MASS LOADING OF THE SOLAR WIND AT 67P

A COMPARISON BETWEEN OBSERVATIONS AND A HYBRID MODEL

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INTRODUCTION

Analyzing data from the ion sensor **RPC-ICA** flying on the european spacecraft **Rosetta**, we study the dynamics of a partially ionized atmosphere interacting with the solar wind around a comet. We then compare our **observations** with results from a **hybrid simulation**.

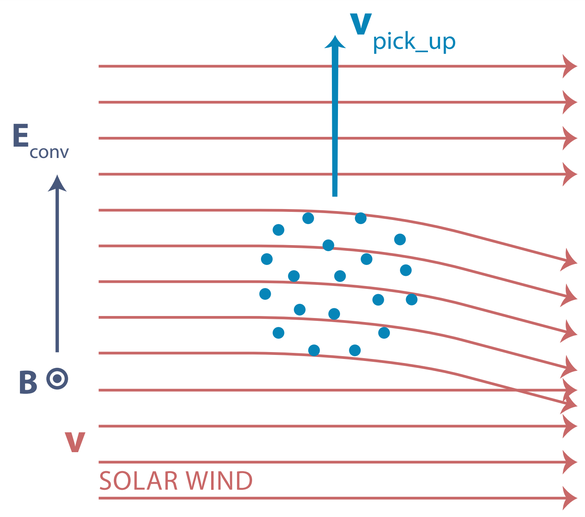
Mass loading is the phenomenon leading, to a large extent, the plasma dynamics within the coma.

MASS LOADING

What happens when a comet introduces new-born ions in the undisturbed solar wind?

GENERAL EXPECTATIONS:
- Pick-up ions accelerated along the local E_{tot} field.
- Solar wind deflection in the opposite direction, velocity decrease.

=> Momentum and energy transfer from the solar wind to the coma.

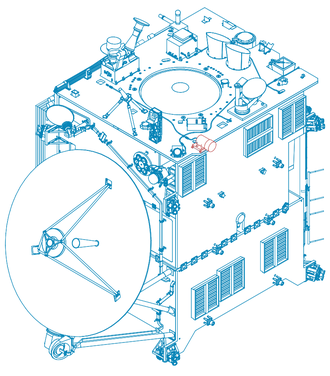


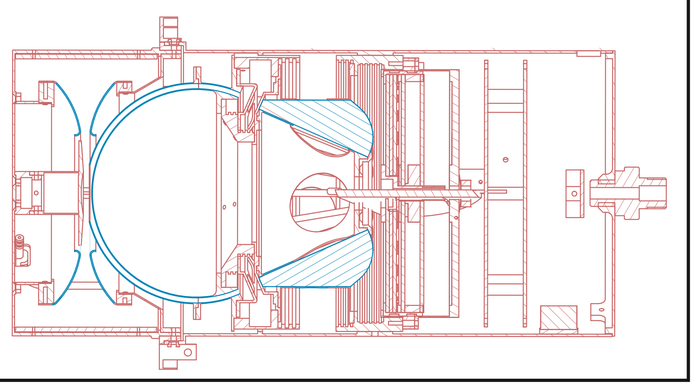
QUESTIONS ADDRESSED, DATA/SIMULATION:

- Along which direction do the different populations flow?
- How do the different solar wind populations behave?
- How those two aspects evolve with the increasing activity and dicreasing distance to the Sun.

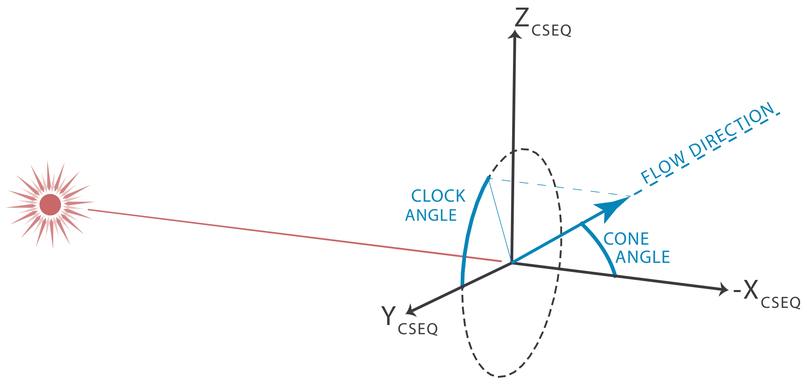
INSTRUMENT

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





COORDINATES



THE MODEL

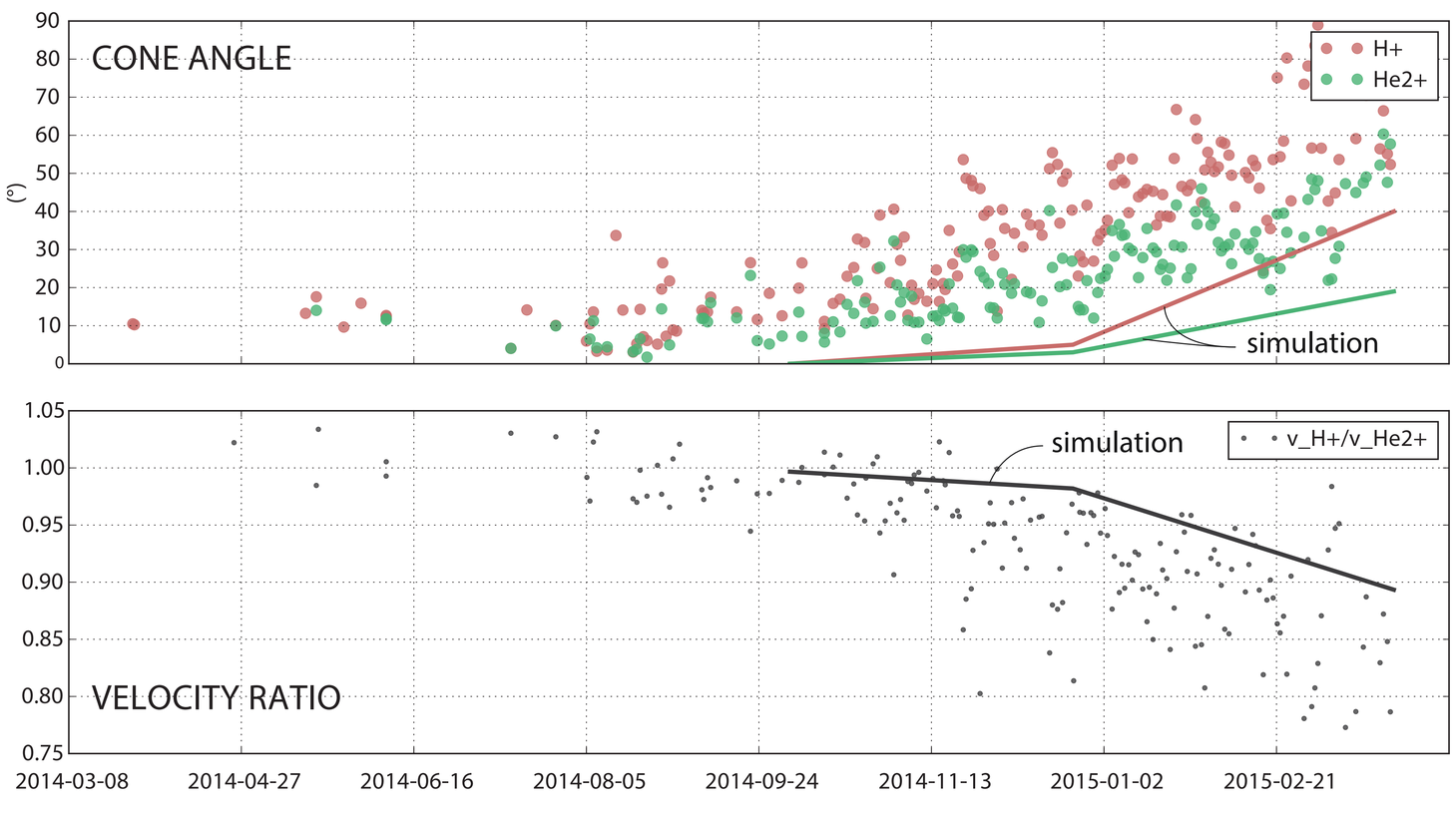
Taking into account the fairly simple configuration of the mass loading phenomenon introduced above, we set up a simplified «laboratory comet» using the following model:

- Hybrid code: ions as particles, electrons as fluid, quasi-neutrality assumed (*Holmström et al.*,20--)
- Fields averaged on a cartesian grid
- Particles and fields advanced according to a leap-frog scheme
- Ion dynamics: Lorentz force only
- 3 populations: solar wind H^+ and He^{++}, cometary H_2O^+
- Neutral production following a non-illuminated Haser model
- No physical obstacle (nucleus)
- No charge seperation
- B field direction: the Parker spiral

4 different times of the mission are simulated, based on *Hansen et al.*, 2007:

3.25 AU	2.7 AU	2.0 AU	1.3 AU	
~Starting comet escort phase			~Perihelion	
1e24 #/s	8e25 #/s	8e26 #/s	5e27 #/s	Total gas production rate, Q
1000 m/s	1000 m/s	1000 m/s	1000 m/s	Neutral expansion
0.9e-7 1/s	1.37e-7 1/s	2.5e-7 1/s	5.88e-7 1/s	Neutral ionization frequency

SOLAR WIND DEFLECTION STATISTICS



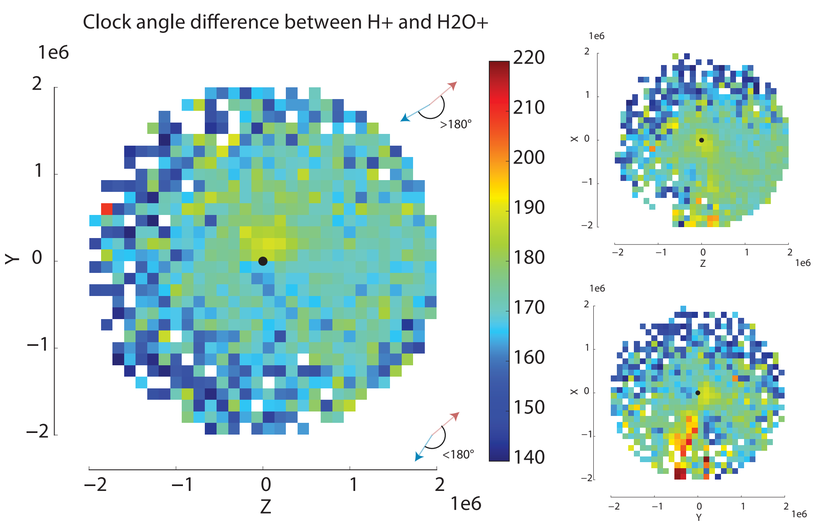
OBSERVATIONS:
- Solar wind protons reach a deflection of 90° from the sun-comet line (terminator plane, >200km cometo-centric distances)
- Solar wind alpha particles are both less deflected and less slowed down.

MODEL:
- The simulated deflections for the solar wind species are consequently smaller than the observed ones.
- Slopes of both observation and simulation deflections are similar. We also find a similar velocity ratio trend: alpha particles are being less slowed down as well as less deflected.

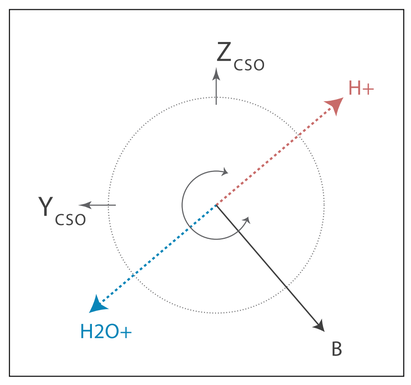
MODEL ADJUSTEMENTS:
- Higher both total gas production and neutral ionization rates, according to *in-situ* observations from the ROSINA package.

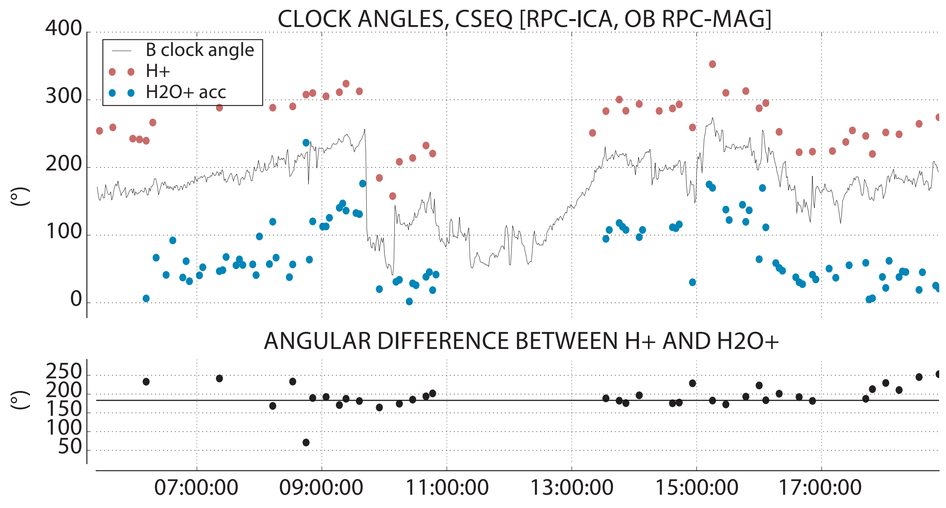
Simulations for the perihilion case result in unfocused population flow, with low densities. We cannot define a deflection for the solar wind anymore. On the observation side, the solar wind is not detected anymore after March/April in the viscinity of the nucleus.

ION DYNAMICS CASE STUDY



SIMULATION





DATA

In the mass loading simplistic model presented above, cometary ion and solar wind flows are in the same plane, their angular difference in terms of clock angle is 180°.

Looking closer at the simulation results for a similar deflection of the solar wind, this 180° difference is also seen, but with an assymetric distribution normal to the B field direction.

Studying one data set from the 28 November 2014, we observe this 180° angular difference, with fluctuations.

Here, the model might give us an indication for a new aspect of the interaction solar wind/coma.