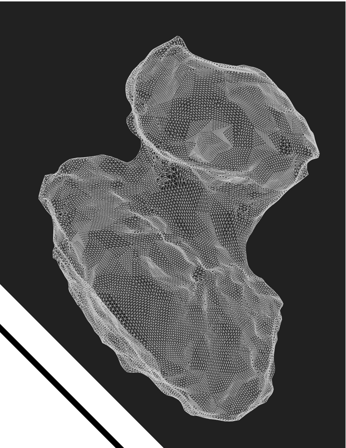
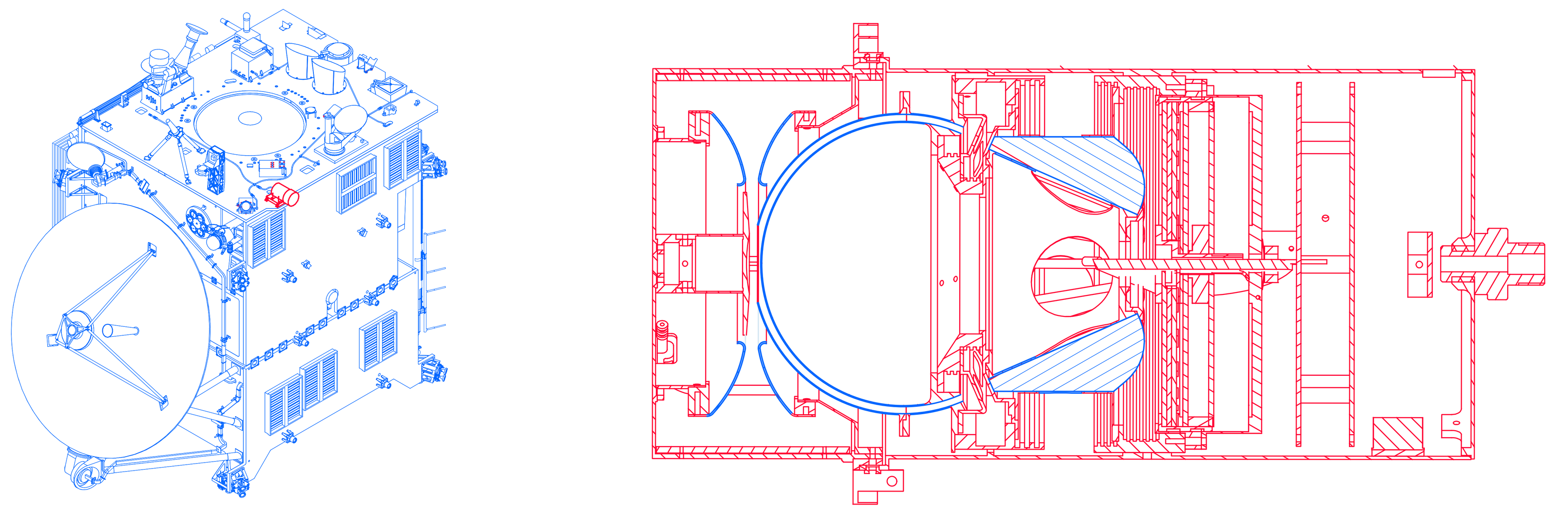
Mass-loading of the solar wind around 67P/CG seen by RPC-ICA

E. Behar, H. Nilsson, G. Stenberg Wiseser, R. Ramstad
the RPC team
Swedish Institute of Space Physics

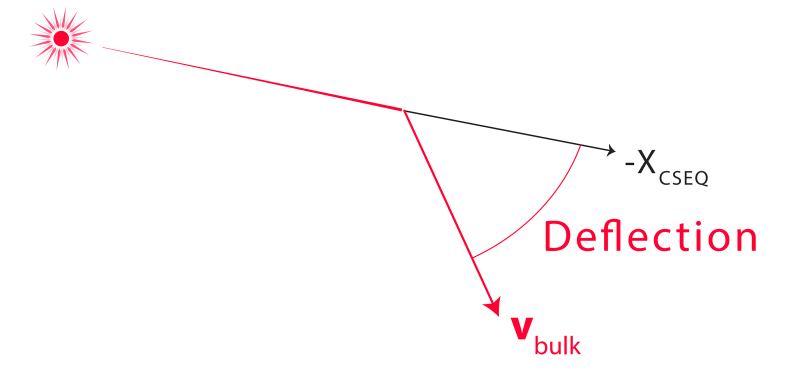


0 INSTRUMENT

The Ion Composition Analyzer, part of the Rosetta Plasma Consortium RPC-ICA:
E: 10 eV - 40 keV ; FOV: 90x360 ° ; Cadence :192 s ; M: 1, 2, 4, 8, 16 and 32 amu/e



2 METHOD & TOOLS



We isolate solar wind protons.
We compute and use the following:

$$\mathbf{v}_{bulk} = \frac{1}{n} \int_{\mathbf{v}} \mathbf{v}\, f(\mathbf{v})\, d^3\mathbf{v} \quad ; \quad v_{bulk} = |\mathbf{v}_{bulk}|$$

$$v_{mean} = \frac{1}{n} \int_{\mathbf{v}} |\mathbf{v}|\, f(\mathbf{v})\, d^3\mathbf{v}$$

$$r = \frac{v_{mean} - v_{bulk}}{v_{mean}} \qquad n = \int_{\mathbf{v}} f(\mathbf{v})\, d^3\mathbf{v}$$

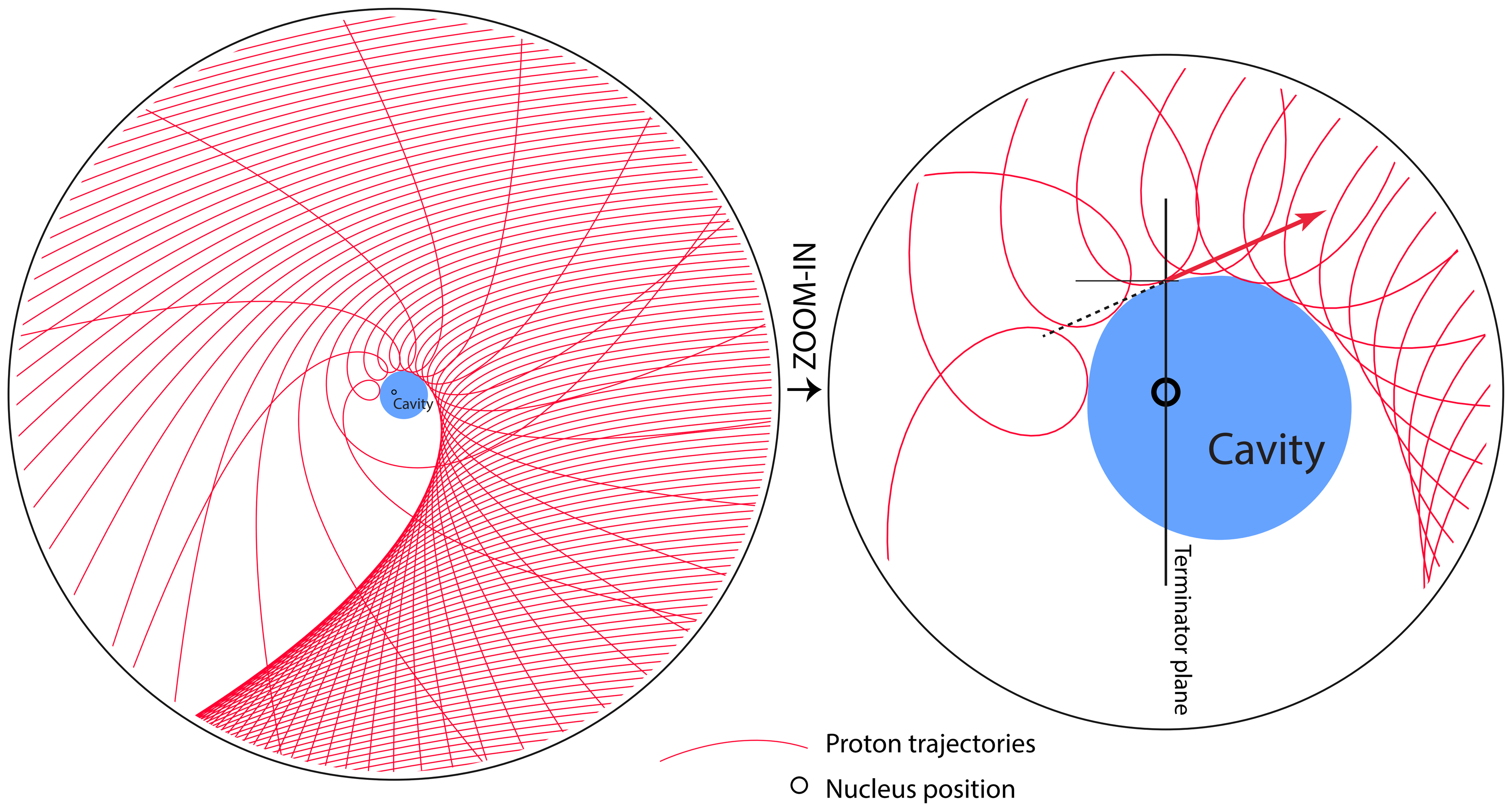
v_{bulk} is the norm of the plasma moment of first order, v_{mean} correspond to the mean energy of single particles, *n* the proton density.

INTERPRETATION

The neutral atmosphere of the comet is initially ionized *within* the solar wind. Through this phenomenon of mass-loading, energy and momentum are transferred from the solar wind to the cometary new-born ions. This results in a deflected and decelerated solar wind.

From the observations, we see that solar wind delfection is very low far away from the Sun, and can reach 180° (upper panel on the left). Macroscopically, the solar wind is decelerated (v_{bulk} decreases), but microscopically single particles do not seem to lose at lot of energy (v_{mean} always close to the estimated upstream speed).

Around perihelion, a solar wind cavity is formed around the nucleus. When the discontinuity passes over the spacecraft, deflection focuses around 140°.



We propose a 2D geometric solution illustrating the major observations. The solar wind gyrates in a draped magnetic field, normal to the plane of the poster. Magnetic field strength follows a/R^b, *R* the distance to the nucleus. We launch single particles in this field, and obtain the above red trajectories. We get a cavity, and seen from a terminator orbit (as is the case with Rosetta), the deflection of the particles at the discontinuity is around 150°. The particles don't lose energy, but the macroscopic bulk speed is greatly reduced.

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SUMMARY

Rosetta provided us with very high resolution observations of the formation of a solar wind cavity. We are able to look at this picture at both microscopic and macroscopic scales:

- Macroscopically, the solar wind is deflected and decelerated
- Microscopically, the solar wind is well ordered, single particles gyrate without losing much energy.

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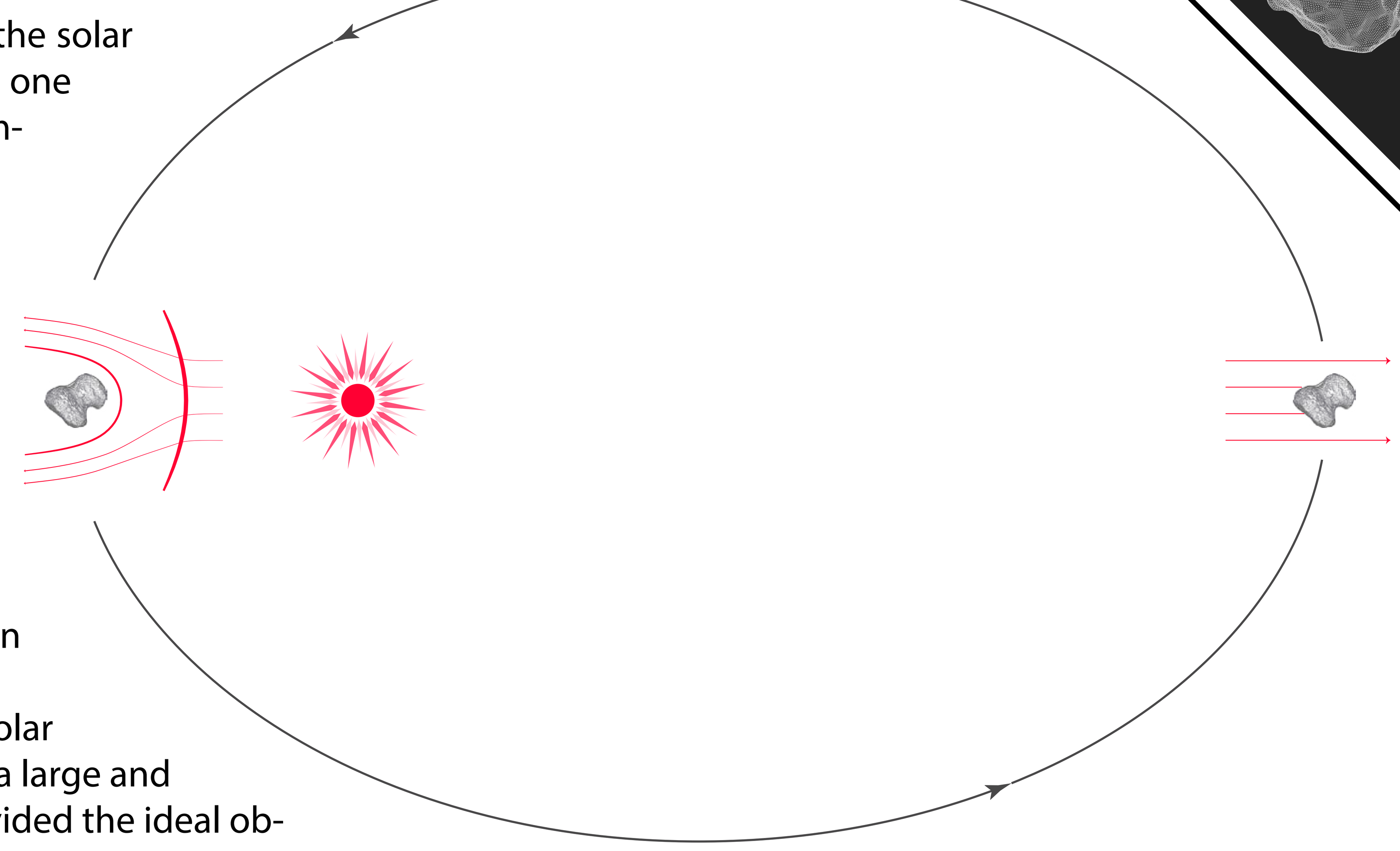
1 CONTEXT AND QUESTIONS

In the study of the interaction between the solar wind and bodies of the solar system, there is one more parameter to consider for comets, compared to planets and moons: the distance to the Sun. The impact of this parameter on the solar wind dynamics around a nucleus is huge. We know that most of the comet present an atmosphere-less nucleus to the solar wind at aphelion, and an extended and dense coma at perihelion. The sun particle stream either directly impacts a bare nucleus, or forms together with the coma a classical bow shock structure, already well studied by the first generation of cometary missions.

But what happens inbetween? How does a solar wind cavity form and grow, out of nothing, to a large and established cavity? For two years, Rosetta provided the ideal observation conditions for this precise topic.



3 OBSERVATIONS