Supporting Information for "Solar Wind Protons forming Partial Ring Distributions at Comet 67P"

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Introduction

This supporting information contains an additional angular plot with a dual colourmap for the reference case. It also contains an overview plot of the spacecraft position in magnetic field coordinates.

Figure S1. Reference case - Angular plots

Figure S1 shows the angular distribution of protons and alpha particles as measured by ICA during our reference case (April 23rd, 2016, at 11:32). The lower median energy of the protons could be due to a slower upstream solar wind, or due to a higher electrostatic

potential difference from the observation point to the upstream solar wind. As the alpha particles are also observed at much lower energies, the dominating influence seems to be the upstream solar wind conditions (Nilsson et al., 2022). The signal to the left in the upper panel is an instrumental effect (cross-talk) and not a real signal.

Figure S2. Spacecraft position in magnetic field coordinates

To define the magnetic / electric field coordinate system we aligned the x-axis with the sunward direction as an approximation for the negative upstream solar wind flow direction. For the y-axis, which is usually aligned along the magnetic field component perpendicular to the velocity in this coordinate frame, we used the local magnetic field measured by MAG for both cases (see green markers in figure S2). Additionally, we also used the estimated ring parameter $\mathbf{u}_{bulk,\parallel}$ to provide an alternative estimate of the magnetic field direction. The results of using the component of $\mathbf{u}_{bulk,\parallel}$ perpendicular to the x-axis is shown with red markers in figure S2. The z-axis completes the right-hand system and is along the convective electric field ($\mathbf{E} = -\mathbf{v} \times \mathbf{B}$). The $+E$- and $-E$-hemispheres are found at $z > 0$ and $z < 0$.

On both days the majority of data points are at $z > 0$, but the spread is significant, especially for the partial rings case when using the local magnetic field measurements. Using the $\mathbf{u}_{bulk,\parallel}$ estimate instead of the MAG measurements significantly reduces the spread to about half of the angular variation.

References

Nilsson, H., Moeslinger, A., Williamson, H. N., Bergman, S., Gunell, H., Wieser, G. S., ... Holmström, M. (2022, 3). Upstream solar wind speed at comet 67p: Reconstruction method, model comparison, and results. *Astronomy and Astrophysics*, *659*. doi:

10.1051/0004-6361/202142867

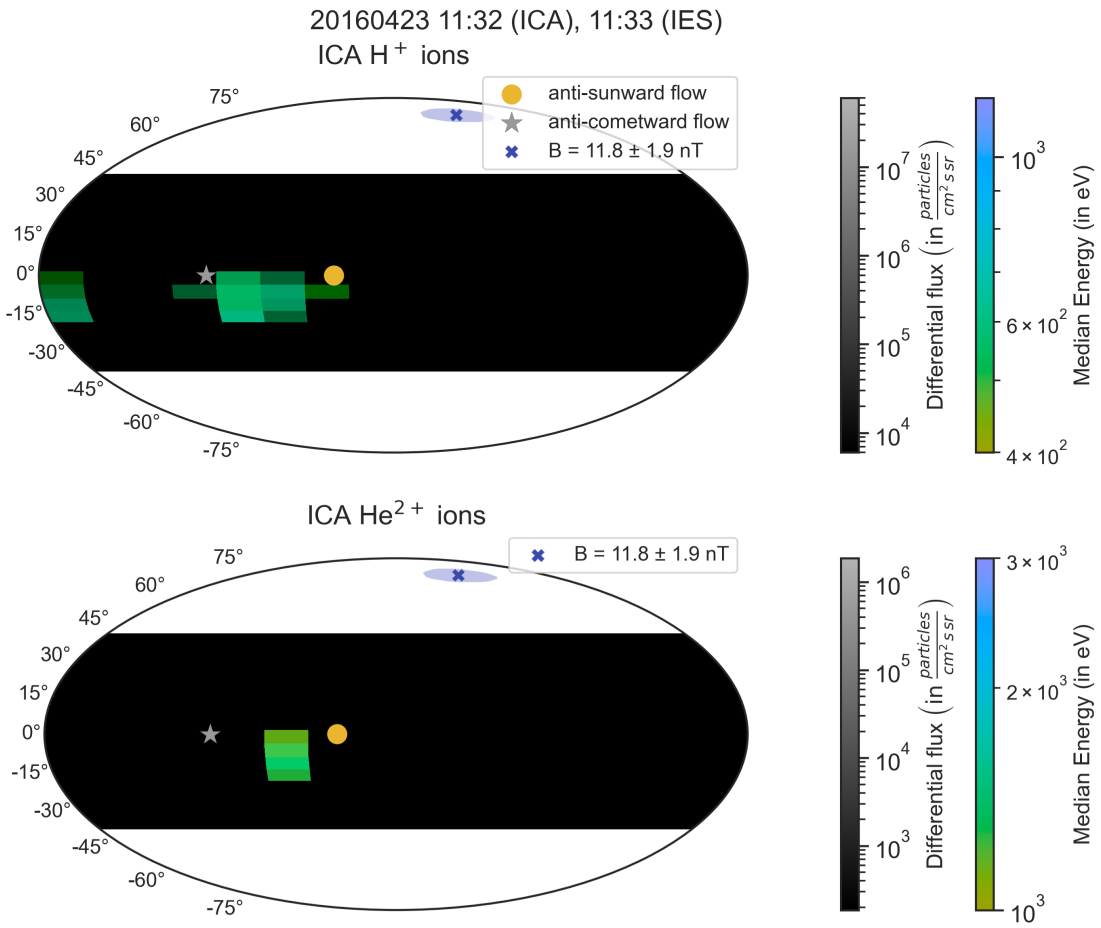

Figure S1. Azimuth - Elevation plots of a single scan during our reference case (April 23rd, 2016, at 11:32). The format is the same as in figure 5 in the main text, but no ring fits are shown.

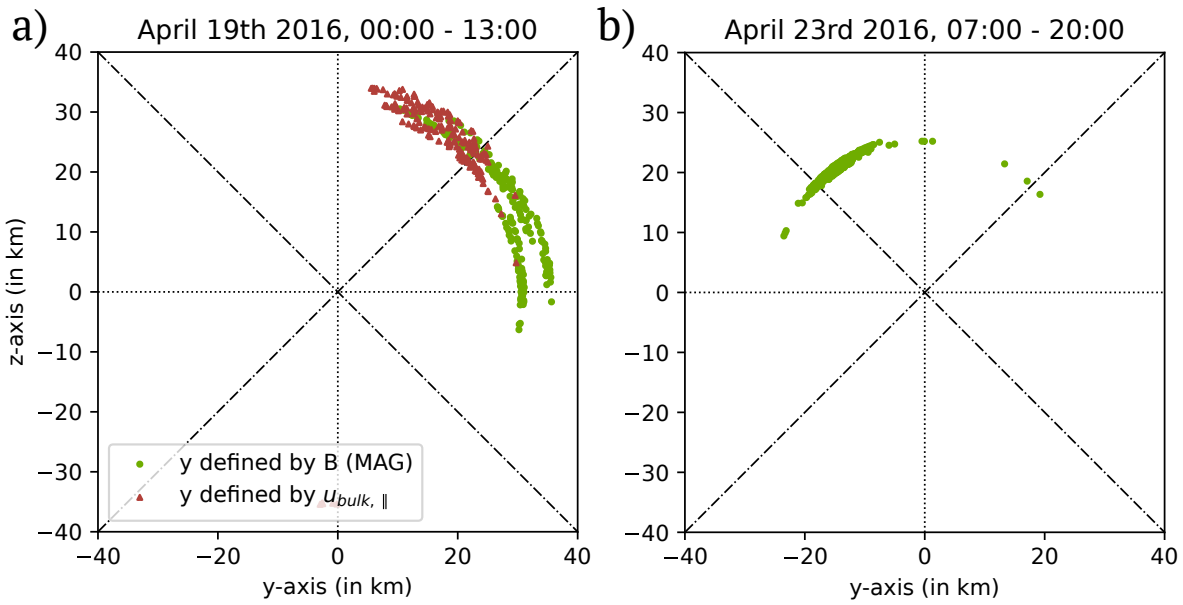

Figure S2. Spacecraft position in magnetic field coordinates projected into the y-z plane. Panel a) shows data for our main case with partial rings, and panel b) for the reference case.