Water chemistry in comet comae in support of spacecraft missions

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Water chemistry is central in understanding the physics and chemistry of comets. It is a major source of ions and electrons that further initiate key gas-phase reactions, leading to the plethora of molecules and atoms seen in cometary atmospheres. The relevant physico-chemical processes are identified within a modeling framework to understand *in situ* measurements of comets from spacecraft missions (e.g., Halley, Borrelly, Tempel 1, Wild 2) and to provide valuable insights into the intrinsic properties of their nuclei [Rodgers, S.D., Charnley, S.B., Huebner, W.F., and Boice, D.C. "Physical Processes and Chemical Reactions in Cometary Comae," in Comets II, Festou, Keller, Weaver, (eds.), Univ. Arizona Press, pp. 505-522 (2005)]. Details of these processes are presented, from the collision-dominated inner coma to the solar wind interaction region. The results include thermodynamics (e.g., temperature and velocity structure) and photo- and gas-phase chemistry (e.g., composition, gas and electron energetics) throughout the cometary atmosphere. The effects of photoelectrons that react via electron impact reactions are important to the overall ionization, as originally discussed by Boice et al. [*Geophys. Res. Lett.* **13**, 381 (1986)] and recently revisited by Bhardwaj [*Geophys. Res. Lett.* **30**, 2244 (2003)] and Boice and Wegmann ["Modeling Comet 19P/Borrelly for the Deep Space 1 Encounter," *Highlights of Astronomy* **13**, in press (2006)]. This extensive modeling effort to investigate these important cometary processes is highly relevant to past, on going, and future spacecraft missions to comets.