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The Ion Tails of Comets

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Abstract Examination of the light emitted from the tails of comets shows that one component of the tail consists of ionised gas (plasma) originating from the comet's atmosphere (or 'coma'). The tail plasma streams away from the comet in the direction radially away from the Sun, and appears to flow along magnetic field lines which are shaped like sharply-bent hair-pins draped over the comet's nucleus. Here we review some features of the environment of a comet which may lead to an understanding of this phenomenon.

1. The nucleus of a comet consists of a ball of ice (and embedded dust) typically a few km in diameter. When the nucleus nears the Sun on its orbit, the surface layers are warmed, to ~300 K near the Earth's orbit, and because of the low gas pressure the ice then sublimes directly to gas. The gas expands slowly (~1 km s^{-1}) away from the nucleus, forming an extended atmosphere around it, called the 'coma'.

2. The nucleus lies in the solar wind plasma which flows radially away from the Sun. The solar wind carries with it magnetic field from the Sun, which is 'frozen into' the flow. There is correspondingly an electric field in the flow, given by $\boldsymbol{E}_{SW} = -\boldsymbol{V}_{SW} \times \boldsymbol{B}_{SW}$. One configuration is shown in Figure 1.

3. Because the solar wind and coma are such tenuous gases, particle collisions are very infrequent indeed, so that initially one might suppose that the solar wind would blow right through coma without really noticing it. However, it occurs to us that some atoms in the coma may be ionised by UV radiation from the Sun, forming ions and electrons which will then 'notice' the electric and magnetic fields of the solar wind. We suggest that it would be worthwhile to examine how these charged particles will move after ionisation, and what effect this could have on the plasma flow and 'frozen in' magnetic field. We conjecture that such studies might lead to an understanding of the existence and nature of the plasma tails of comets.

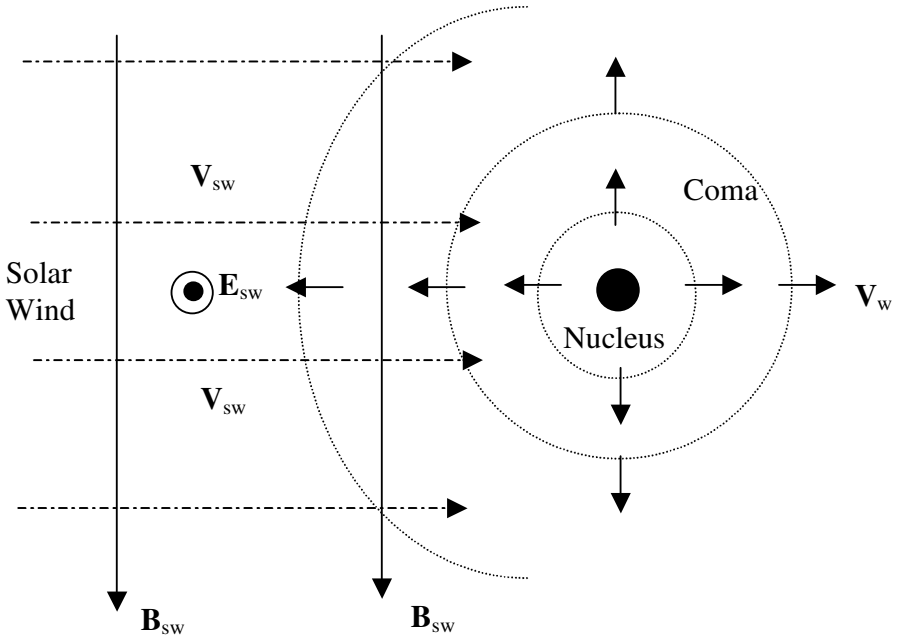

Figure 1. The solar wind plasma and frozen-in magnetic field blows directly through the coma of a comet.