, Rosen, S, Le Padellec, A, Derkatch, AM, Shi, W, Vikor, L, Larsson, M, Semaniak, J, Thomas, R, Nagard, MB, Andersson, K, Danared, H, af Ugglas, M
TI Dissociative recombination of D3O+ and H3O+: Absolute cross sections and branching ratios
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AB Dissociative recombination of the polyatomic ions D3O+ and H3O+ with, electrons have been studied at the heavy-ion storage ring CRYRING (Manne Siegbahn Laboratory, Stockholm University). Absolute cross sections have been determined from 0.001 eV to 0.25 eV center-of-mass energy for D3O+ and from 0.001 eV to 28 eV for H3O+. The cross sections are large (7.3x10(-13) cm(2) for D3O+ and 3.3x10(-12) cm(2) for H3O+ at 0.001 eV). At low energies, the cross sections for D3O+ are E-1 energy dependent whereas it is slightly steeper for H3O+. A similar E-1 energy dependence was also observed by Mul [J. Phys. B 16, 3099 (1983)] with a merged electron-ion beam technique for both H3O+ and D3O+ and by Vejby-Christensen [Astrophys. J. 483, 531 (1997)] with the ASTRID storage ring in Denmark, who presented relative cross sections for H3O+. A resonance has been observed around 11 eV for H3O+. It reflects an electron capture to Rydberg states converging to an excited ionic core. A similar structure was reported by Vejby-Christensen Our absolute measurements are in fairly good agreement with those from Mul, which were first divided by 2 (Mitchell, 1999, private communication) and from Heppner [Phys. Rev. A 13, 1000 (1976)] for H3O+. Thermal rates were deduced from the measured cross sections for electron temperatures ranging from 50 K to 30 000 K. At 300 K, the thermal rate is equal to 7.6x10(-7) cm(3) s(-1) for H3O+ and to 3.5x10(-7) cm(3) s(-1) for D3O+. Complete branching ratios for all the possible product channels have been determined from 0 eV to 0.005 eV center-of-mass energy for D3O+ and at 0 eV for H3O+, using a well-characterized transmission grid in front of an energy-sensitive surface-barrier detector. No isotope effect was observed within the experimental uncertainties. The three-body break-up channel OX+X+X (where X stands for H or D) is found to occur for 67%-70% of the dissociations. Water or heavy water is produced with an 18%-17% probability and the production of oxygen atoms is negligible. These results support the three-body break-up dominance already found by Vejby-Christensen for the DR of H3O+ in a similar heavy-ion storage ring experiment. However, even if the general trend is the same for both storage rings, significant differences have been observed and will be discussed. (C) 2000 American Institute of Physics. [S0021- 9606(00)01229-0].
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