The Structure and Properties of Martian Magnetosphere at ~ 70° Solar-Zenith Angle in MSE Coordinates as Observed on MAVEN

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Motivation

Mars dayside magnetosphere

-The part of structure with which the solar wind interacts

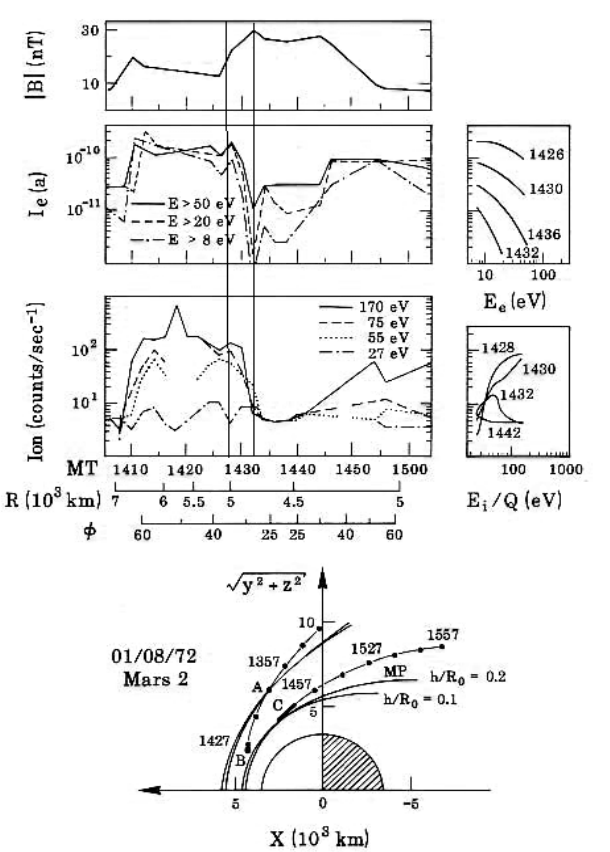
- It is not sufficiently studied due to small temporal resolution of past spacecraft

- There are differences in identification and names

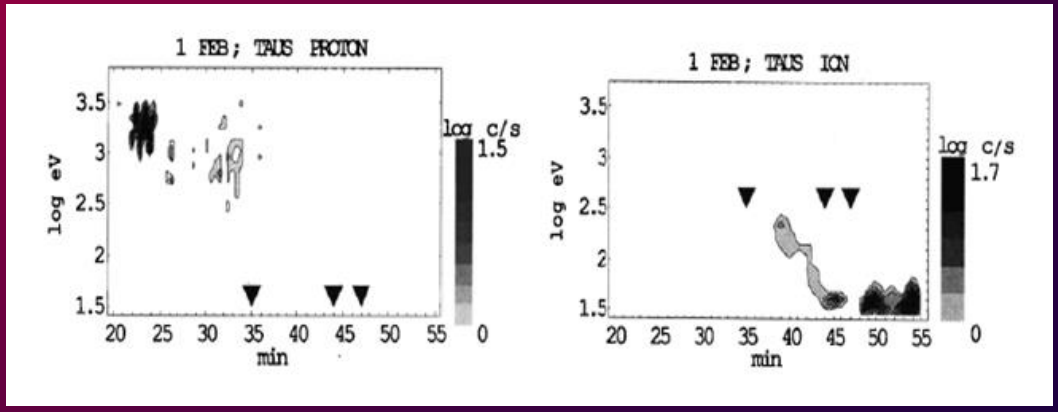
- Computer models are limited

- MAVEN provides new possibilities in investigation

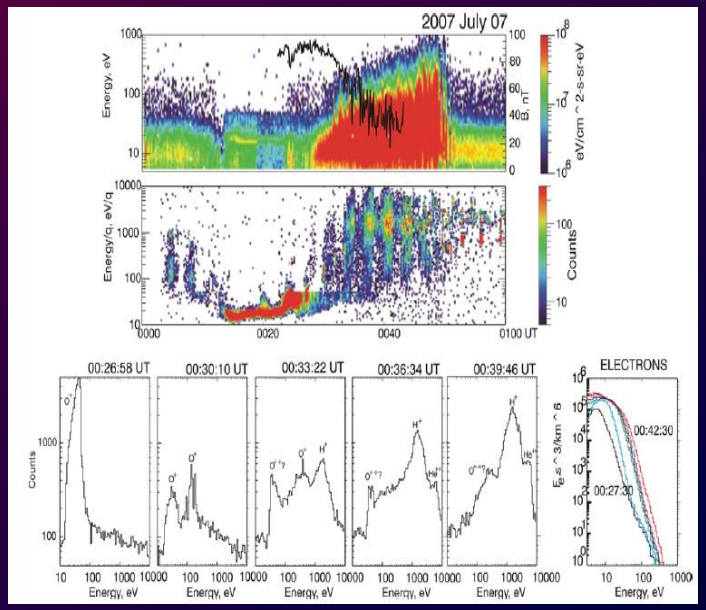
Early observations of dayside magnetosphere of Mars



The region of low energy ions observed on Mars-2 (Bogdanov and Vaisberg, 1975)

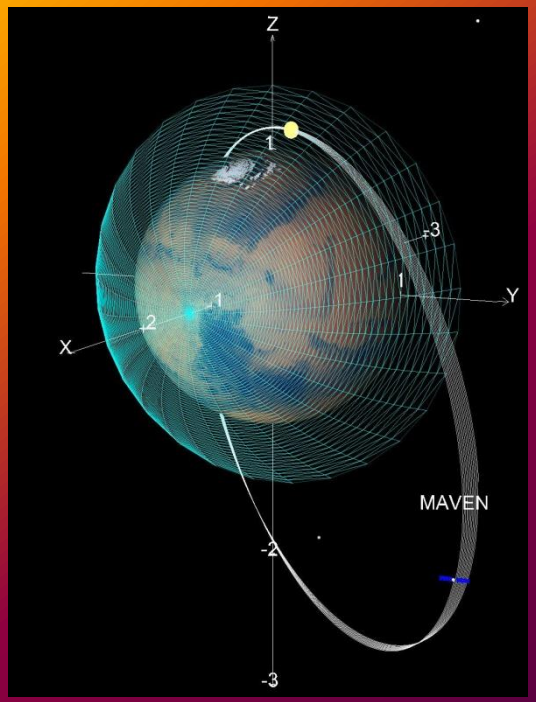


The boundary layer or mantle as observed on Phobos-2 (Szego et al., 1998)

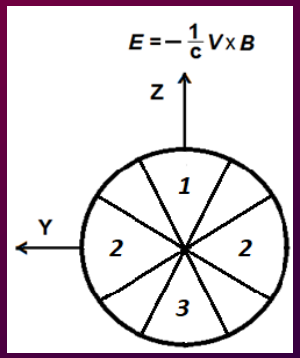


Magnetic barrier structure as seen from Mars-Express (Dubinin et al., 2008)

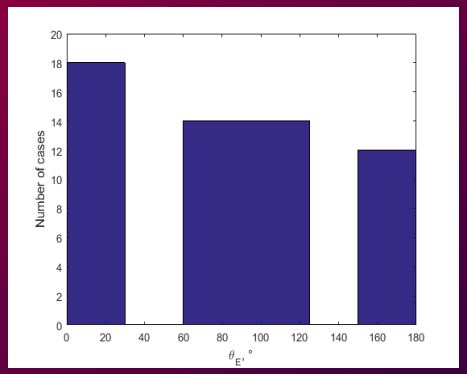
Mars dayside magnetosphere in MSE coordinate system



MAVEN orbit during chosen time interval

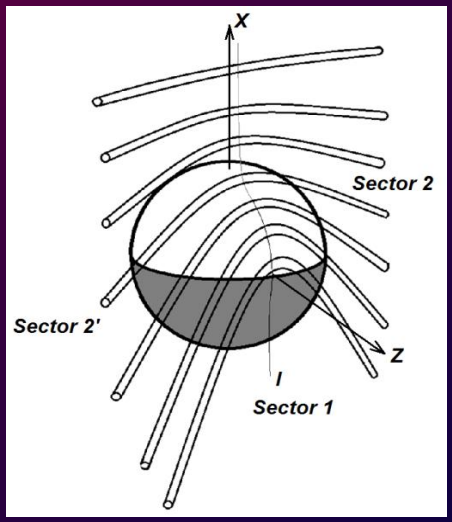


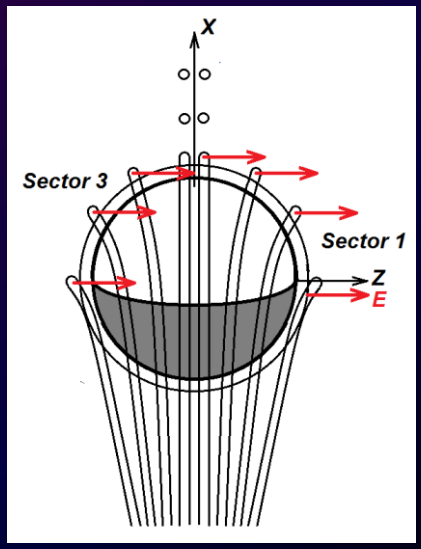
3 sectors in MSE coordinates



Selected magnetosphere crossings by MAVEN along inbound trajectories in 17.01.2016 – 04.02.2016 time interval

 # 1 0°-30° (18 crossings);
 # 2 60°-120° (14 crossings);
 # 3 150°-180° (13 crossings}



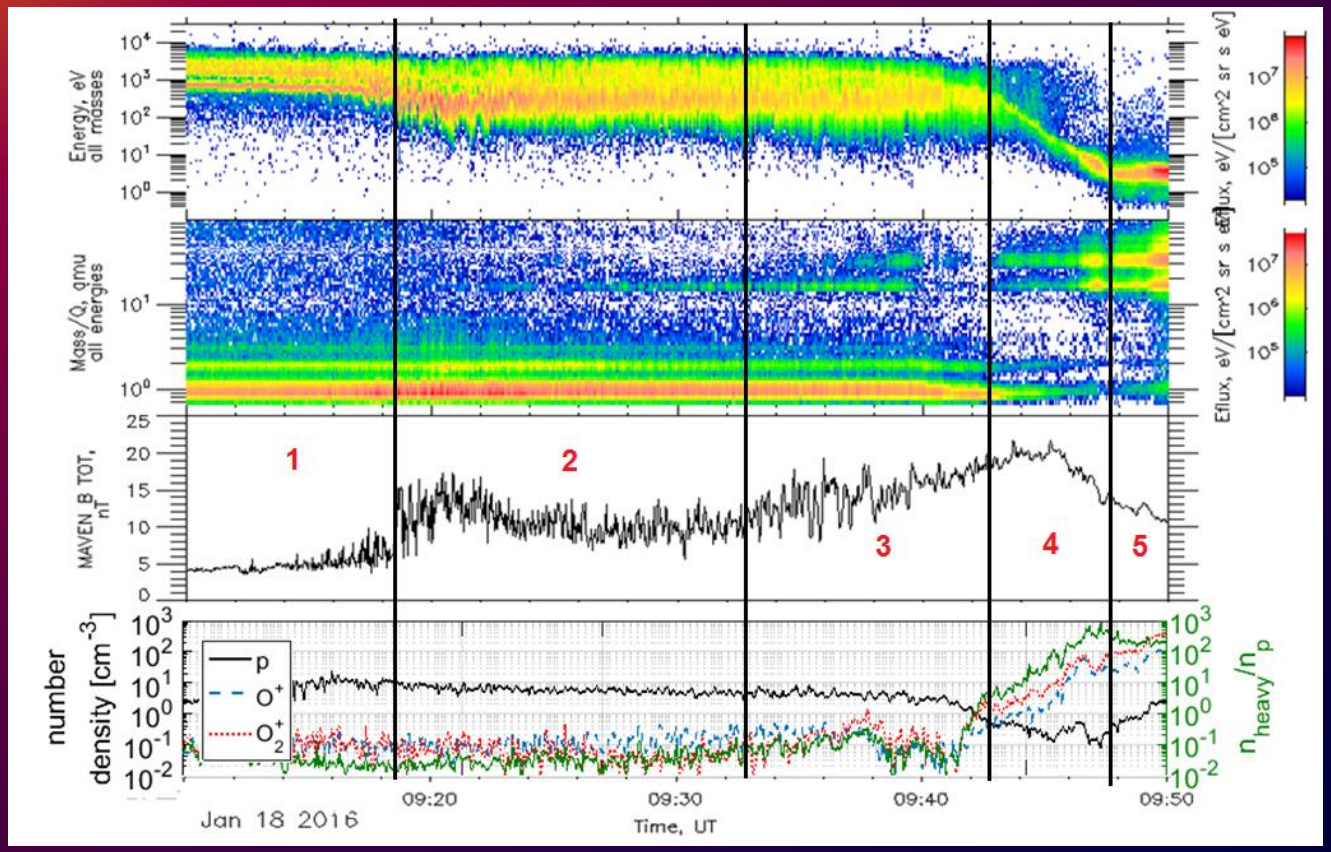


Magnetosphere definition

Magnetosphere as the region between the magnetosheath flow of the solar wind plasma and the ionosphere, we define

- magnetopause by ratio 0.1< n (O^++ O_2^+)/n(p) < 1 and/or its sharp increase accompanied by protons energy drop

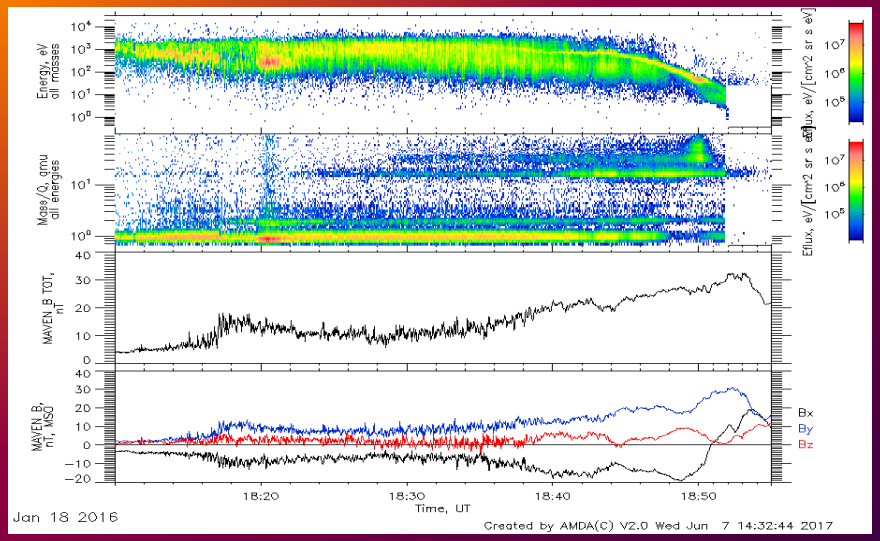
- boundary with ionosphere by energy and number density of ions

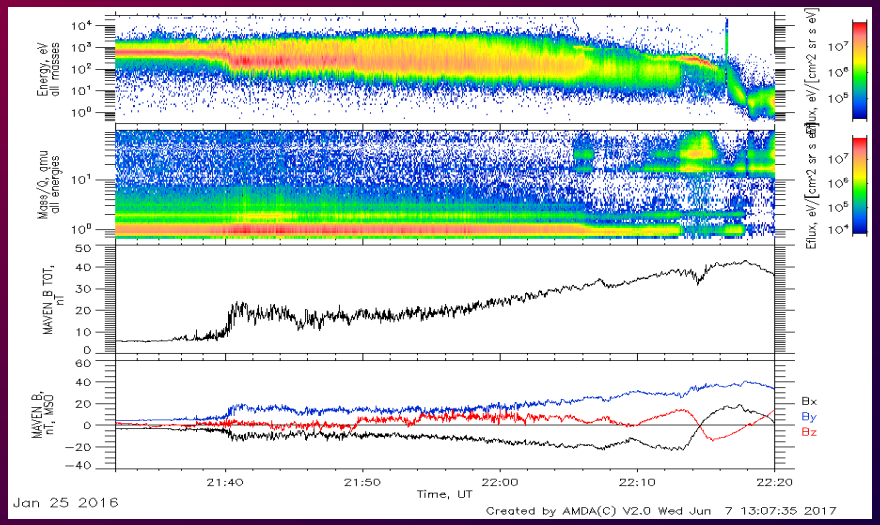


An example of the solar wind-Mars interaction region.

1 - solar wind
2- magnetosheath
3 – magnetic barrier
4 – magnetosphere
5 – ionos;here

Sector 0°-30° (North)





Magnetic barrier is in the magnetospheath and magnetosphere.

Magnetic field maximum witnin magnitosphere/ionosphere.

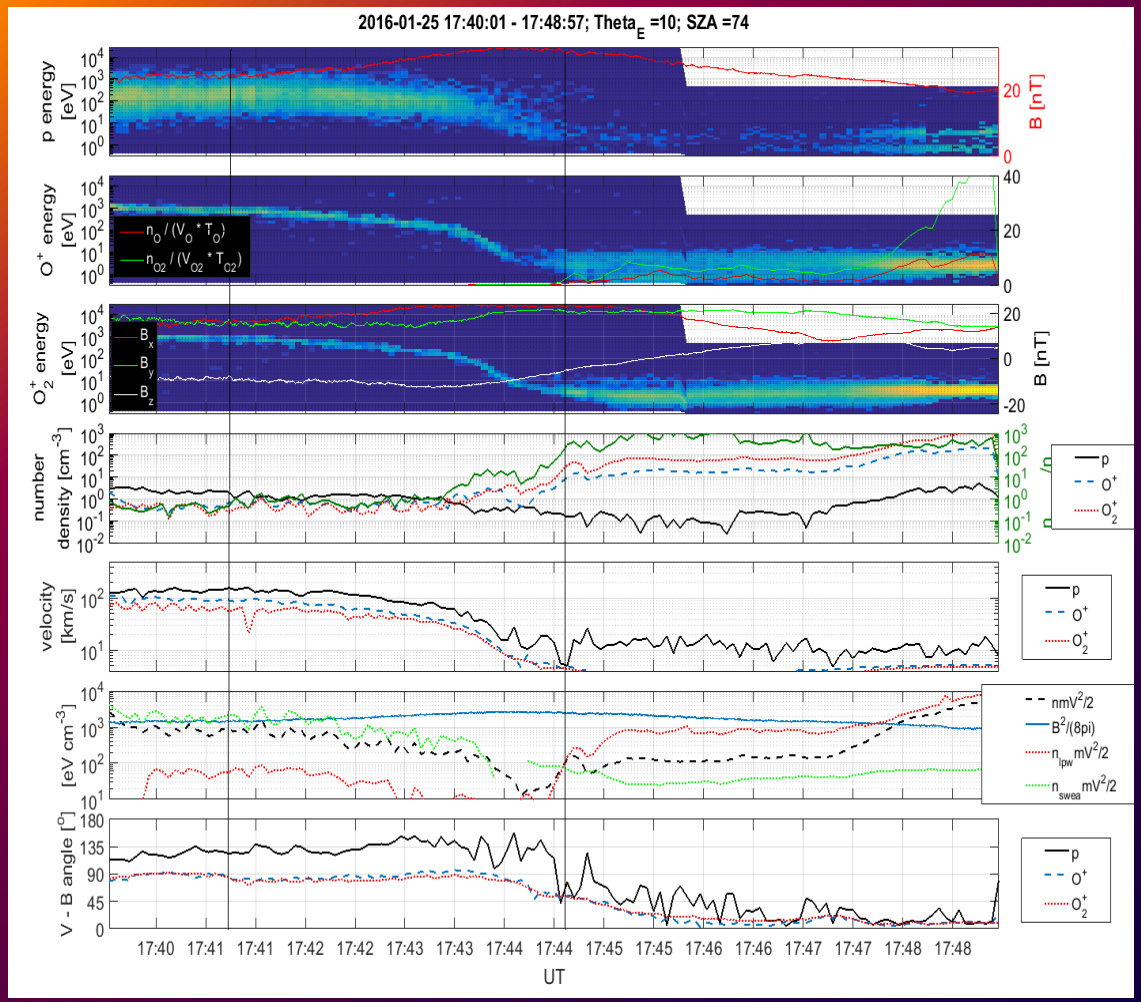
Magnetopause is defined by heavy ions gradient at $0.1 < n(O^+ + O_2^+)/n(p) < 1$

Magnetosphere is dominated by heavy ions

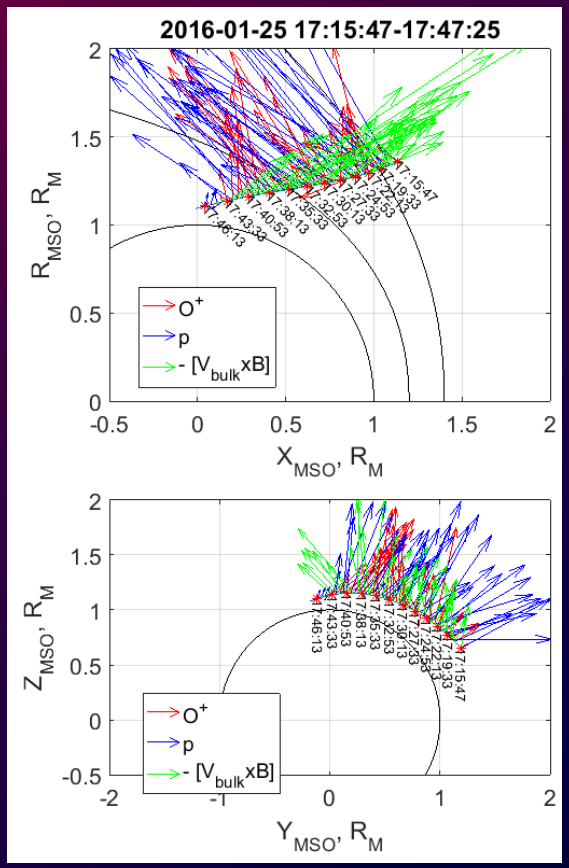
Heavy planetary ions plume is within magnetospeath and in magnetosphere

Magnetic pressure domonates in the magnetosphere.

Sector 0°-30° (North)

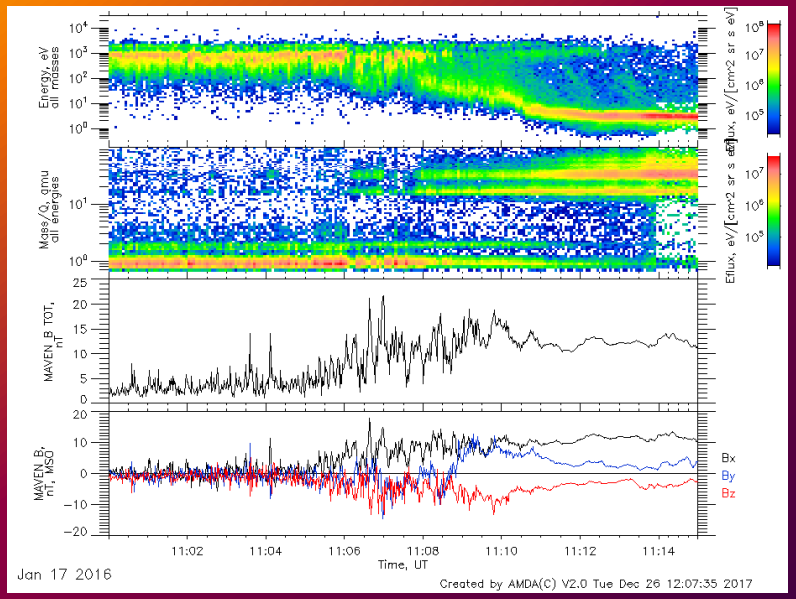


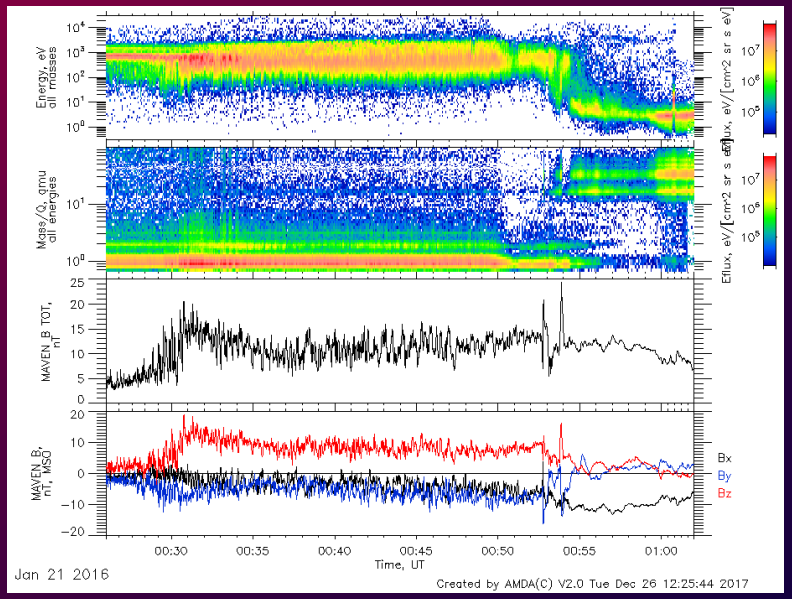
Quantitative characteristics of the magnetosphere



Motional electric field - green arrows, protons - blue arrows, O^+ - red arrows

60°-120° (low magnetic latitude)





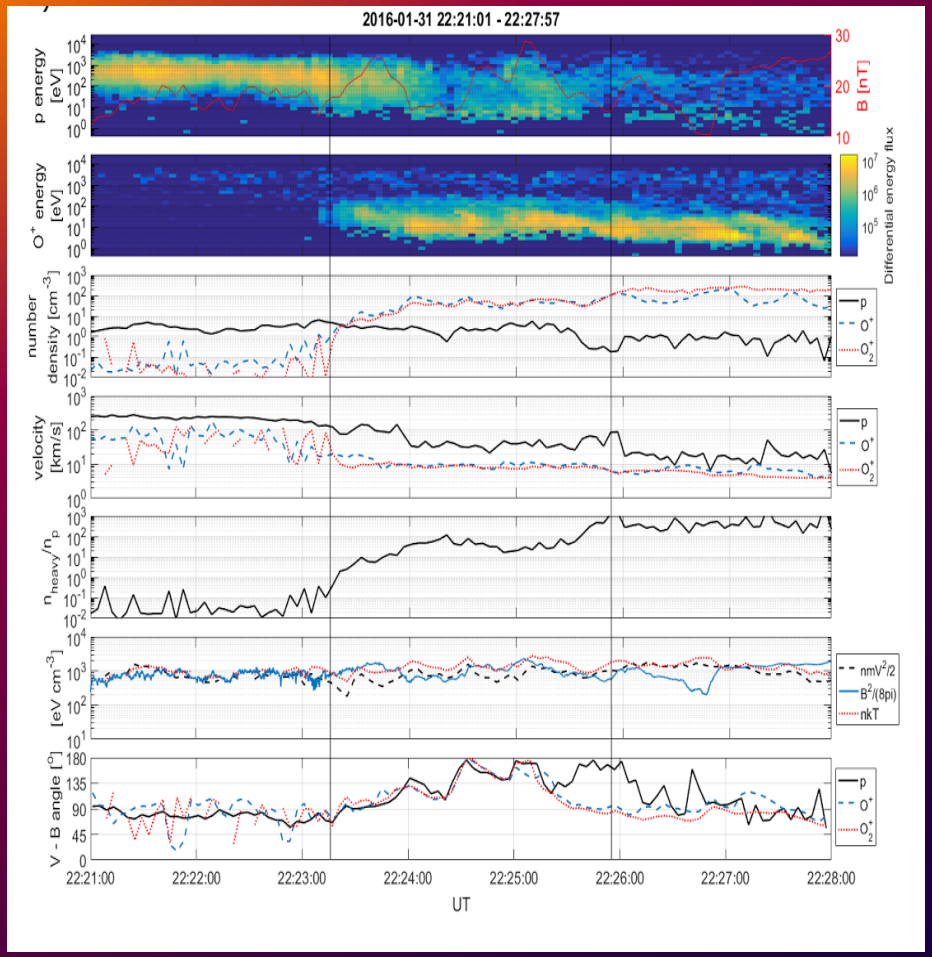
Magnetic field within barrier is structured and less pronounced.

The structure of the plasma flow upstream of magnetosphere and within magnetosphere is disturbed.

Magnetic field magnitude within magnetosphere can dominate or being small and disturbed.

Energy dispersed plasma structures are observed within magnetosphere

60°-120° (low magnetic latitude)



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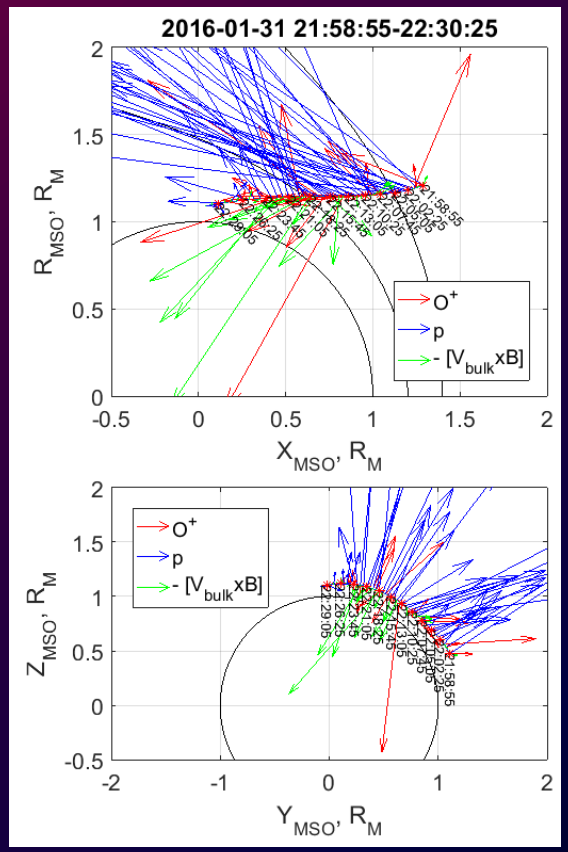
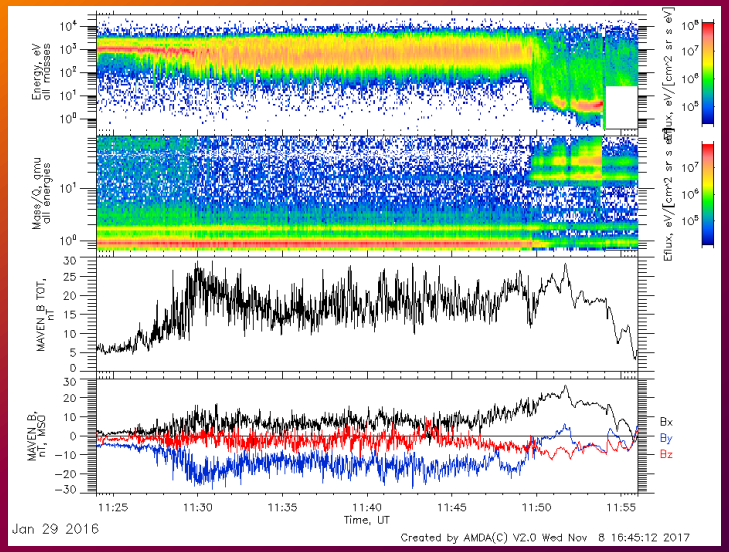
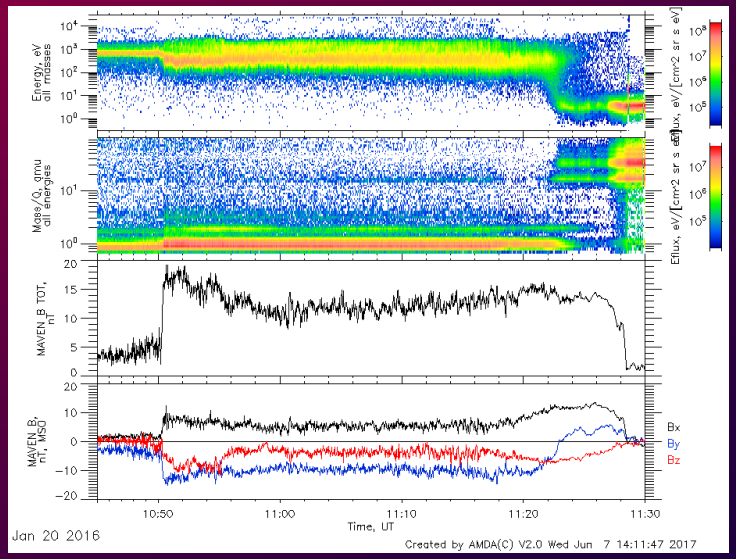


Motional electric field -green arrows, protons - blue arrows, O^+ - red arrows

Sector 3: 160 ^{0} -180^{0} (southern latitude)





Magnetic barrier starts just after shock-associated magnetic field increase.

Magnetic field in the magnetosheath is smaller than in the sector 1

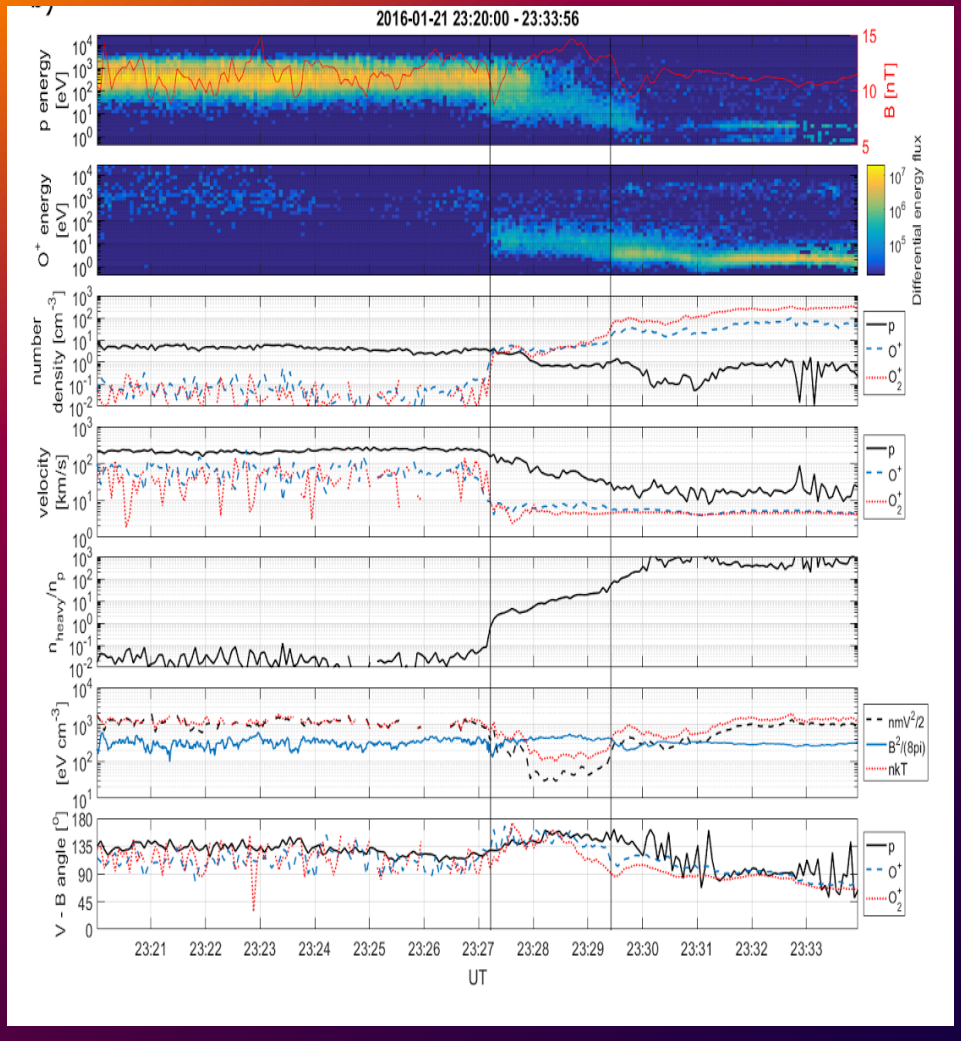
Proton velocity do not drop in front of magnetopause and can increase compared to magnetoseath

Proton number flux frequently diminishes in front of magnetopause.

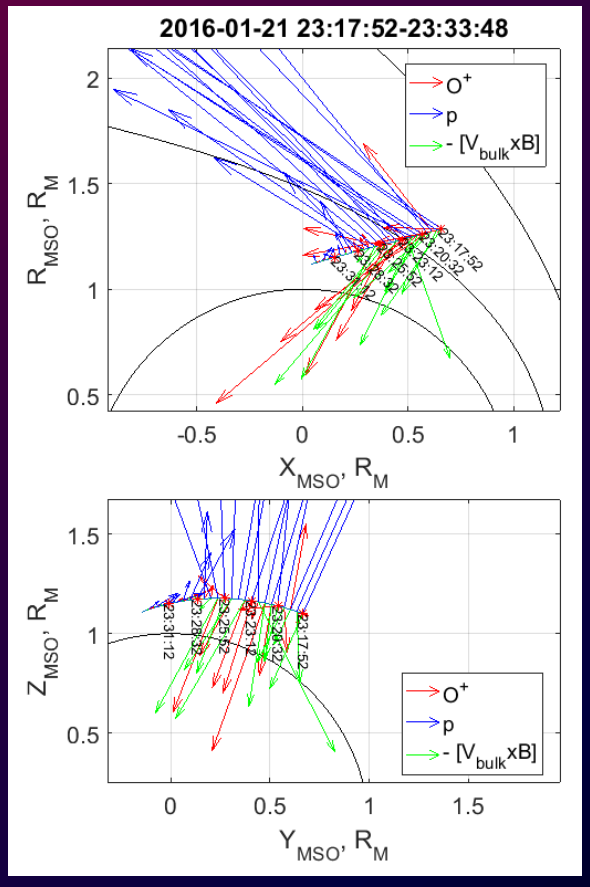
Magnetic field in magnetosphere may be less than in magnetosheath.

Magnetic pressure in magnetosphere can surpass plasma pressure or mabe equal to it (Alfvenic flow)

Sector 3: 160 ^{0} -180^{0} (southern latitude)

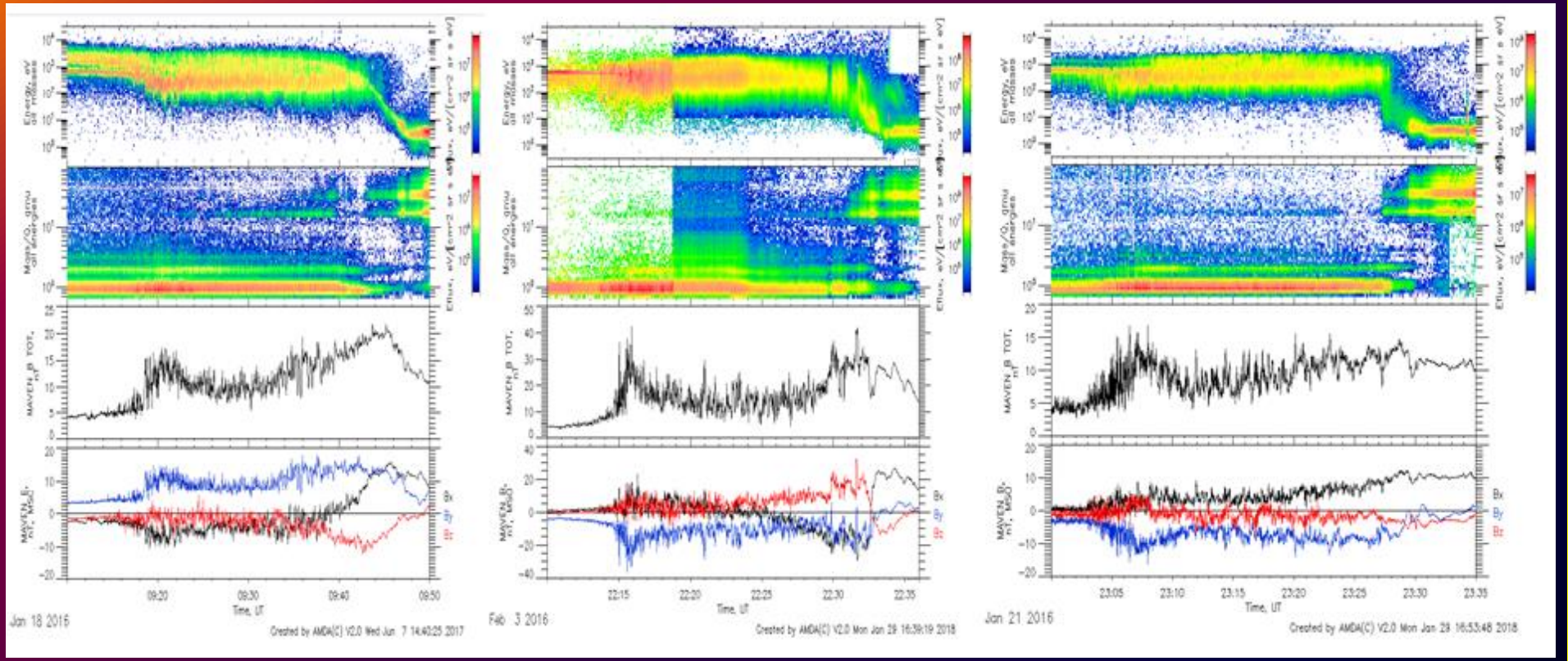


Quantitative characteristics of the magnetosphere



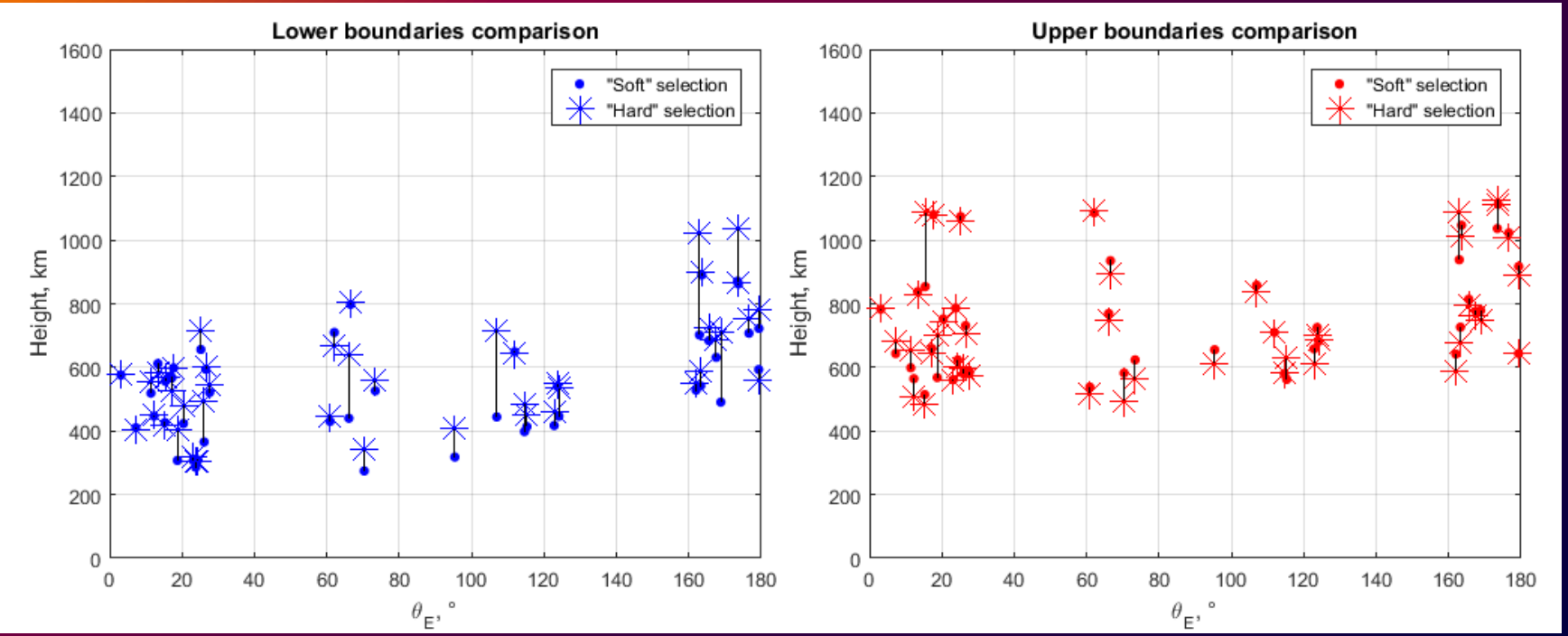
Motional electric field - green arrows, protons - blue arrows, O^{+} - red arrows

“Typical” structures in 3 sectors



0^0 - 30^0 **60^0 - 120^0** **160^0 - 180^0**

Magnetospheric boundaries



	Magnetopause height	Ionopause height	Magnetosphere thickness
0 °-30°	727 ± 44	491 ± 27	236
60° -120°	691 ± 43	550 ± 35	141
160°-180°	870 ± 56	764 ± 48	106
Average	763 km	601 ± 40	160

Conclusions

- The dayside of the magnetosphere was not previously studied in detail because of its small scale. The MAVEN spacecraft with its comprehensive scientific payload and high temporal resolution enables detailed study of dayside magnetosphere of Mars.
- Since Mars does not have global magnetic field, the solar wind interacts directly with the gas envelope of Mars. The magnetic field tubes of the solar wind, which are bending around planet and form a magnetic-plasma shell between magnetosheath and the ionosphere.
- This interaction leads to the formation of a magnetosphere from magnetic flux tubes mass-доaded by planetary ions accumulated during their convection through the dayside of the planet.
- b The magnetic structure and proprties of planetary ions in the dayside magnetosphere depend on the MSE coordinate.
- The magnetosphere of Mars and the magnetic barrier are different entities .
- The Mars magnetosphere is not an induced one due to ionospheric currents being rather the accretion or pick-up magnetosphere.

Common properties: Magnetic barrier starts upstream of the magnetosphere
Magnetic pressure may dominate in the magnetosphere.
Two plasma regimes inside magnetosphere: pick-up in external, disturbed ionospheric plasma in interval.


MAVEN
Thank you!