Multi-fluid Modelling of the Cometary Atmosphere

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Abstract: Comets are icy bodies that reside in the outer regions of the Solar System. The primary volatile present in cometary ice is water, along with CO, CO_2, NH_3, and other volatiles. When a comet approaches the Sun, sublimation of the volatiles occurs, resulting in the formation of the surrounding coma. The dominant component in the coma is generally water vapour, particularly at smaller heliocentric distances (< 2 AU). At further distances, species such as CO may dominate, as these have higher vapour pressure than water and sublimate faster[1]. In this work, we assume a cometary nucleus made up of assorted primary cometary ices like H_2O, CO_2, and N_2. These primary volatile species sublimate, and undergo photodissociation due to solar UV radiation, resulting in the formation of secondary species. The products of photolytic decomposition also react with each other. All of these species form the coma and expand outward. In the inner regions of the coma ($< 10^4$ km), the density is high enough to adopt a fluid approach for the gas. A multi-fluid approach is considered, such that the neutral species evolve differently from the atomic hydrogen and the electrons. The equations for the conservation of number density, momentum, and energy are used to describe the evolution of the coma with cometocentric distance[2]. Numerical integration of these equations is done to obtain the radial profile of the temperature, velocity, and number densities of the different species.

References:

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