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Modeling the neutral gas and dust coma of Comet 1P/Halley

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The neutral gas environment of a comet is largely influenced by dissociation of parent molecules created at the surface of the comet and collisions of all the involved species. We compare the results from a kinetic model of the neutral cometary environment with measurements from the Neutral Mass Spectrometer (NMS) and the Dust Impact Detection System (DIDSY) onboard the Giotto spacecraft which flew-by at comet 1P/Halley in 1986. We further show that our model is in good agreement to measurements obtained by the International Ultraviolet Explorer (IUE), sounding rocket experiments, and the International Halley Watch (IHW). The model solves the Boltzmann equation with a Direct Simulation Monte Carlo technique [Tenishev et al. (2008, Astrophys. J., 685, 659-677)] by tracking trajectories of gas molecules and dust grains under the influence of the comet's weak gravity field with momentum exchange among particles modeled in a probabilistic manner. The cometary nucleus is considered to be the source of dust and the parent species (in our model: H_2O, CO, H_2CO, CO_2, CH_3OH, C_2H_6, C_2H_4, C_2H_2, HCN, NH_3, and CH_4) in the coma. Subsequently our model also tracks the corresponding dissociation products (H, H_2, O, OH, C, CH, CH_2, CH_3, N, NH, NH_2, C_2, C_2H, C_2H_5, CN, and HCO). This work has been supported by JPL subcontract 1266313 under NASA grant NMO710889, NASA planetary atmospheres program grant NNX09AB59G, grant AST-0707283 from the NSF Planetary Astronomy program, and the Swiss National Science Foundation.