Magnetospheric Geography

Narges Ahmadi
University of New Hampshire
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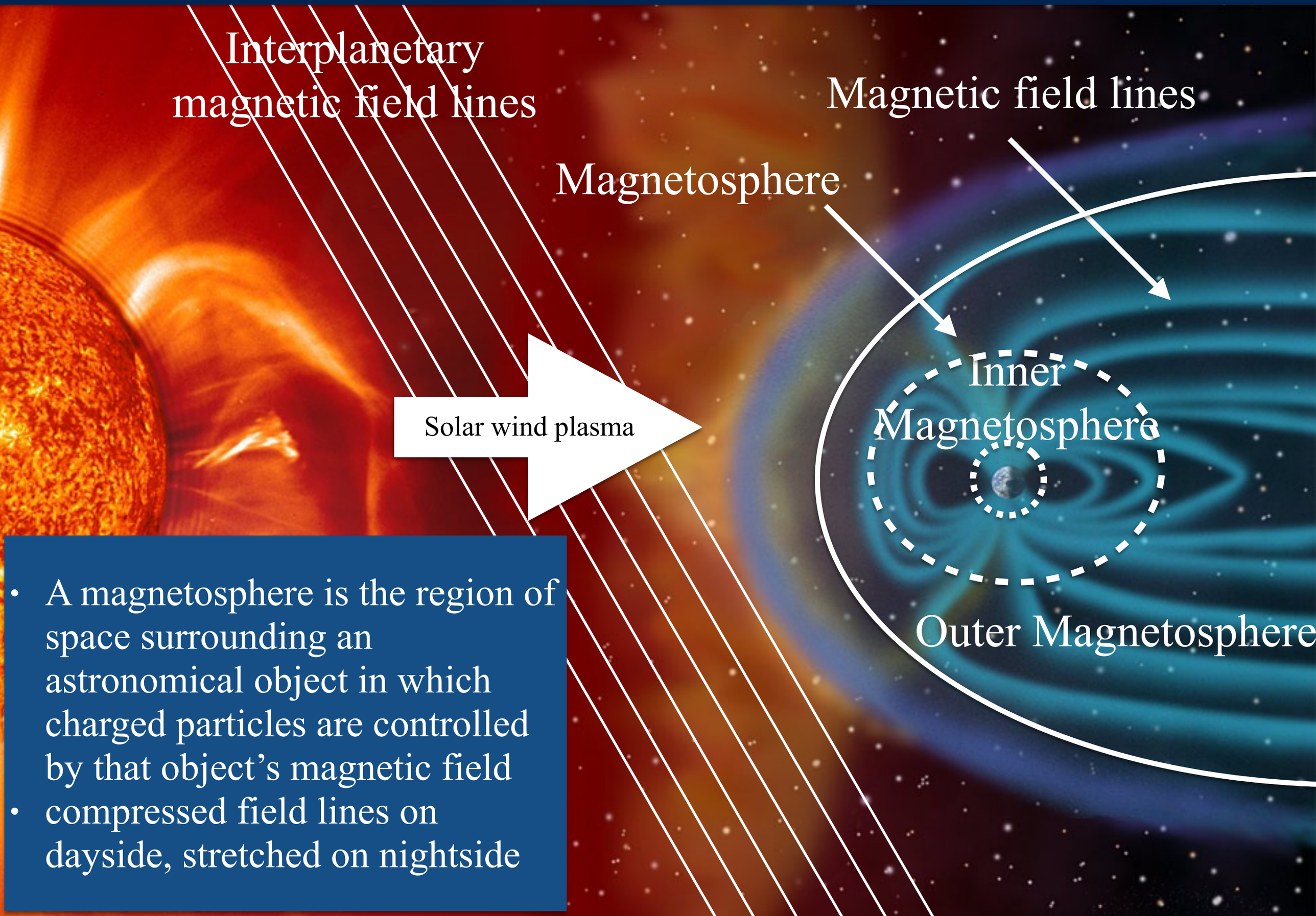
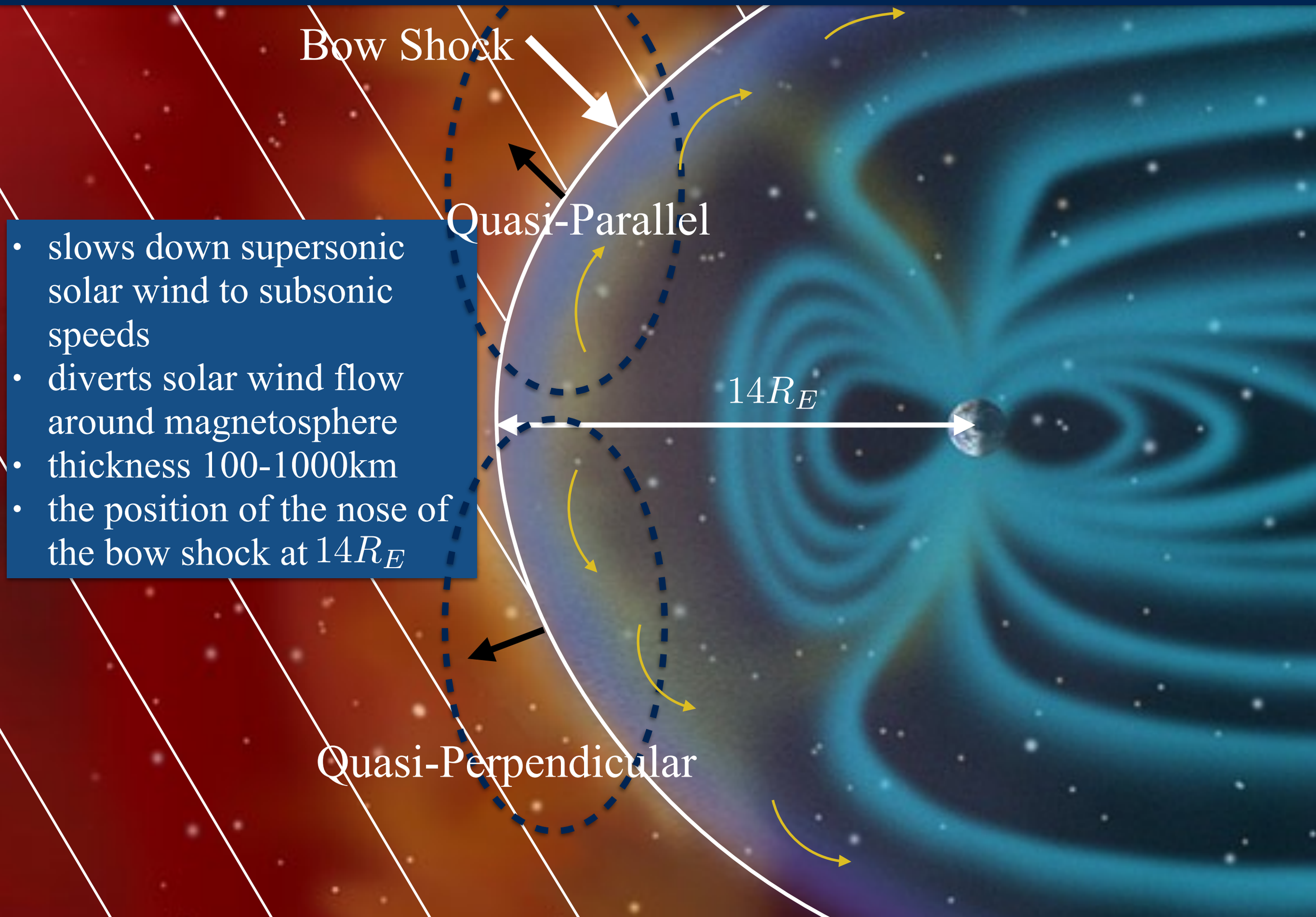
How is Magnetosphere formed?



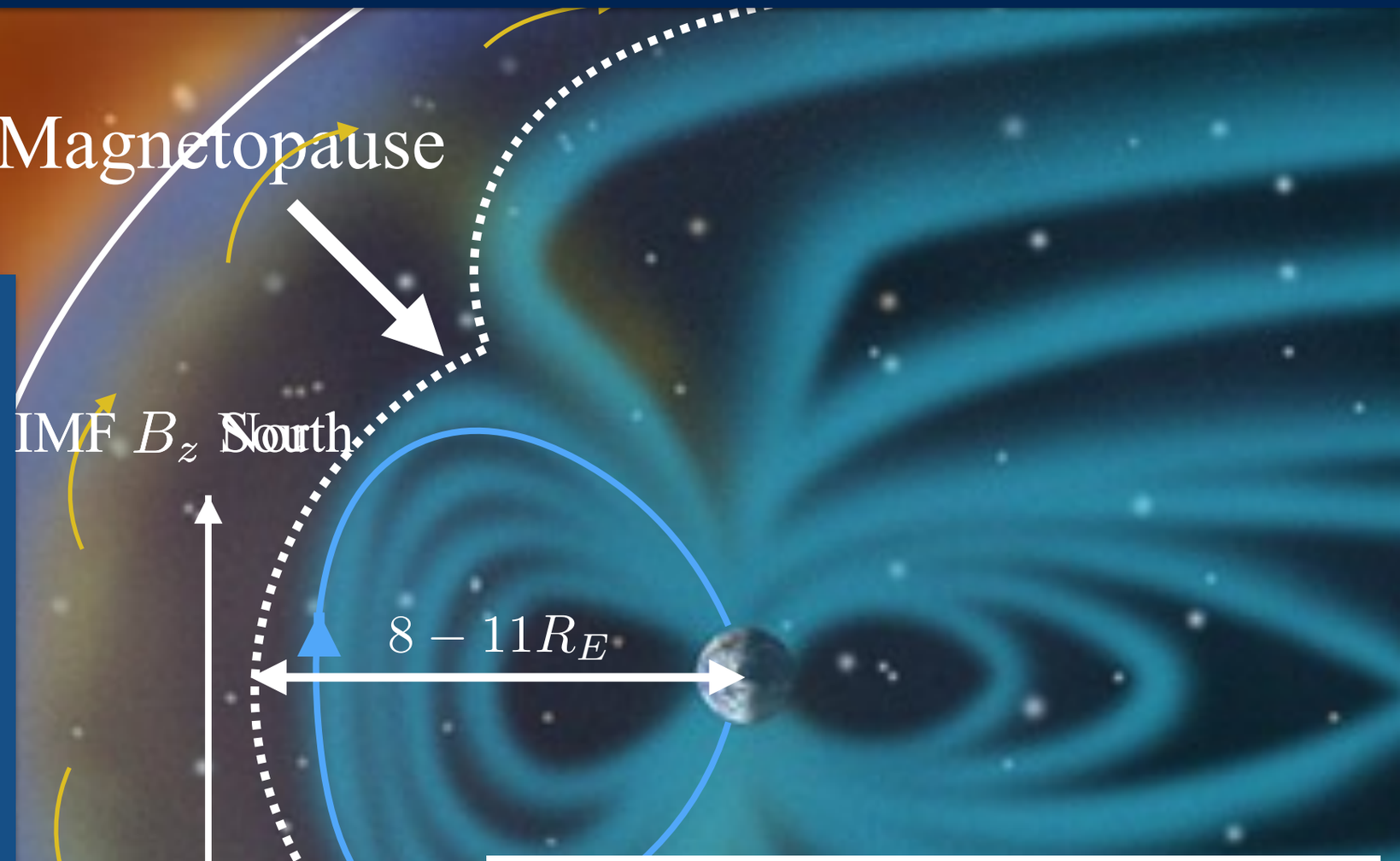
- A magnetosphere is the region of space surrounding an astronomical object in which charged particles are controlled by that object's magnetic field
- compressed field lines on dayside, stretched on nightside

Bow Shock

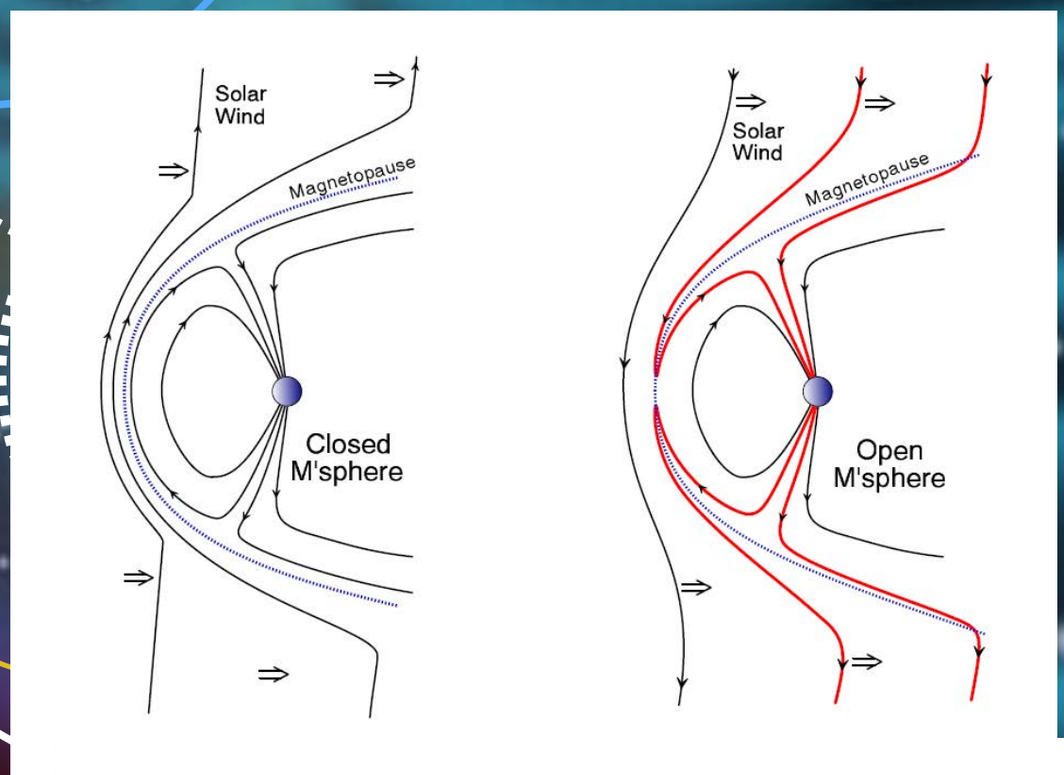


- slows down supersonic solar wind to subsonic speeds
- diverts solar wind flow around magnetosphere
- thickness 100-1000km
- the position of the nose of the bow shock at $14R_E$

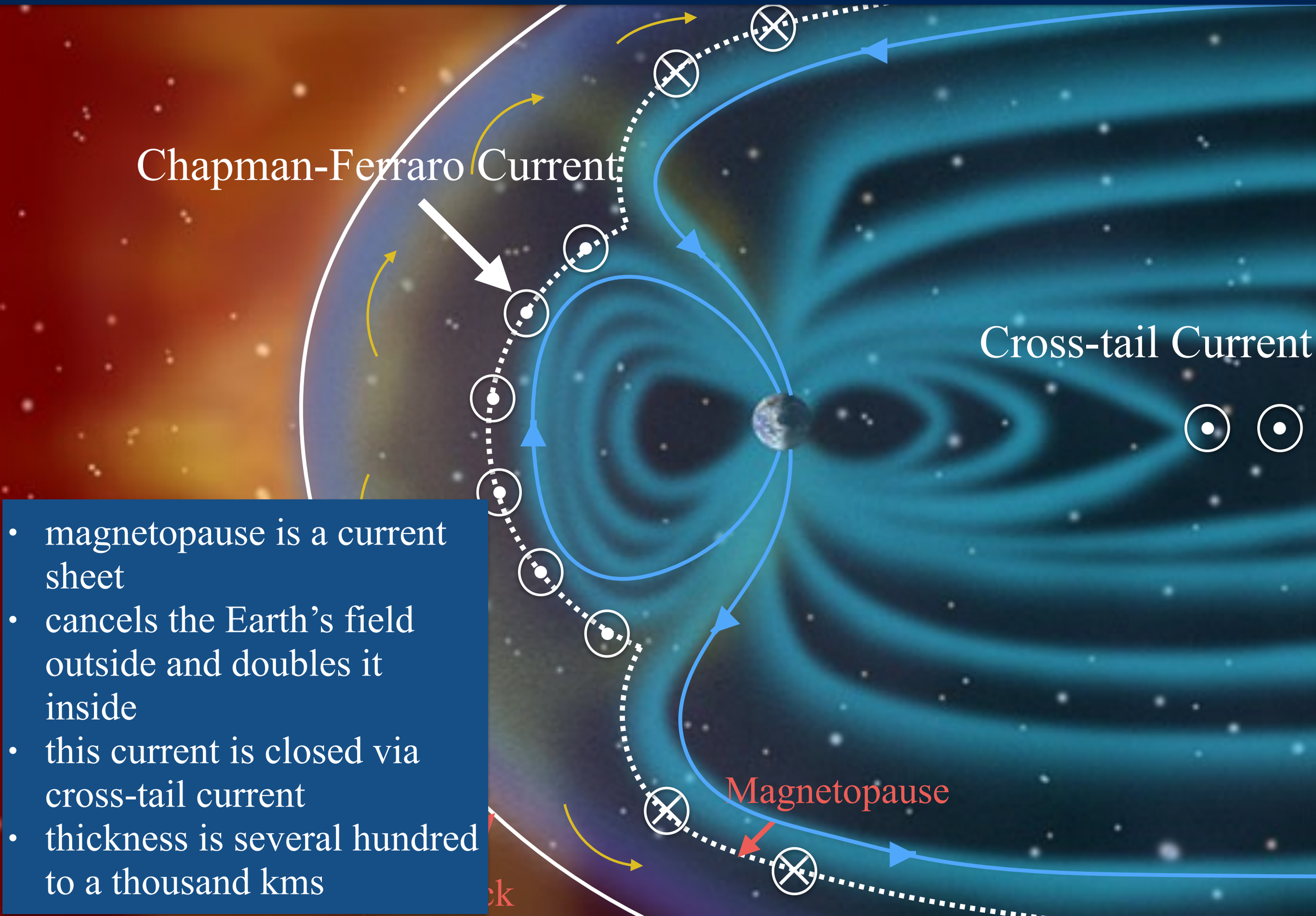
- boundary between the Earth's magnetic field and solar wind
- location is determined by the balance between solar wind dynamic pressure and Earth's magnetic field pressure
- the location at $8 - 11R_E$



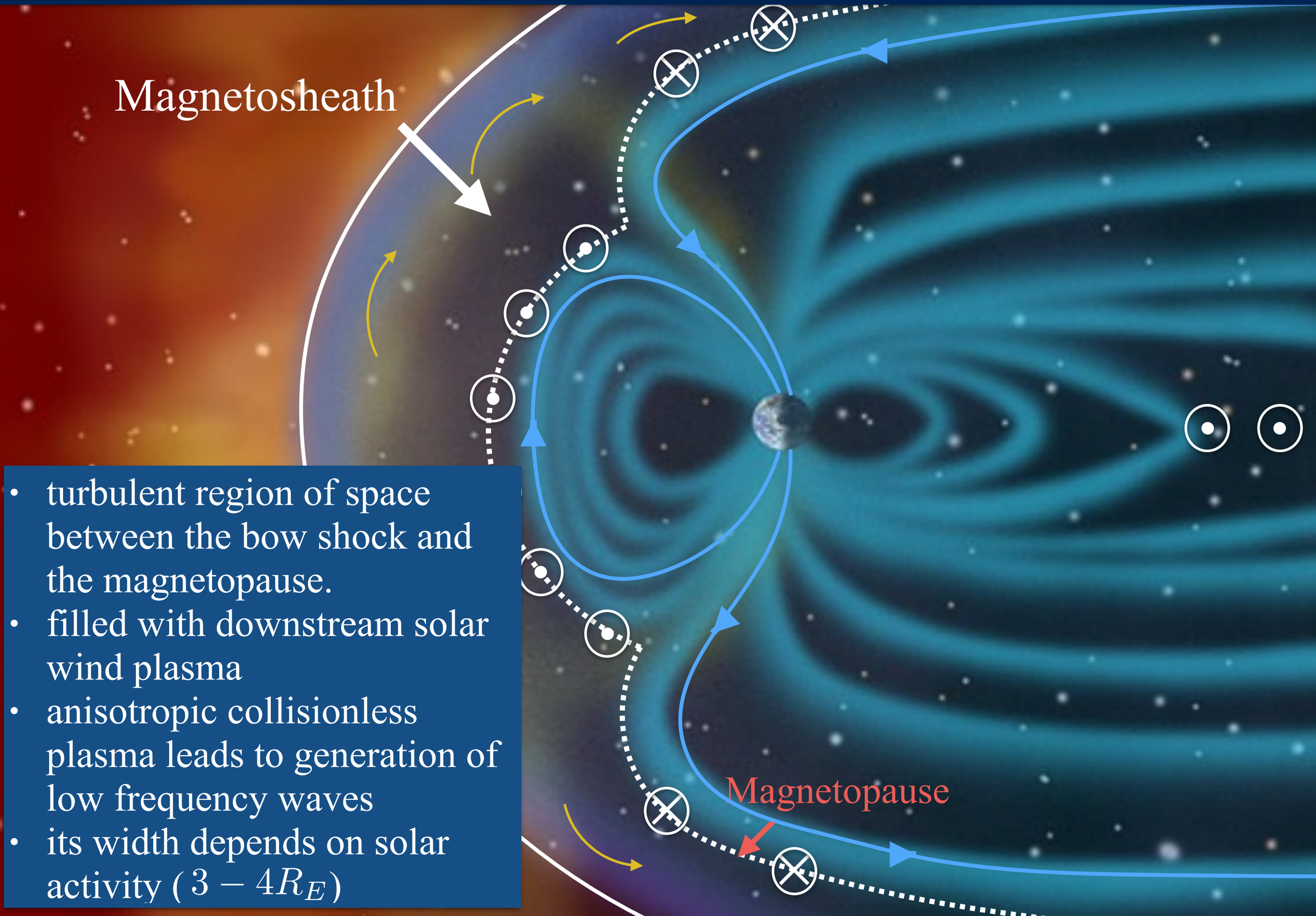
IMF B_z North:
Closed field lines
No mass transport, Momentum and energy transported by waves
IMF B_z South:
Open field lines
Mass, momentum, and energy transport by reconnection



Magnetopause Current



- magnetopause is a current sheet
- cancels the Earth's field outside and doubles it inside
- this current is closed via cross-tail current
- thickness is several hundred to a thousand kms



- turbulent region of space between the bow shock and the magnetopause.
- filled with downstream solar wind plasma
- anisotropic collisionless plasma leads to generation of low frequency waves
- its width depends on solar activity ($3 - 4R_E$)

Magnetospheric Boundary Layers

Region close to the Earth's magnetopause in which magnetosheath plasma has strong influence

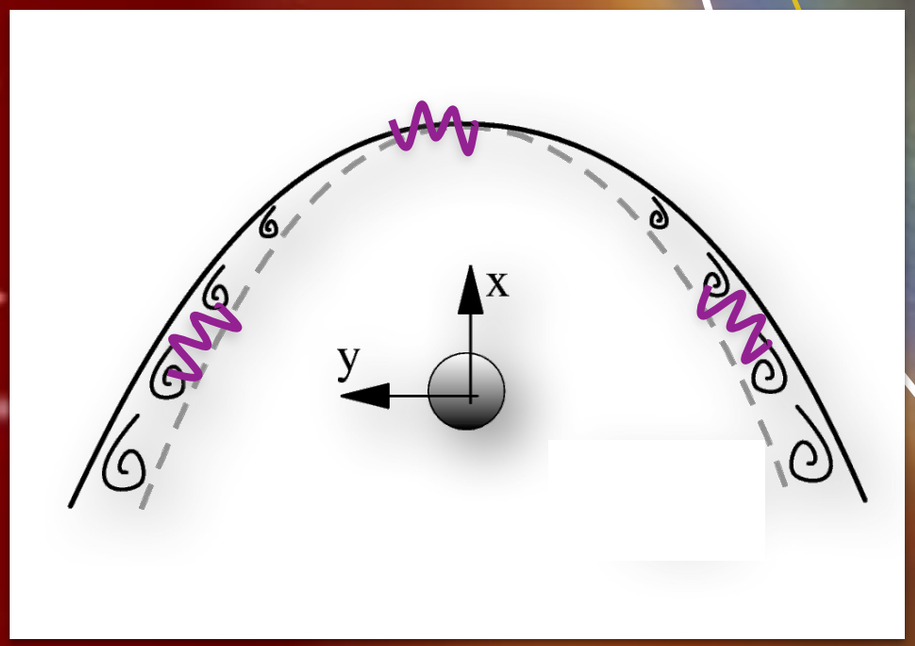
Mantle

Cusp

LLBL

Cusp

Mantle



Low Latitude boundary layer (LLBL)

- transferring a large fraction of plasma from magnetosheath into magnetosphere
- thickness increases with increasing distance from subsolar point
- may be partially on open field lines, especially during southward IMF

Magnetospheric Boundary Layers

Region close to the Earth's magnetopause in which magnetosheath plasma has strong influence

Mantle

Cusp

LLBL

Cusp

Mantle

Cusps

- transition region at the dayside boundary of the polar cap between IMF lines going sunward and tail-ward
- magnetospheric plasma directly enter the magnetosphere resulting in auroral displays

Magnetospheric Boundary Layers

Region close to the Earth's magnetopause in which magnetosheath plasma has strong influence

Mantle

Cusp

LLBL

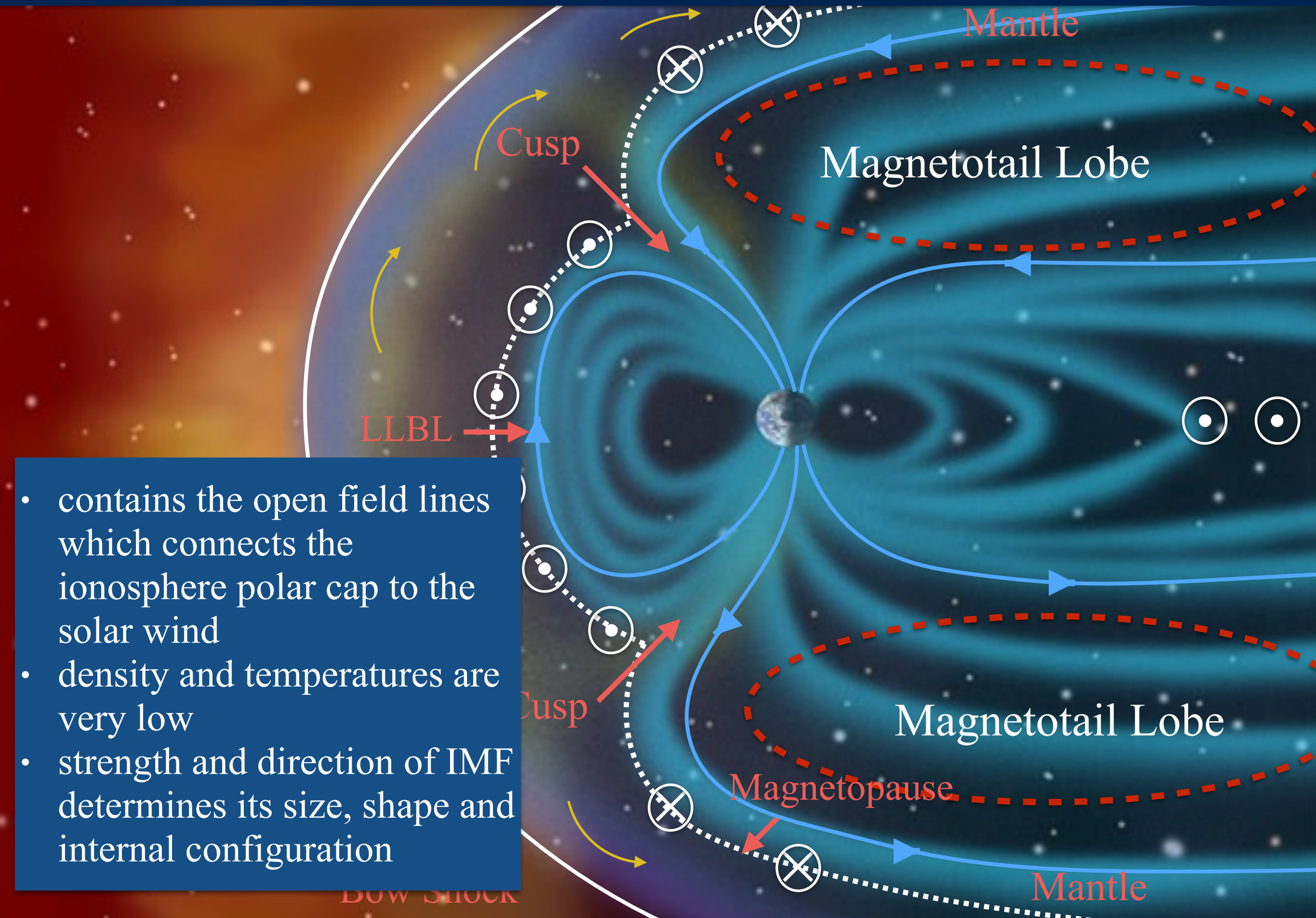
Cusp

Mantle

High Latitude boundary layer (Plasma Mantle)

- covers much of the high-latitude region extending poleward of the cusp region
- the density decreases when moving inward
- tailward flow velocities
- thicker for southward IMF

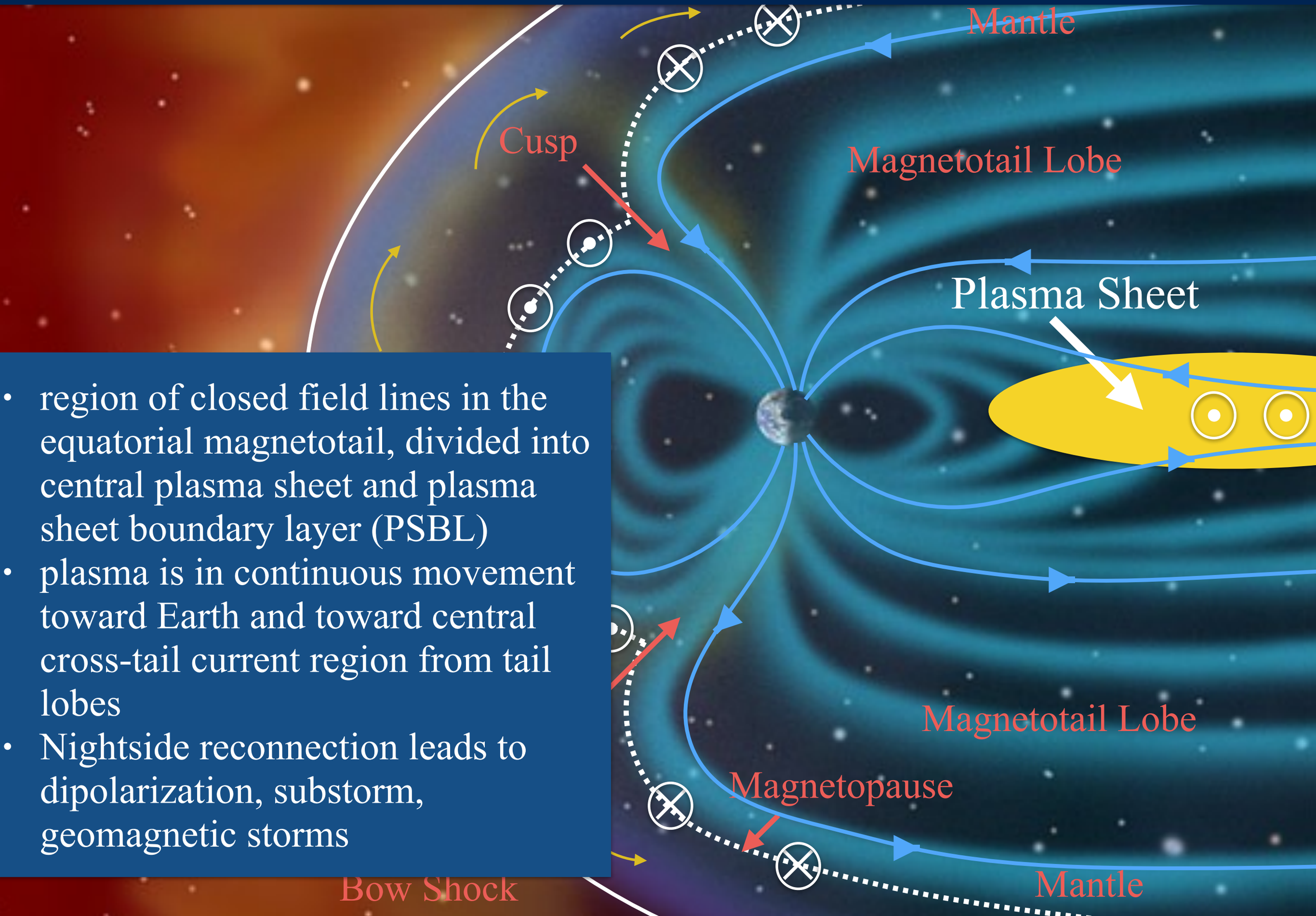
Magnetotail Lobe

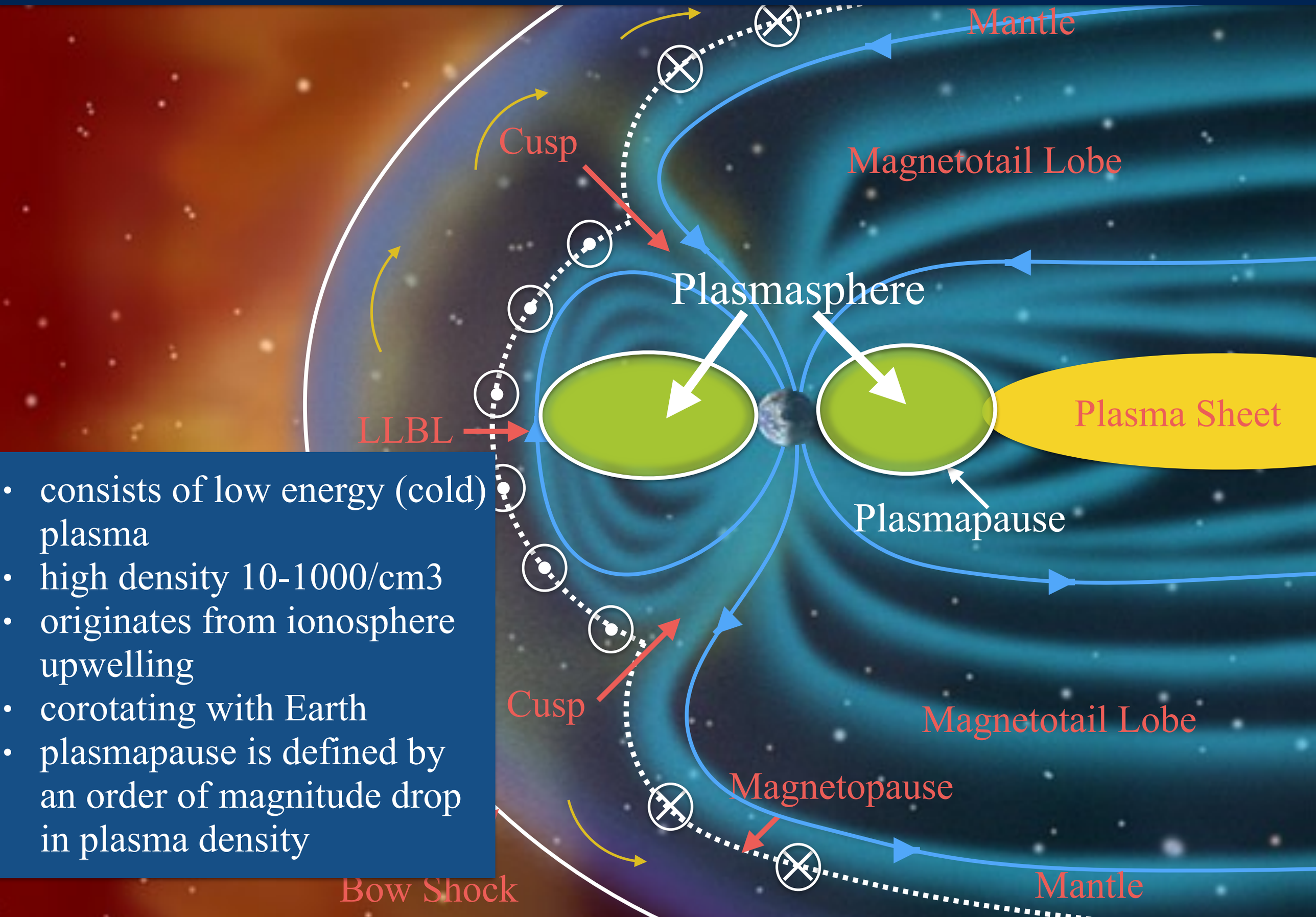


- contains the open field lines which connects the ionosphere polar cap to the solar wind
- density and temperatures are very low
- strength and direction of IMF determines its size, shape and internal configuration

Plasma Sheet

- region of closed field lines in the equatorial magnetotail, divided into central plasma sheet and plasma sheet boundary layer (PSBL)
- plasma is in continuous movement toward Earth and toward central cross-tail current region from tail lobes
- Nightside reconnection leads to dipolarization, substorm, geomagnetic storms





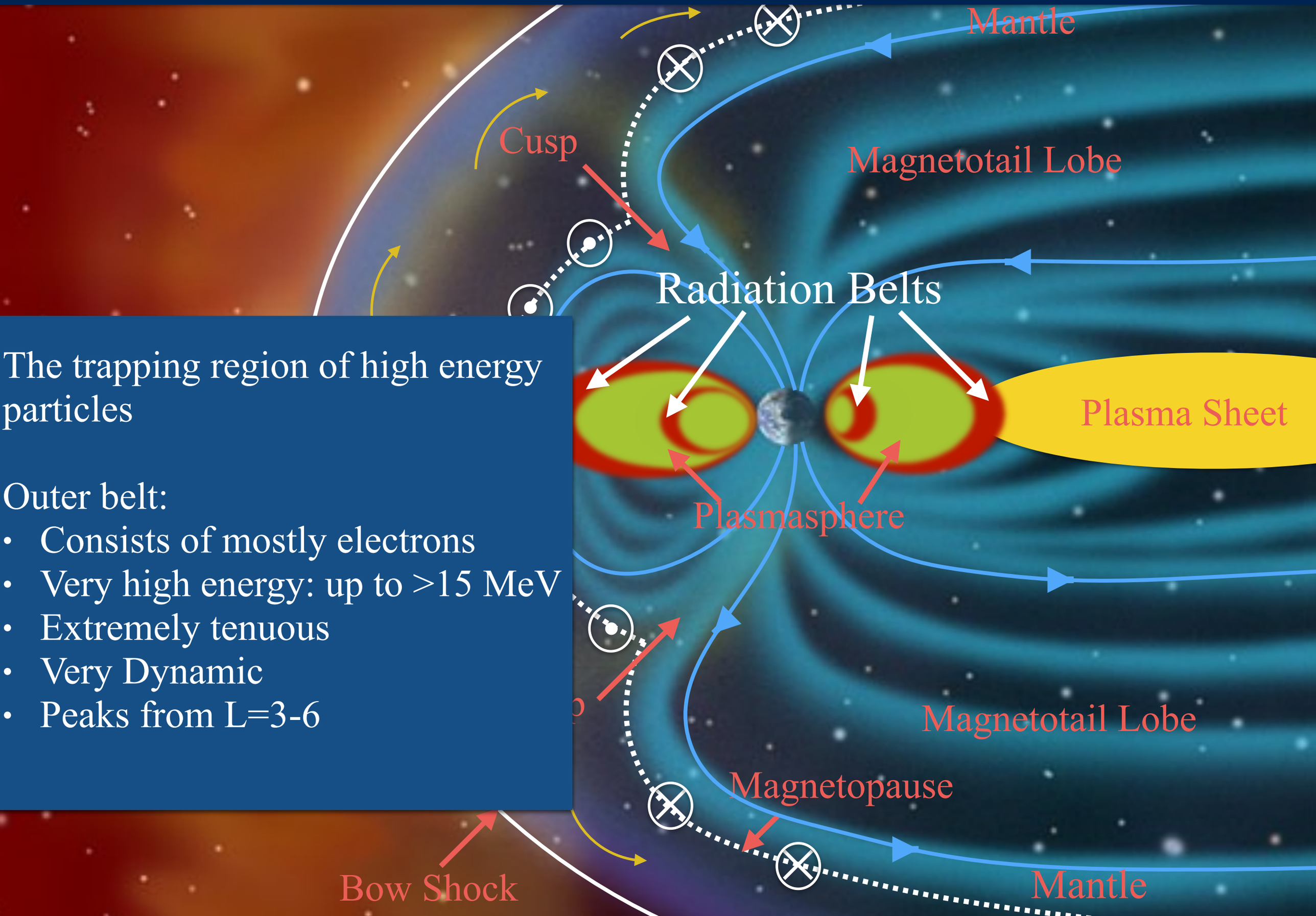
- consists of low energy (cold) plasma
- high density 10-1000/cm3
- originates from ionosphere upwelling
- corotating with Earth
- plasmapause is defined by an order of magnitude drop in plasma density

Radiation Belts

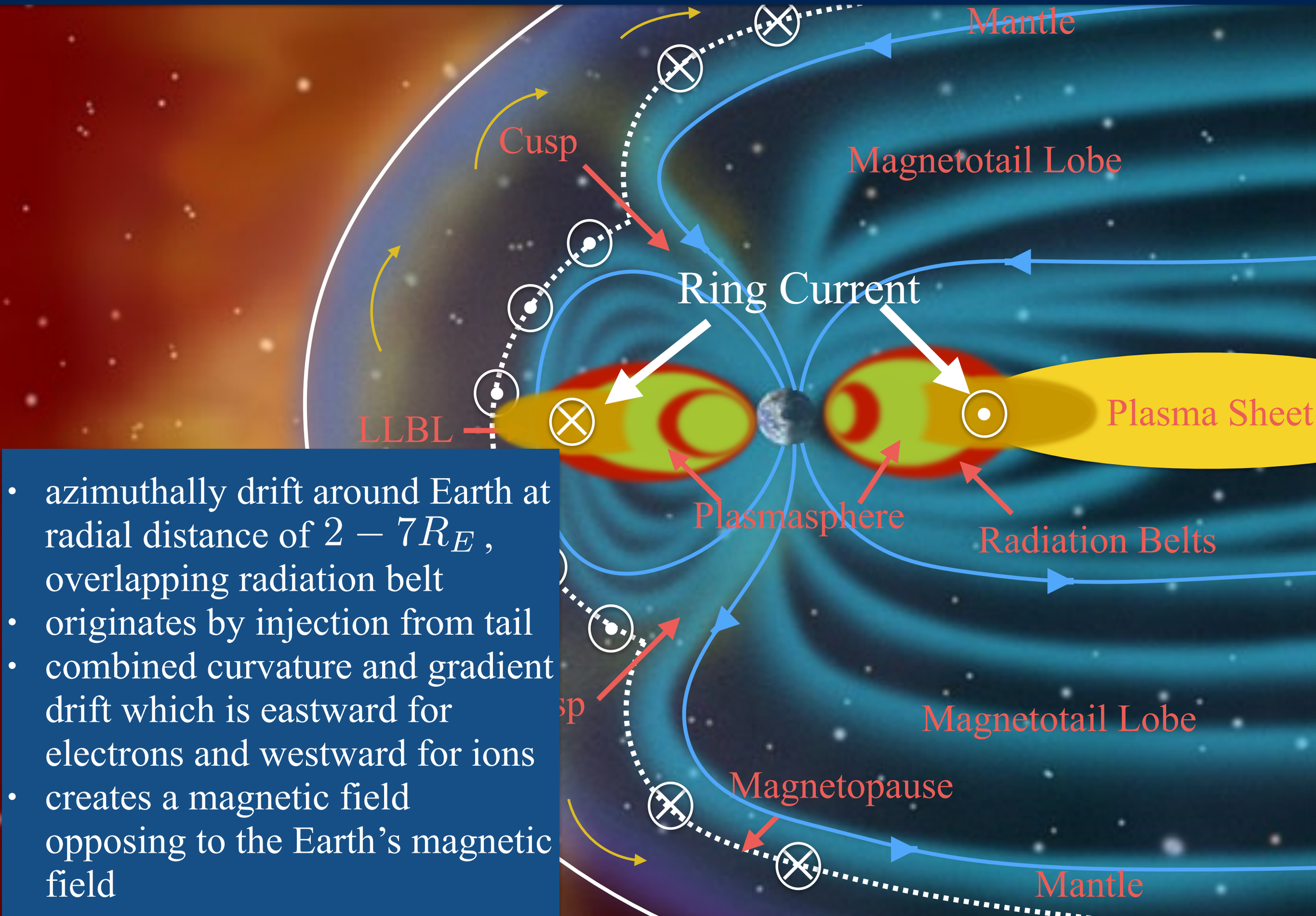
The trapping region of high energy particles

Outer belt:

- Consists of mostly electrons
- Very high energy: up to >15 MeV
- Extremely tenuous
- Very Dynamic
- Peaks from L=3-6

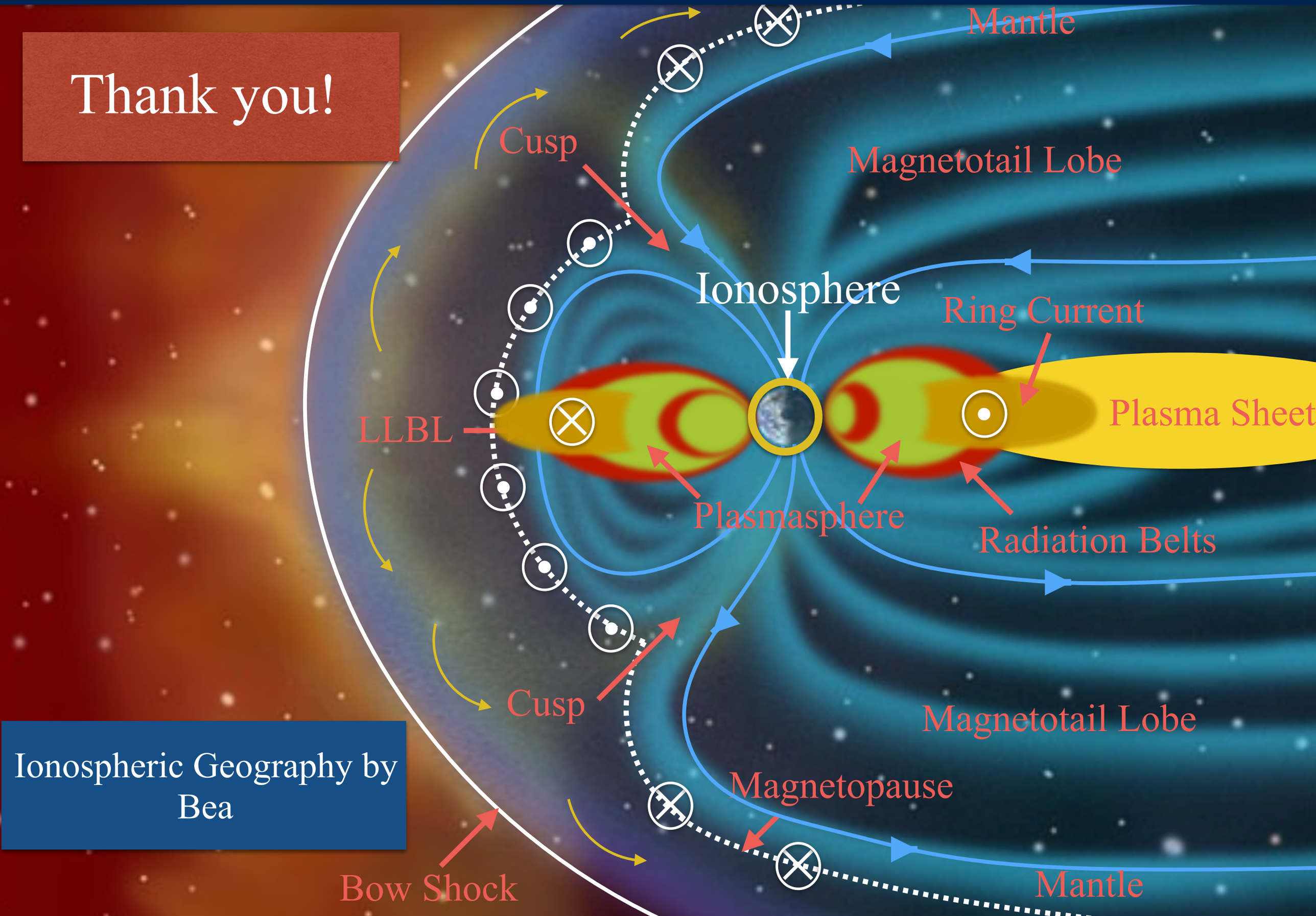


Ring Current



- azimuthally drift around Earth at radial distance of $2 - 7R_E$, overlapping radiation belt
- originates by injection from tail
- combined curvature and gradient drift which is eastward for electrons and westward for ions
- creates a magnetic field opposing to the Earth's magnetic field

Thank you!



Ionospheric Geography by Bea