67P/Churyumov-Gerasimenko:
Never a boring rock

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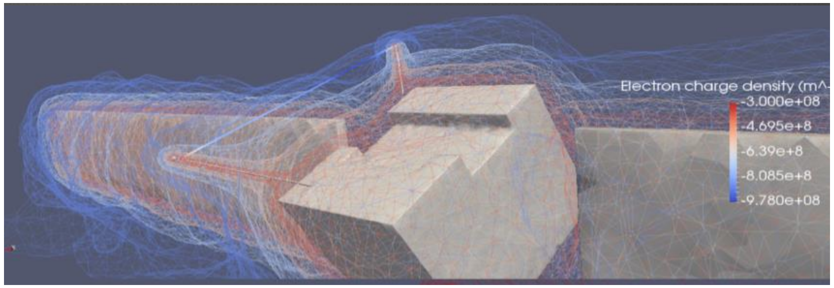
RPC science highlights

- No boring rock: Already at arrival (3.5 A.U), the comet had an **ionosphere** of its own: we **never saw an inactive asteroid-like case** ***[Edberg et al., GRL, 2015; Yang et al. MNRAS 2016]***.

- Formation and evolution of cometary ionosphere: observations and comparison with neutral gas density (ROSINA/COPS) and modelling show **cometary ions dominate the plasma**: close to 67P, plasma source and sink identified and first order density variations explained by surprisingly ignoring the solar *wind* ***[Vigren et al., AJ, 2016; Galand et al., MNRAS, 2016]***.

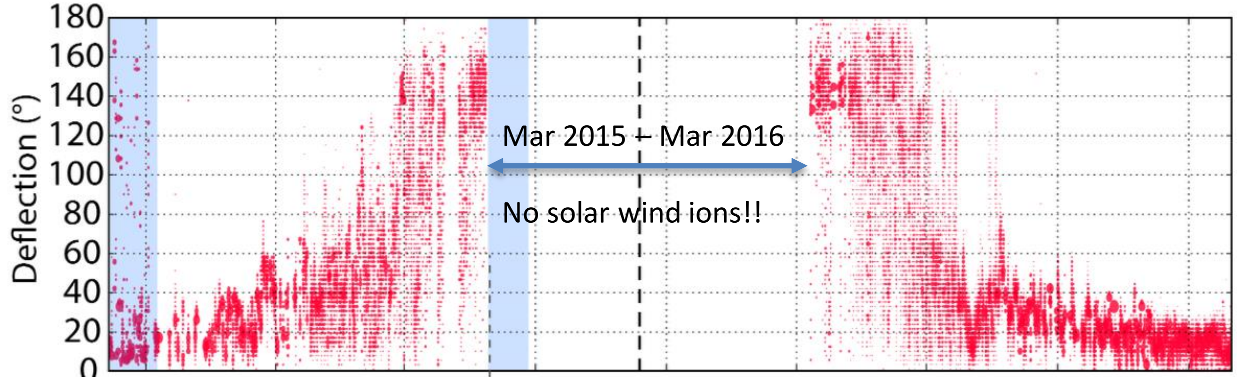
- A **hot ionosphere**: The **s/c potential** being negative since arrival at the comet shows the **electron** flux is dominated by a population **around 100,000 K** (10 eV) throughout the mission ***[Odelstad et al., GRL, 2015]***. Importance of **s/c-plasma interactions** in the cometary coma



[SPIS simulations of Rosetta. Johansson et al., 2016]

RPC science highlights

Birth of the comet induced magnetosphere [Nilsson et al., Science, 2015; Nilsson et al., A&A, 2015] and its interaction with solar wind **[Broiles et al., A&A, 2015]** through mass-loading / pick-up ions **[Béhar et al., GRL, 2016; Goldstein et al, GRL, 2015]**



Solar wind ion deflection over whole Rosetta mission

[Solar wind ion deflection, ICA] Mass loading of the solar wind plasma by cometary ions deflects the solar wind ions because of conservation of momentum

A lot of dynamics generated by the pickup ions:

→ **Mirror modes waves [Volwerk et al., An Geo, 2016]**

→ **Field line draping and current sheets**

→ **Very dynamic plasma, short time-scale variations**

→ **Singing comet waves** during low activity at close cometocentric distances: discovery of quasi-coherent, large-amplitude, compressional magnetic field oscillations. **[Richter et al., Ann. Geophys, 2015; Richter et al., Ann. Geophys, 2016; Koenders et al., A&A, 2016, Meier et al., Ann. Geophys, 2016]** the singing disappeared as the activity increased (or was hidden in the turbulence) and re-appeared when the activity decreased again

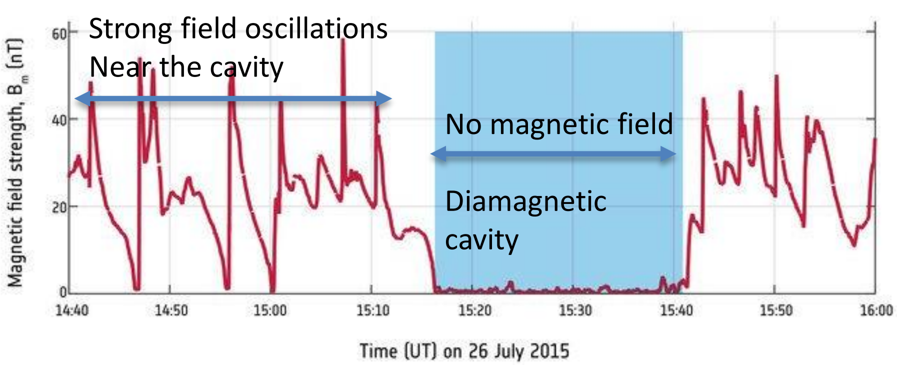
RPC science highlights

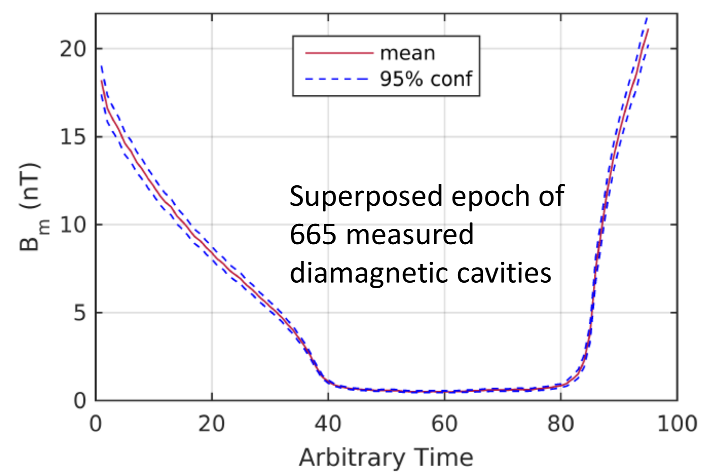
Charge exchange (and double charge exchange) in cometary coma **[Nilsson et al. Science, 2015; Burch et al., GRL, 2015; Wedlund et al., A&A, 2016]** creation of H- through double charge exchange of solar wind protons with cometary H2O observed for the first time

Cometary plasma boundaries:

A **collisionopause** boundary in the ion pileup region of the coma, **[Mandt et al, MNRAS, 2016]**, separation of collision dominated and non-collisional dominated regions.

Discovery of an **atypical diamagnetic cavity** near perihelion **[Goetz et al., A&A, 2016; Goetz et al., MNRAS, 2016]**. A total of 665 crossings of the cavity were measured with a duration of 6 sec to 40 minutes. The superposed epoch analysis shows a remarkable robust shape of the cavity





[Diamagnetic cavity, Goetz et al. 2016]

RPC science highlights

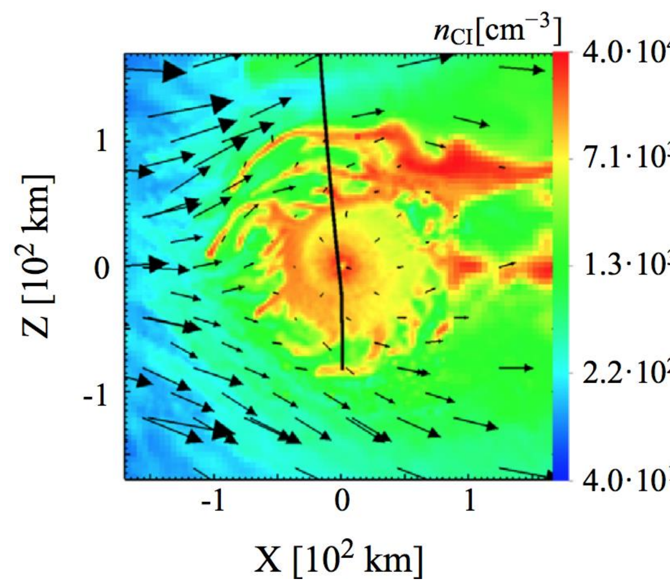
Negatively charged nanograins (dust) from the comet are picked up by the solar wind and return to the vicinity of the comet. **[Burch et al., 2015, GRL; Gombosi et al., A&A, 2015]**

Response to external forcing: Solar wind transient events – comet interactions: **CIR/CME** **[Edberg et al, JGR, 2015; Edberg et al., MNRAS, 2016]**

Response to internal forcing: **Cometary outburst** impact on cometary induced magnetosphere **[Gruen et al.]**

Solar wind – comet interaction simulations to support RPC operations and RPC data analysis **[Koenders et al, PSS, 2013; Koenders et al, PSS, 2015]**

- Other hybrid simulations
- Photoionisation, charge-exchange and electron ionisation
- Solar wind comet interactions model
- Effect of convective E-field



[Cometary induced magnetosphere Simulation Koenders et al, 2015]

Rosetta Plasma Consortium

Things RPC had expected and found:

- Lots of activity,
- Formation & disappearance of induced cometary magnetosphere,
- Particles, EM fields, Wave-particle interactions, …
- Surprises!

What RPC did not expect:

- No inactive comet from plasma point of view
- No fully picked up ions / unexpected solar wind deflection
- Not only cold plasma (cold plasma yes, but then coexisting with warm)
- High negative s/c potential most of the time
- Strong inhomogeneities / erosion of cold plasma
- Different waves than expected (e.g. singing comet waves)
- No large scale stable diamagnetic cavity
- Stronger electron impact
- Negative ions (double charge exchange)
- Stronger interaction region than expected