

Network of small satellites for the exploration of planetary Magnetospheres (NETSSEM)

Leblanc F.¹, André N.², Cecconi B.³, Delcourt D.⁴,
Henri P.⁴, Langlais B.⁵, Modolo R.⁶, Sahraoui F.⁷

¹ LATMOS/CNRS, Sorbonne Université, Paris, France

² IRAP, Toulouse, France

³ LESIA/Observatoire de Paris, Meudon, France

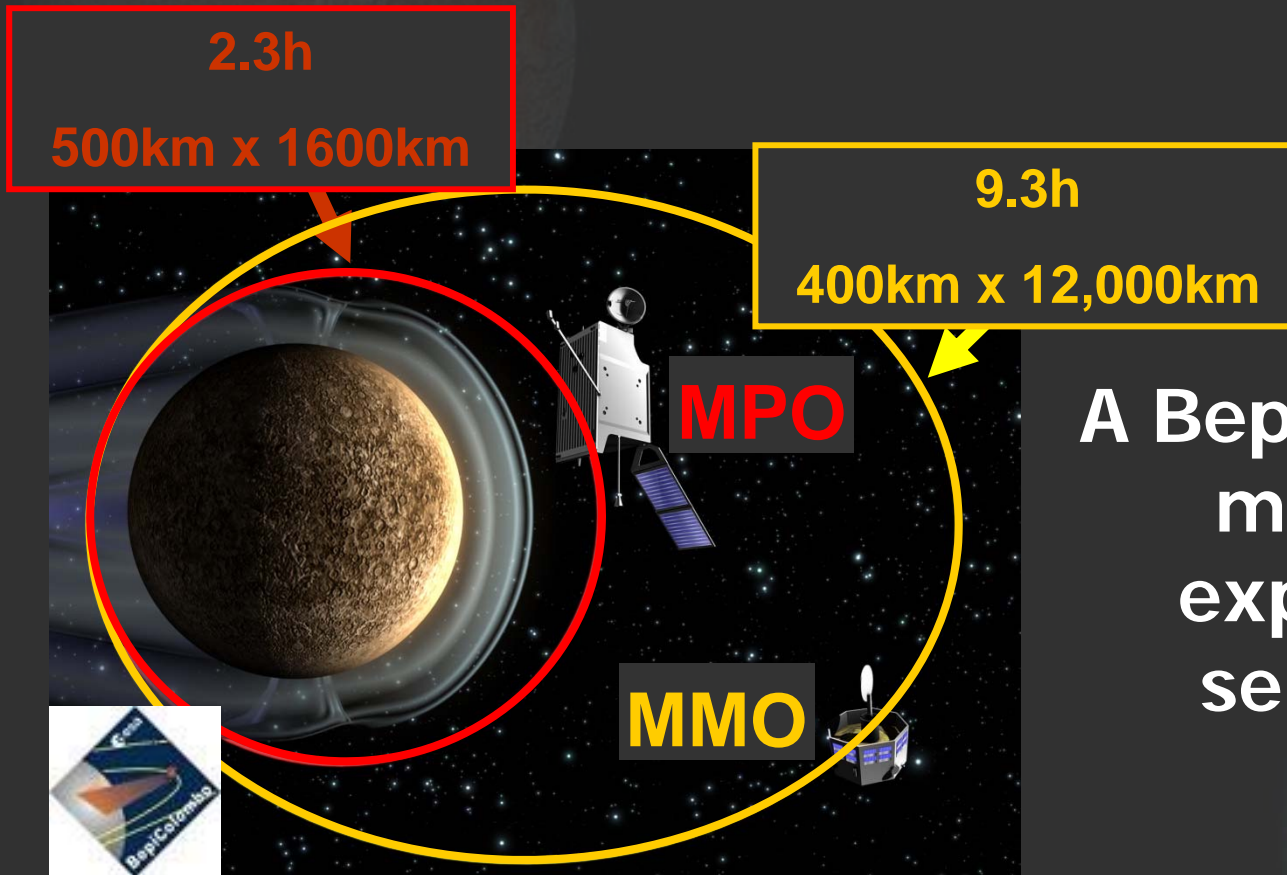
⁴ LPC2E/CNRS, Univ. Orléans, Orléans, France

⁵ LPG, CNRS & Univ. Nantes, Nantes, France

⁶ LATMOS/IPSL, UVSQ, Guyancourt, France

⁷ LPP/CNRS-Ecole Polytechnique-Sorbonne Univ.-Obs. Paris,
Palaiseau, France

Towards the exploration of the solar system using multi-spacecraft mission...



A Bepi-Colombo type mission is too expensive to be selected today

⇒ Nano-satellites might be a solution for planetary objects not too far from the Sun

CNES phase 0 study (start in April 2018)

Submitted in 07/2017 to CNES of a phase 0 study,
selected in 02/2018, KO 03/18

Feasibility study of a mission concept for the exploration of planetary magnetospheres and environments from multi-point measurements:

- a mothership
 - several nano-satellites
-
- ⇒ Definition of the mission profile
 - ⇒ Evaluation of available resources
 - ⇒ Design of nano-satellites and payload (~ 30 kg)

How a solar perturbation impact and re-configure a magnetosphere?

- Need of a solar wind monitoring
 - A dedicated solar wind nano-satellite
- At least two other probes (ideally 4 to allow 3D space sampling) within the magnetosphere to follow the propagation of the perturbation:
 - Energy transfer from the solar wind into the magnetosphere/atmosphere;
 - Acceleration mechanisms within different magnetospheric regions;
 - Magnetospheric boundaries evolution.
- If possible, simultaneous atmospheric/ionospheric sounding to follow the induced atmospheric/ionospheric perturbations.

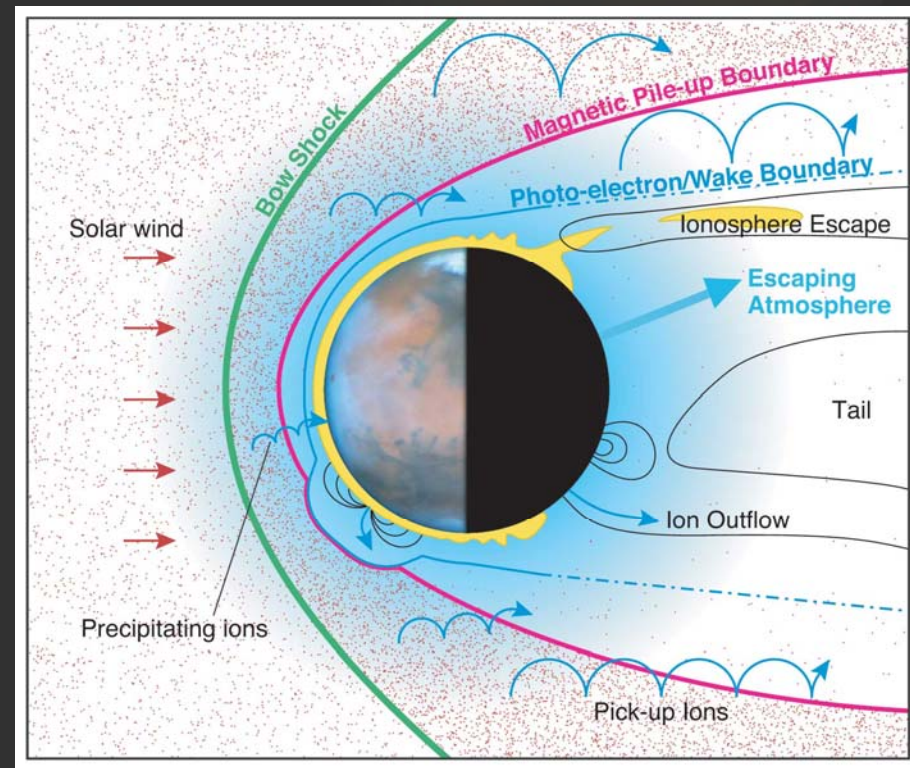
How spatial and temporal processes drive a magnetosphere?

→ At least three points of measurement within the magnetosphere to probe with high spatial and temporal resolutions:

→ Characterization of reconnection regions and of the ionospheric currents

→ Characterization of the acceleration mechanisms in the magnetospheric tail

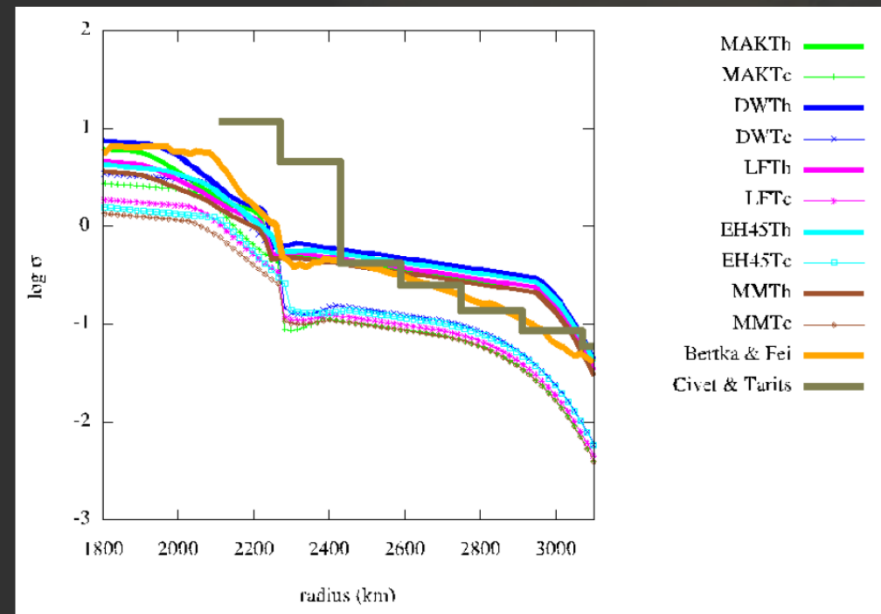
→ Spatial and temporal variabilities of the magnetospheric boundaries (Kelvin-Helmholtz instability...)



Mars' magnetosphere
(Copyright LASP)

How magnetic field perturbations are related with planetary internal properties?

- At least three points of measurement, outside and within the magnetosphere
- Monitoring of the solar wind conditions (quiet/periodic and active)
- Simultaneous measure of the planetary interior response
- Electrical conductivity of the interior can be assessed by analyzing frequency-dependant internal (induced) and external (inducing) signals



Mars' proposed electrical conductivity profiles (Verhoeven, pers. com., and Smrekar et al., in prep)

Typical mission scenario

- ① A Nano-satellite measuring the solar wind parameters
- ② Two to three Nano-satellites dedicated to magnetospheric and closer-to-the-planet in-situ observations
- ③ A mothership for telemetry
 - Definition of a mission scenario (insertion, orbits...)
 - Definition of the nano-satellite payload (performances, ressources...)
 - Towards the design of nano-satellite (ressources, EMC, cost...)