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Revisiting Cometary Bow Shock Positions

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The interaction region between the exosphere of a comet and the solar wind reveals a variety of plasma structures and boundaries which are predicted by several plasma models and/or have been observed by a spacecraft mission, e.g. by the GIOTTO mission to comet 1P/Halley and 26P/Grigg-Skjellerup. With regard to the arrival of the next cometary spacecraft mission ROSETTA at its target comet 67P/Churyumov-Gerasimenko (CG), it is necessary to develop models of the estimated positions of the different plasma boundaries. This knowledge will be used for the mission planning of the ROSETTA mission in order to prepare the required trajectories for the measurements, to ensure the scientific success of this unique mission.

One of the boundaries in the interaction region, which is of particular interest for the mission planning, is the bow shock, where the supersonic flow is strongly decelerated to subsonic velocities. This boundary has been first predicted by Biermann et al. [1967]. They used a one-dimensional hydrodynamical model to describe the plasma flow in front of the bow shock. As a result, they ascertained that the velocity of the plasma decreases during the injection of mass into the flow. Furthermore, they found a point at which the mean molecular weight of the plasma normalised by proton mass reaches the critical value of 4/3. Hence, Biermann et al. [1967] suggested that the bow shock is located at this position. For typical solar wind conditions at 1.3 AU and a gas production rate of $5 \cdot 10^{27}$ 1/s this point would be 5557 km in front of comet CG. However, more recent numerical simulation results of Hansen et al. [2007] and Gortsas et al. [2010] for the same set of parameters forecast distances of 3500 km and 1764 km, respectively.

Using the A.I.K.E.F. hybrid code, we present detailed further simulations and determinations of the bow shock stand-off distance. Deviations from the earlier results by Biermann et al. [1967] are discussed and explained.