ESS 415/515

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Grading:
About 5 homework assignments (50%)
Two exams (20%): November 4th and December 9th
Paper/presentation (10%)

Book:
Basic Space Plasma Physics
By Baumjohann and Treumann

Topics Covered:

Introduction to Magnetospheres
Characterizing Plasmas
Generation of the solar wind
Magnetohydrodynamics (and extension to other methods)
Diffusion of Magnetic Field in a Plasma
Intro to Waves and Instabilities in a Plasma
Diamagnetism and Boundaries
Guiding Center Theory
Magnetic Mirroring and the Radiation Belts
Gradient and Curvature Drifts
Currents in the Magnetosphere
Substorms, storms and aurora
Plasma processes at other planets and moons
Related topics (dynamo theory, lab plasmas)

Paper

Due December 2, 2009

Write a 5-6 page paper on the important processes in the near space environment of the planet/moon of your choice other than the Earth. This means the exosphere and above for of a planet /moon with a thin atmosphere, or the ionosphere and above of a planet/moon with a thick atmosphere. Discuss how these processes combine with the inherent characteristics of the planet/moon, such as the composition, distance from the Sun/star, or location within a planet's magnetosphere, to make the system unique and/or of scientific interest.

Use 1.5 spacing, 10-12 pt font, and one inch margins. Figures are allowed and encouraged but they can not constitute more than 1 full page of the paper and make sure you cite the source of the figure.

You must use at least three refereed journal articles as sources of information (e.g. from Journal of Geophysical Research, Astrophysical Journal, Science). You can use (reputable) web sites for additional information; just make sure you cite them like a regular reference. Please list your reference in your bibliography according to the following style:

Author #1, Author #2, "Paper Title", *Journal Name, vol.*, (no.), pages, year

Some web sites to help you get started are:

http://solarsystem.nasa.gov/planets/index.cfm
http://www.nineplanets.org
http://www.jpl.nasa.gov/solar_system/planets/planets_index.html

Your paper will be graded on
- scientific accuracy,
- the clarity of your explanations/discussion, and
- grammar.

You will also give a 12 minute presentation in class, on December 2nd or 7th, on the material.

Sun

Solar wind ⇨ boiling off stellar atmosphere
(corona ~ 1 million degrees)

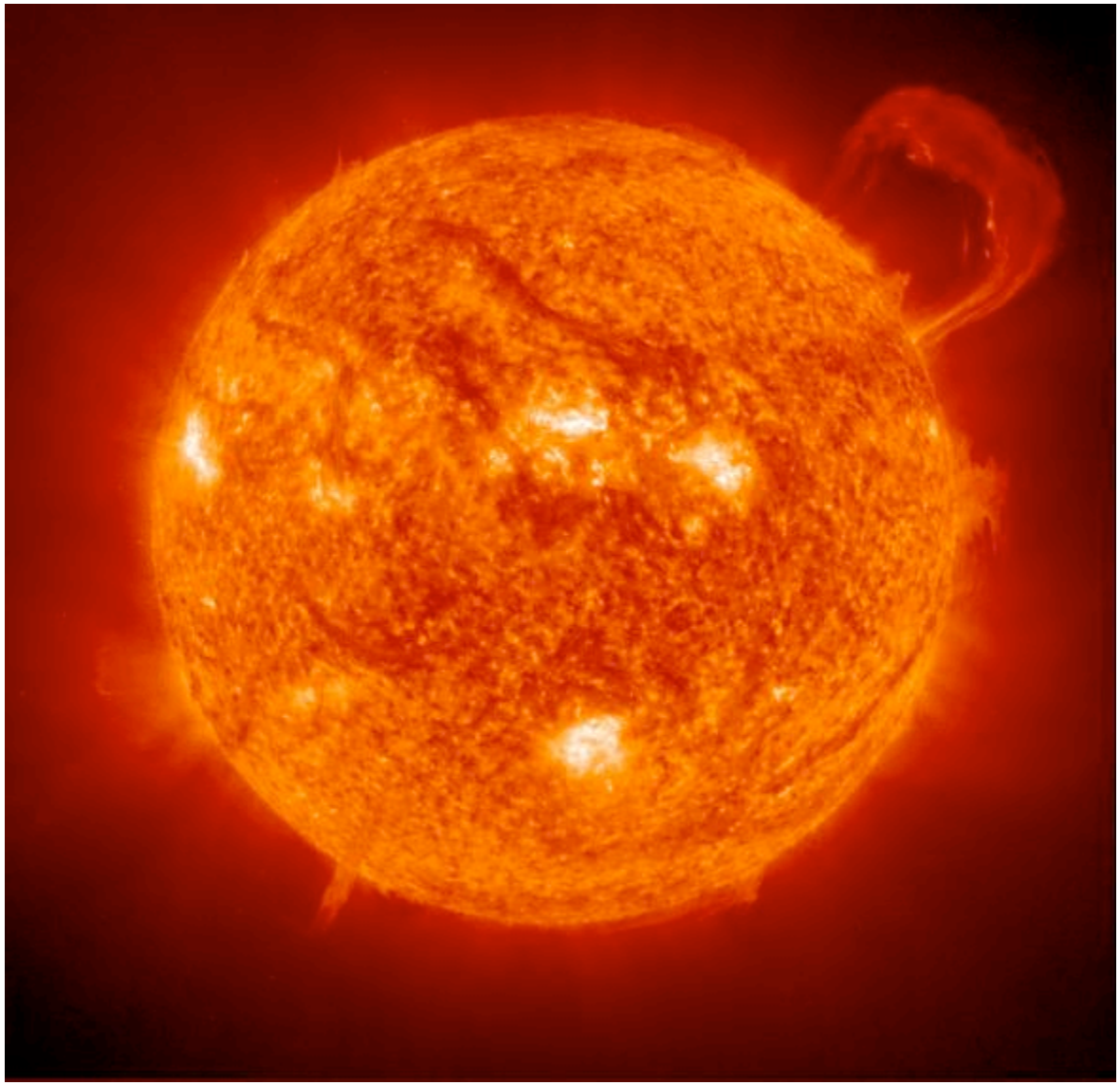
H^+ & e^- ~ 95%

He^+ ~ 4 – 5%

O^{6+} rare but a tracer in magnetosphere

n ~ $5/cm^3$

V ~ 400 km/s ⇨ Sound speed ~ 50 km/s



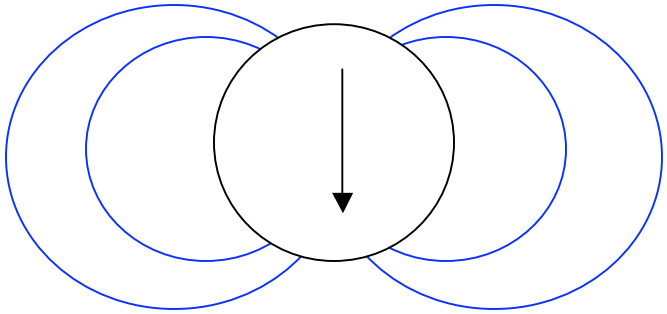
Magnetic Field

Active Regions

- Coronal Mass Ejections
  → High Density
  → Turbulent Magnetic Field

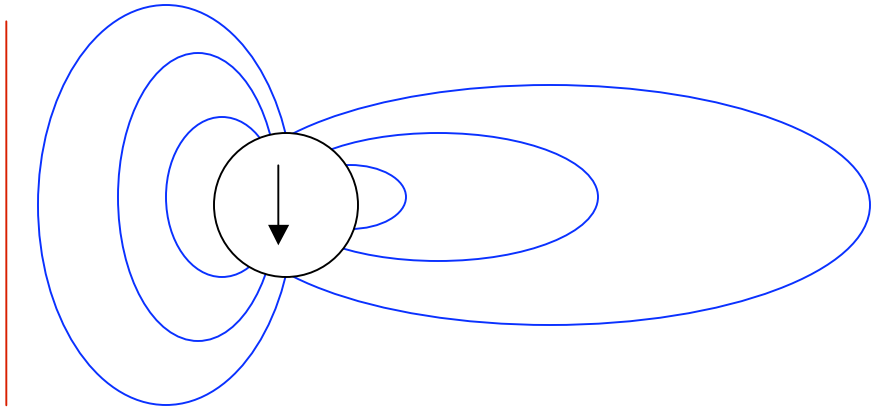
- High speed flows

SW ⇨



0.3 G at equator = 30,000 nT (base units)

SW + magnetic field ⇨ magnetosphere

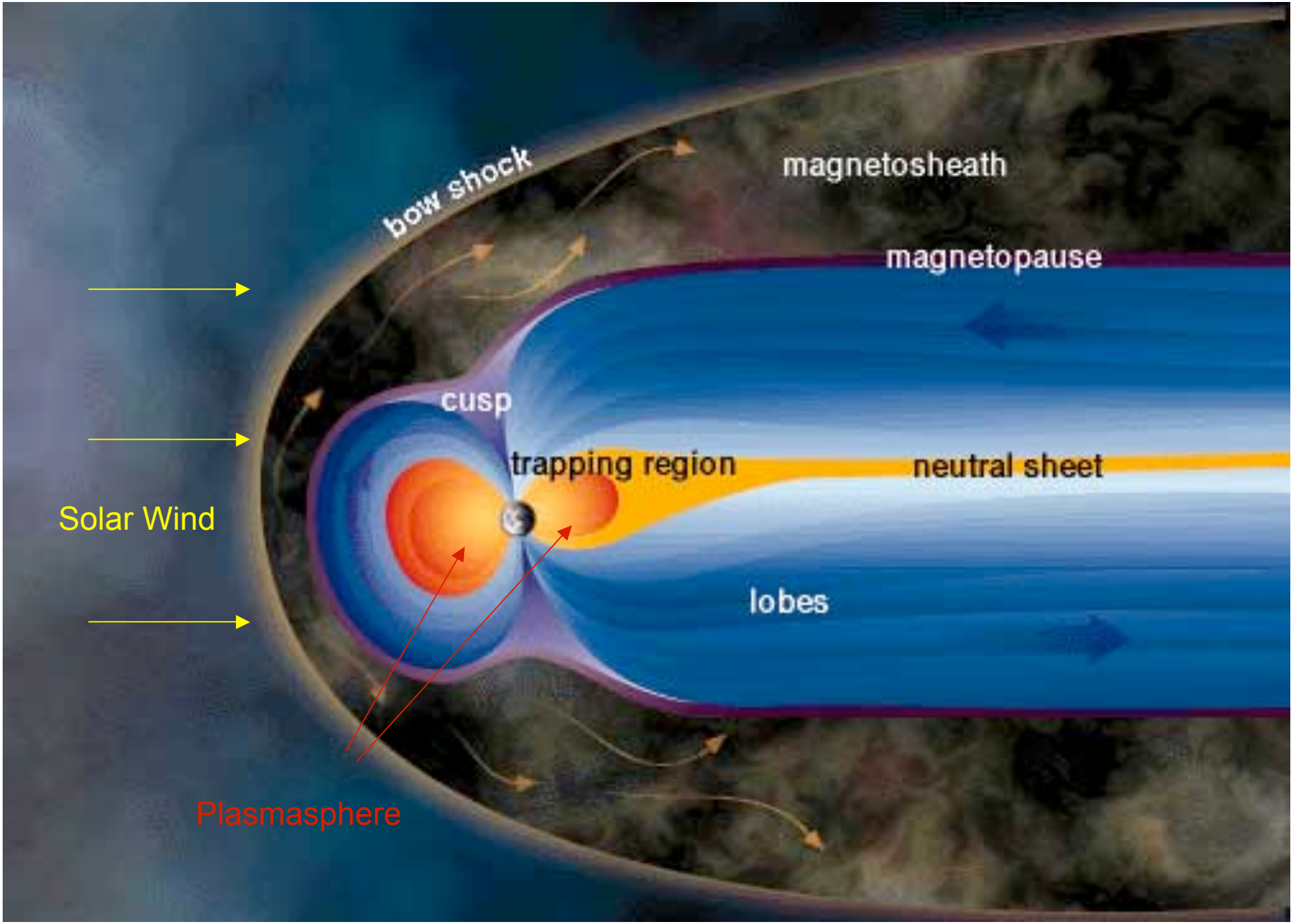


Bow Shock : solar wind supersonic

Magnetopause : balance region; SW dynamic pressure = planet magnetic pressure

$$\rho v^2 = B^2/\mu_o$$

Plasmasphere : under Earth's influence (continuation of ionosphere)


bow shock
magnetosheath
magnetopause
cusp
trapping region
neutral sheet
Solar Wind
lobes
Plasmasphere

Planetary Magnetic Fields

Earth, Jupiter, Saturn, Neptune, Uranus, Mercury (small), Ganymede

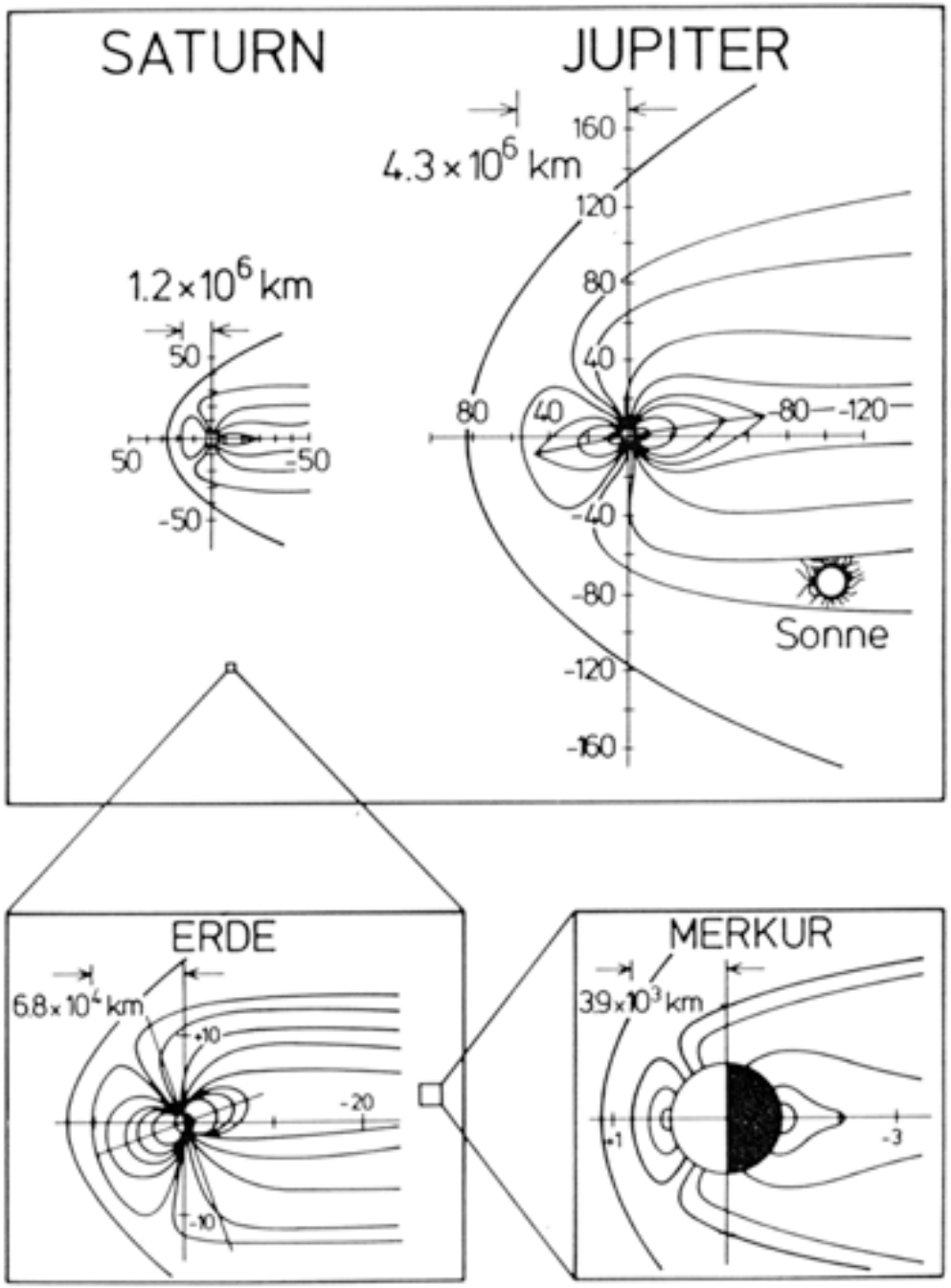
No Global Field

⇨ induced magnetic fields

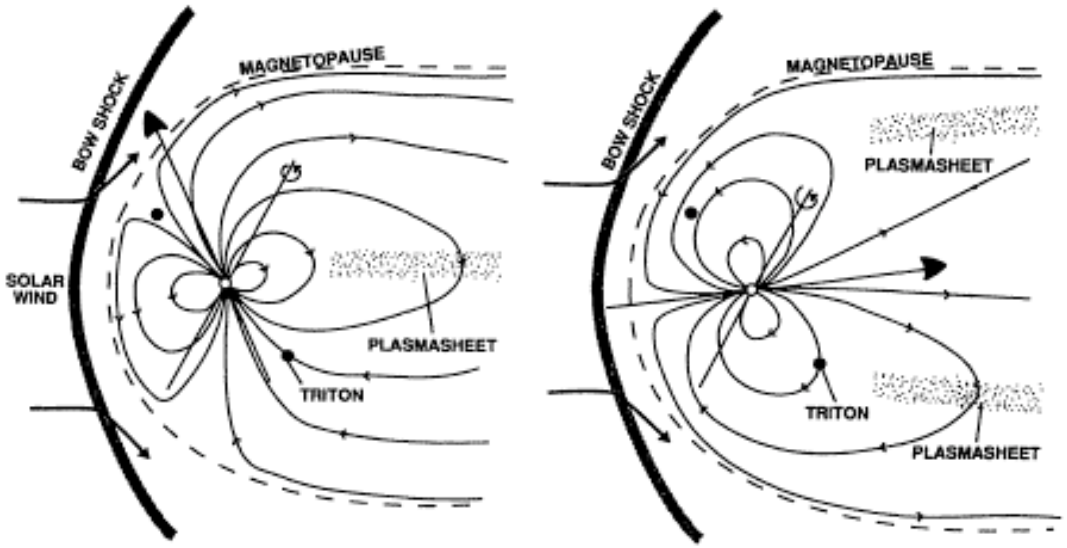
Venus, Io, Europa

Magnetic Anomalies

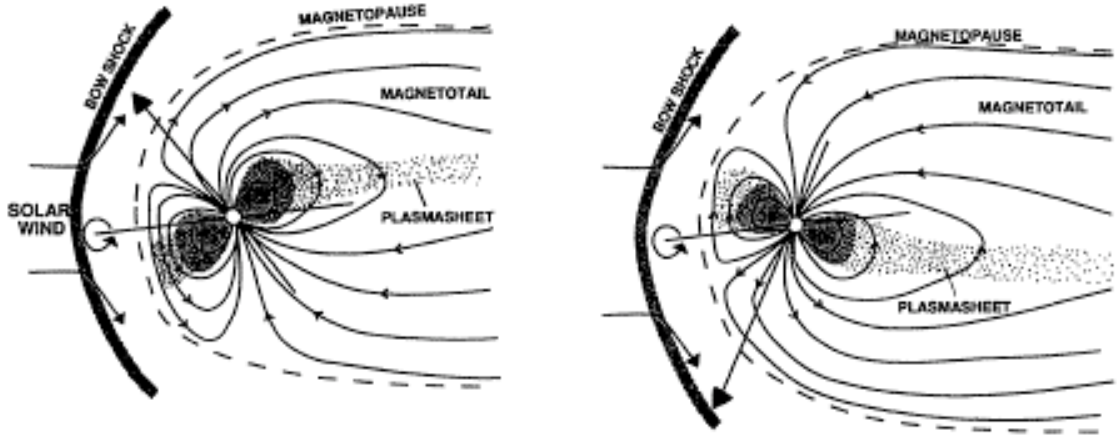
Mars, Moon



NEPTUNE



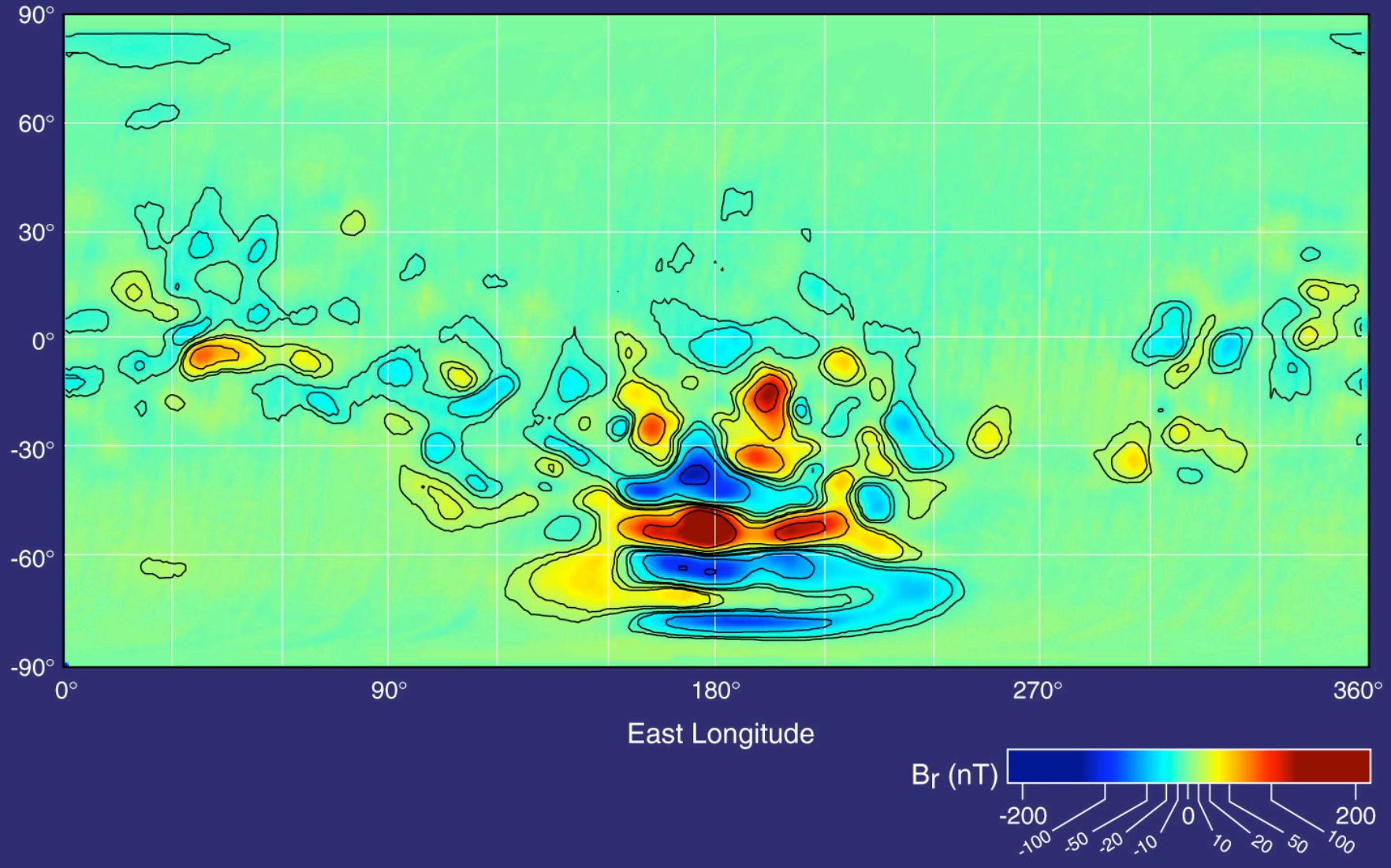
URANUS



Mars Crustal Magnetism

Mars Global Surveyor

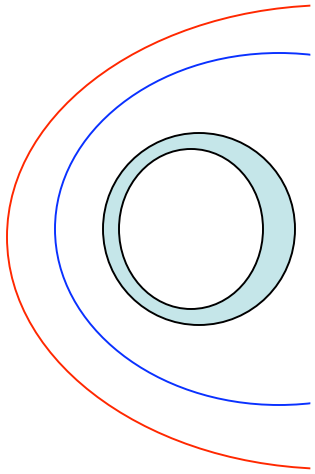
MAG/ER



Connerney et al., *Geophys.Res. Lett., 28,* 4015-4018, 2001.

ConJ2001187.001v

SW + ionosphere ⇨



Ionopause = balance region (thermal pressure of ionosphere)

$\rho v^2 = nkT$

MPB = magnetic pileup boundary

Bow shock

Applicable to:

Mars, comets, Pluto(?)

Ion pick-up – applicable to Jovian moons

Why is this important?

- Space Weather
- Planetary Evolution
- Overlap with other fields