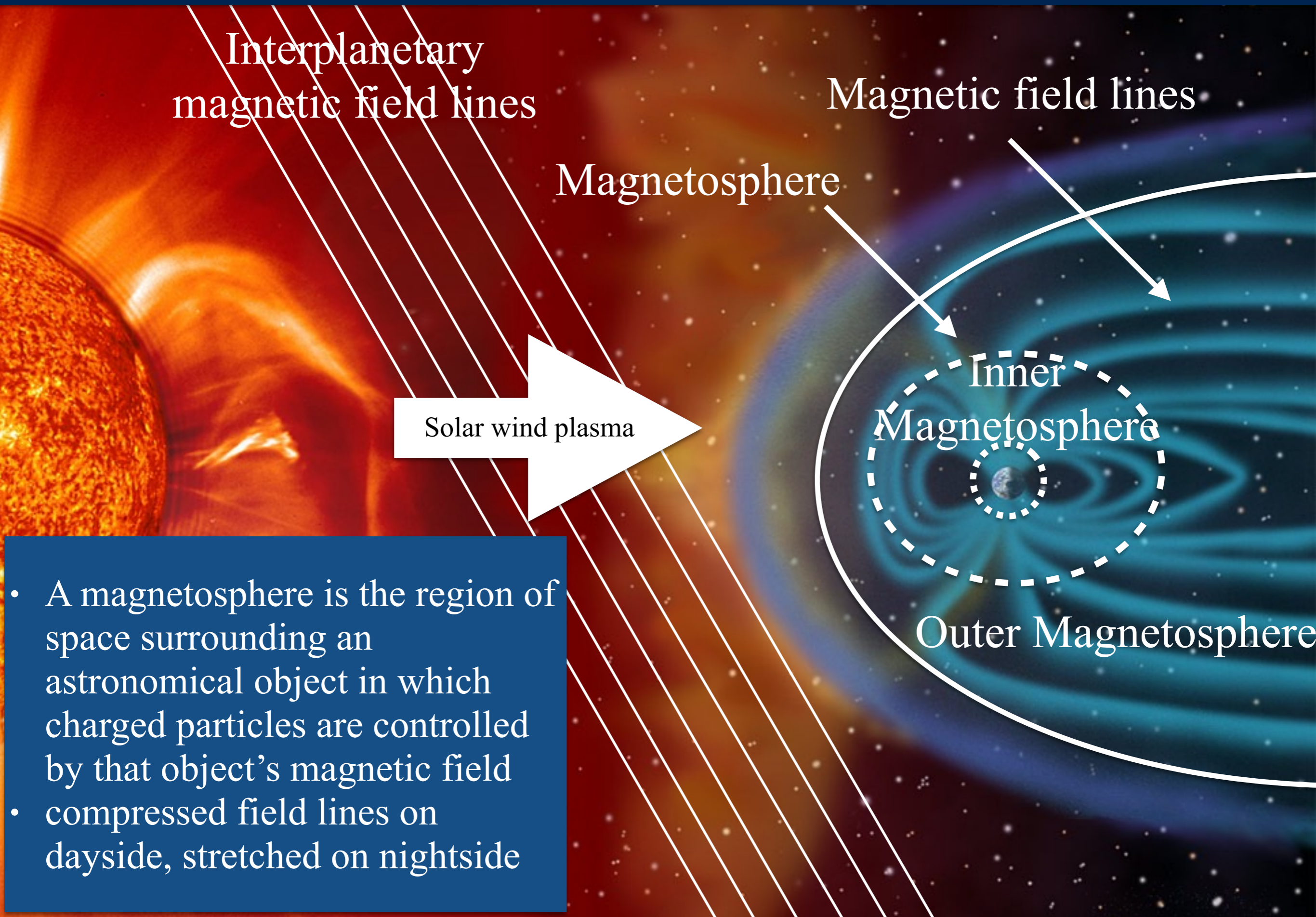


Magnetospheric Geography

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How is Magnetosphere formed?



Interplanetary
magnetic field lines

Magnetic field lines

Magnetosphere

Solar wind plasma

Inner
Magnetosphere

Outer Magnetosphere

- 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

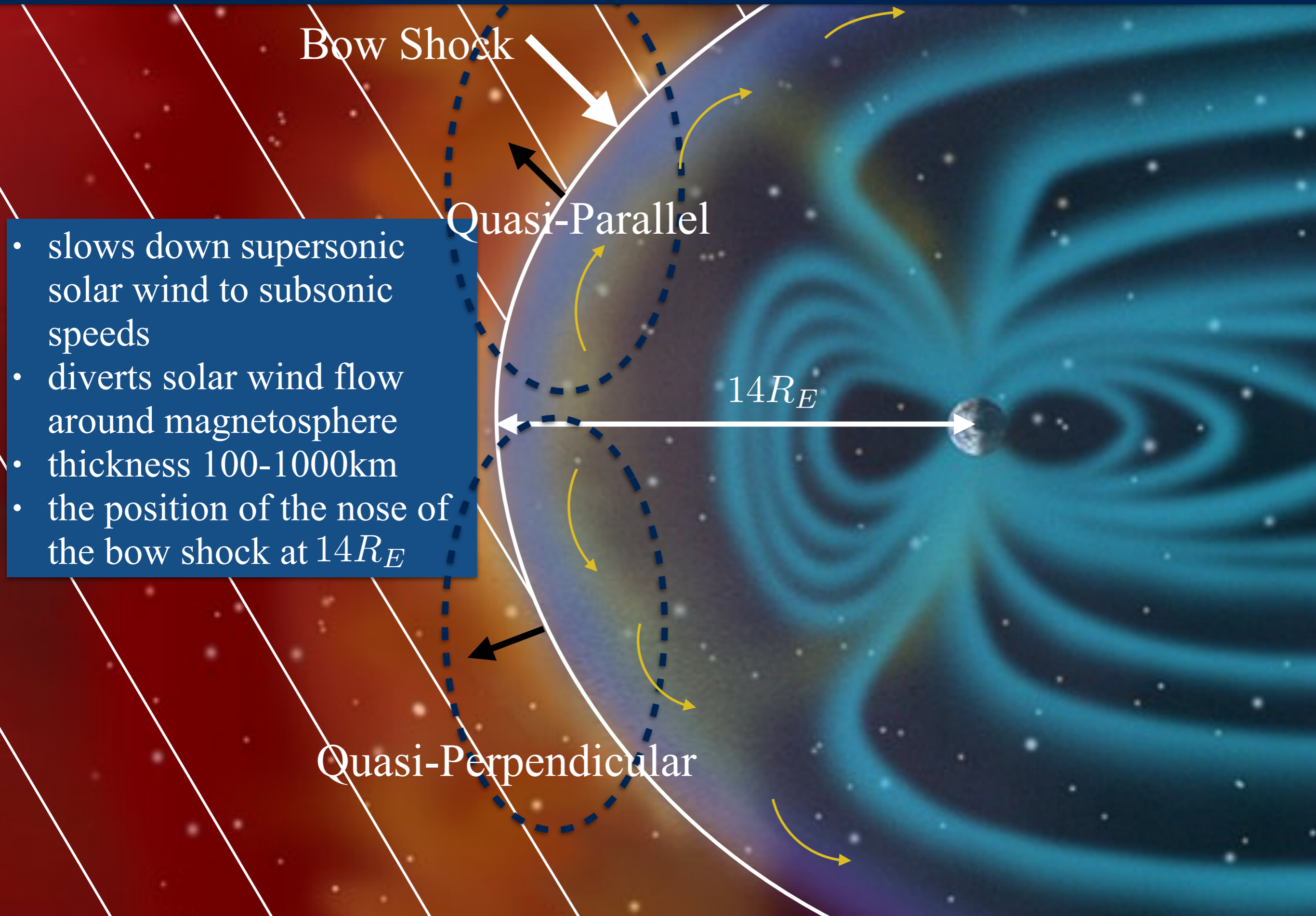
Bow Shock

Quasi-Parallel

 $14R_E$

Quasi-Perpendicular

- 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 $14R_E$



Magnetopause

Magnetopause

IMF B_z North $8 - 11R_E$

- 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:

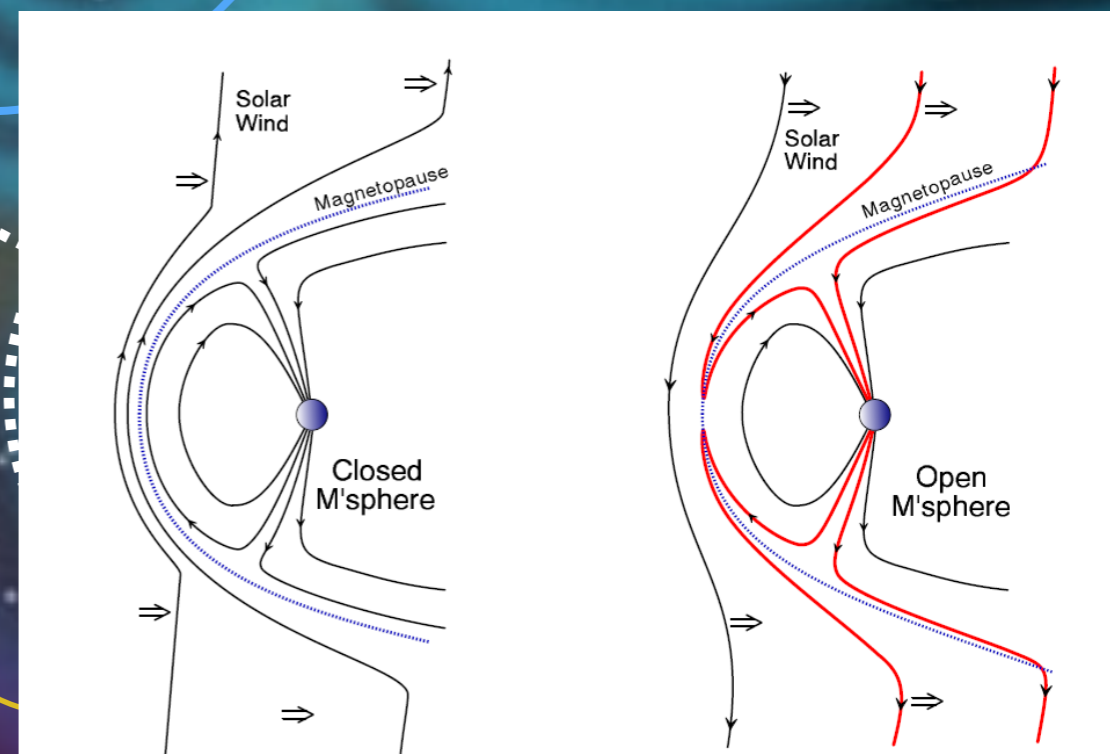
Closed field lines

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

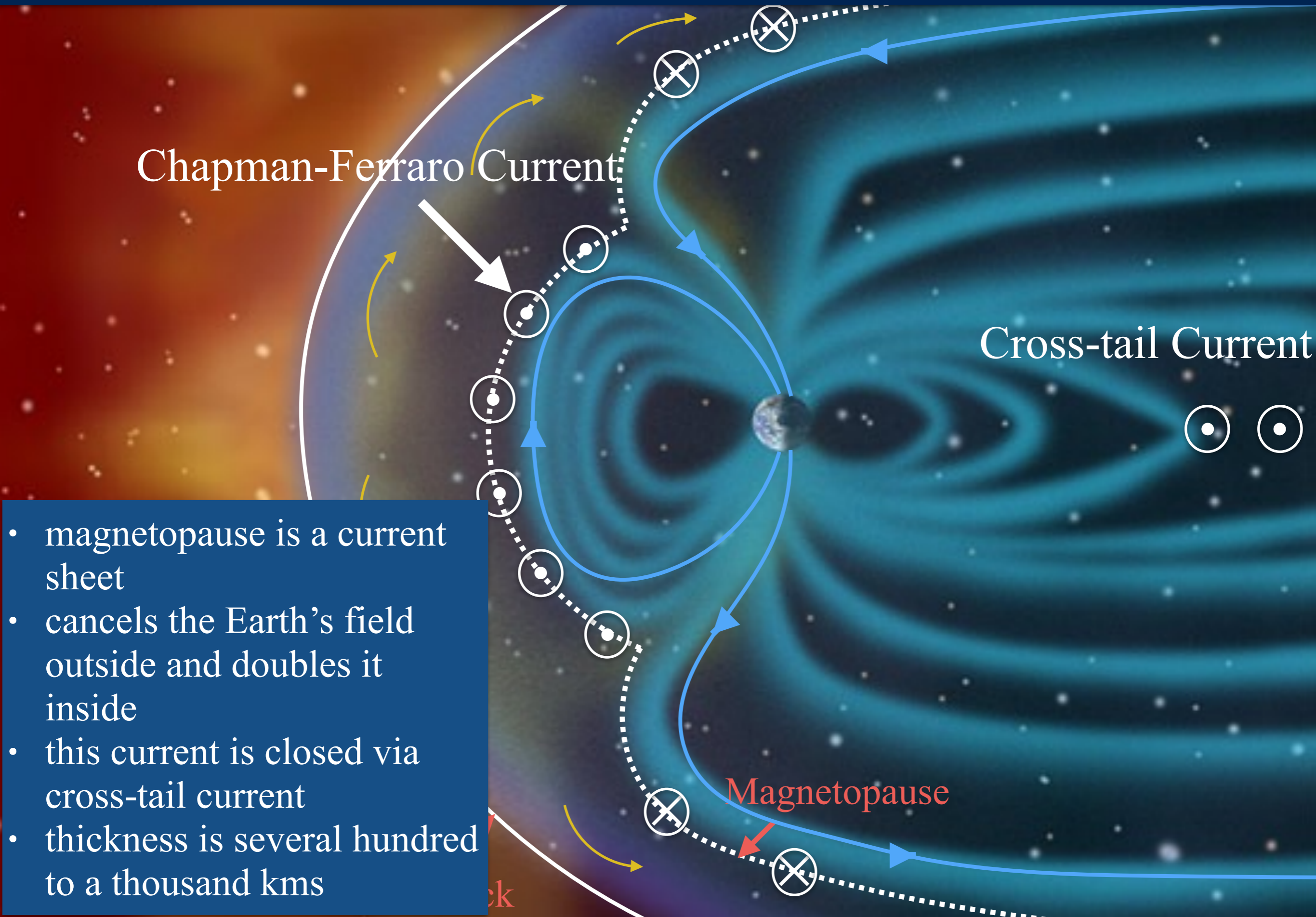
Chapman-Ferraro Current

Cross-tail 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

Magnetopause

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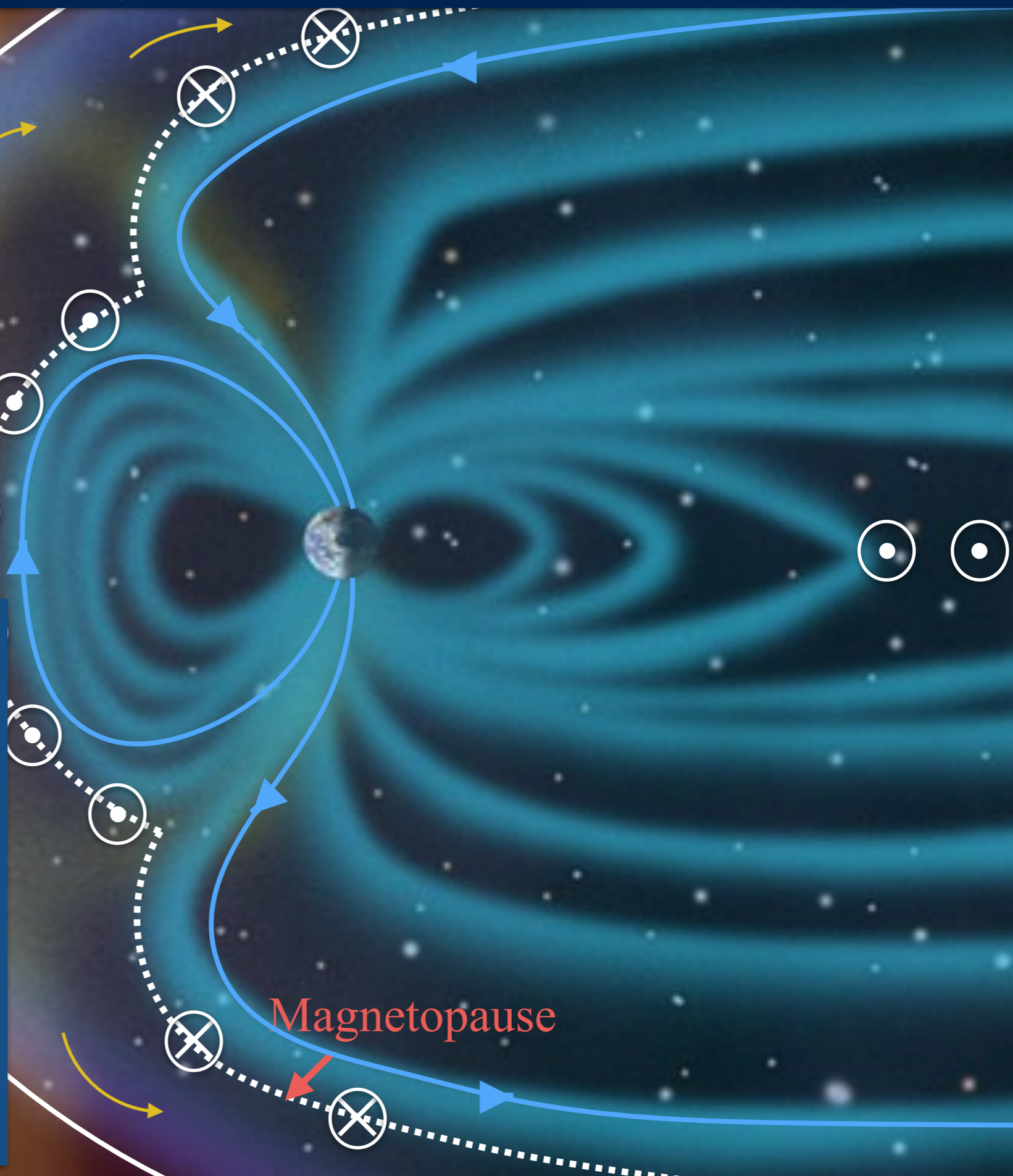


Magnetosheath

Magnetosheath

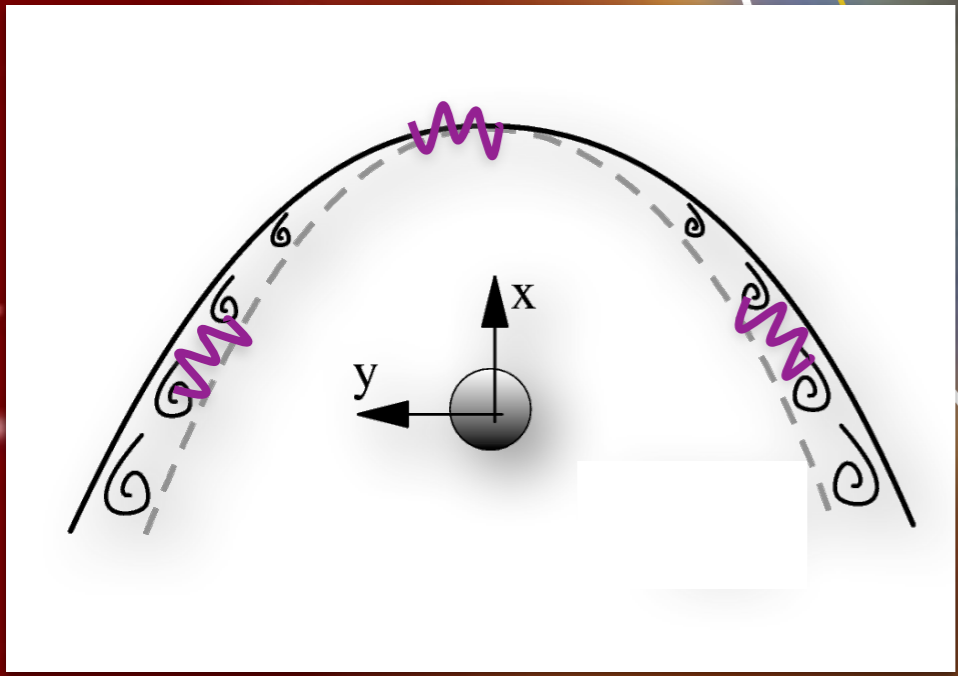
- turbulent region of space between the bow shock and the magnetopause.
- filled with downstream solar wind plasma
- anisotropic collisionless plasma leads to generation of low frequency waves
- its width depends on solar activity ($3 - 4R_E$)

Magnetopause



Magnetospheric Boundary Layers

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



LLBL

Cusp

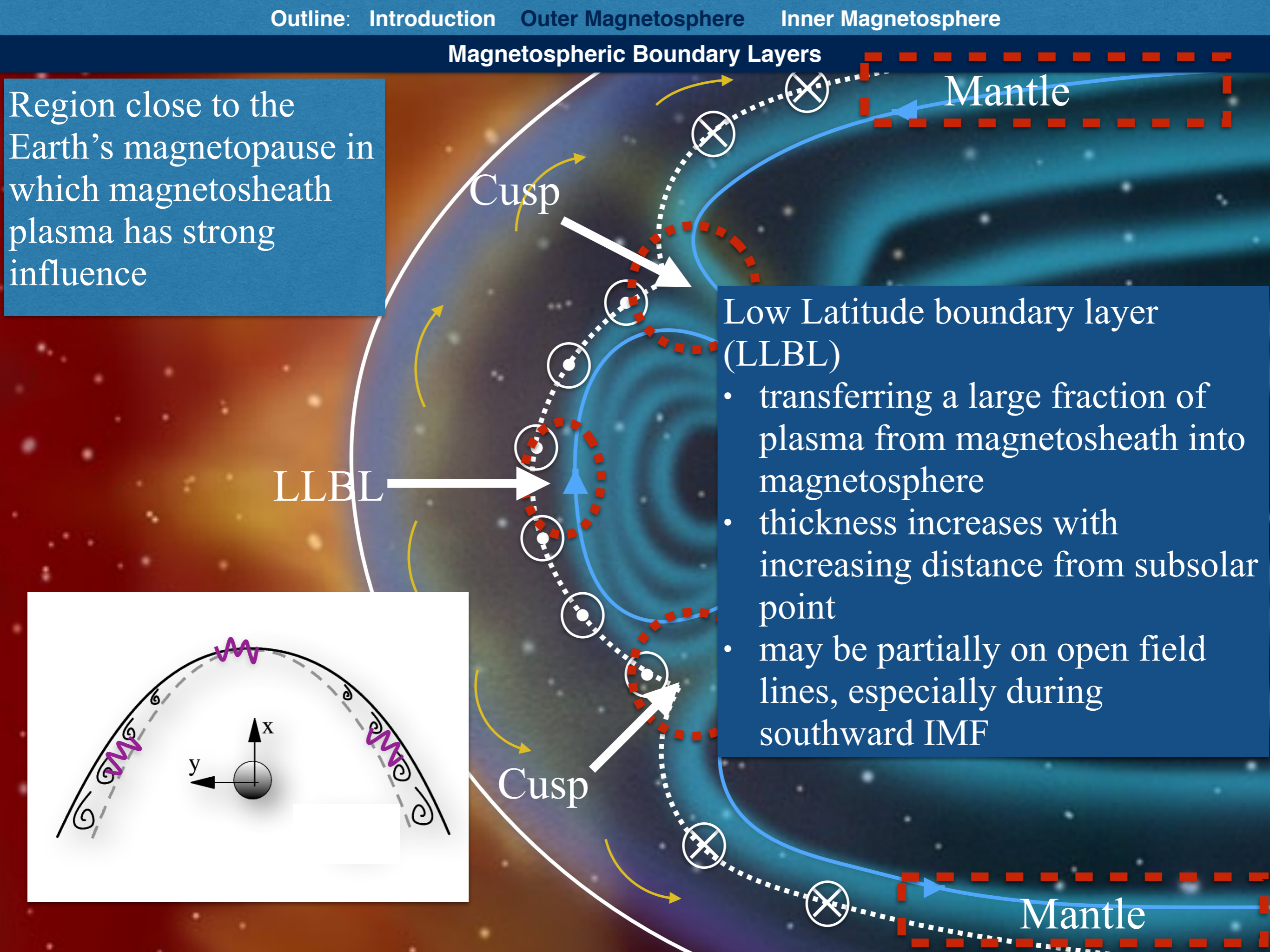
Cusp

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

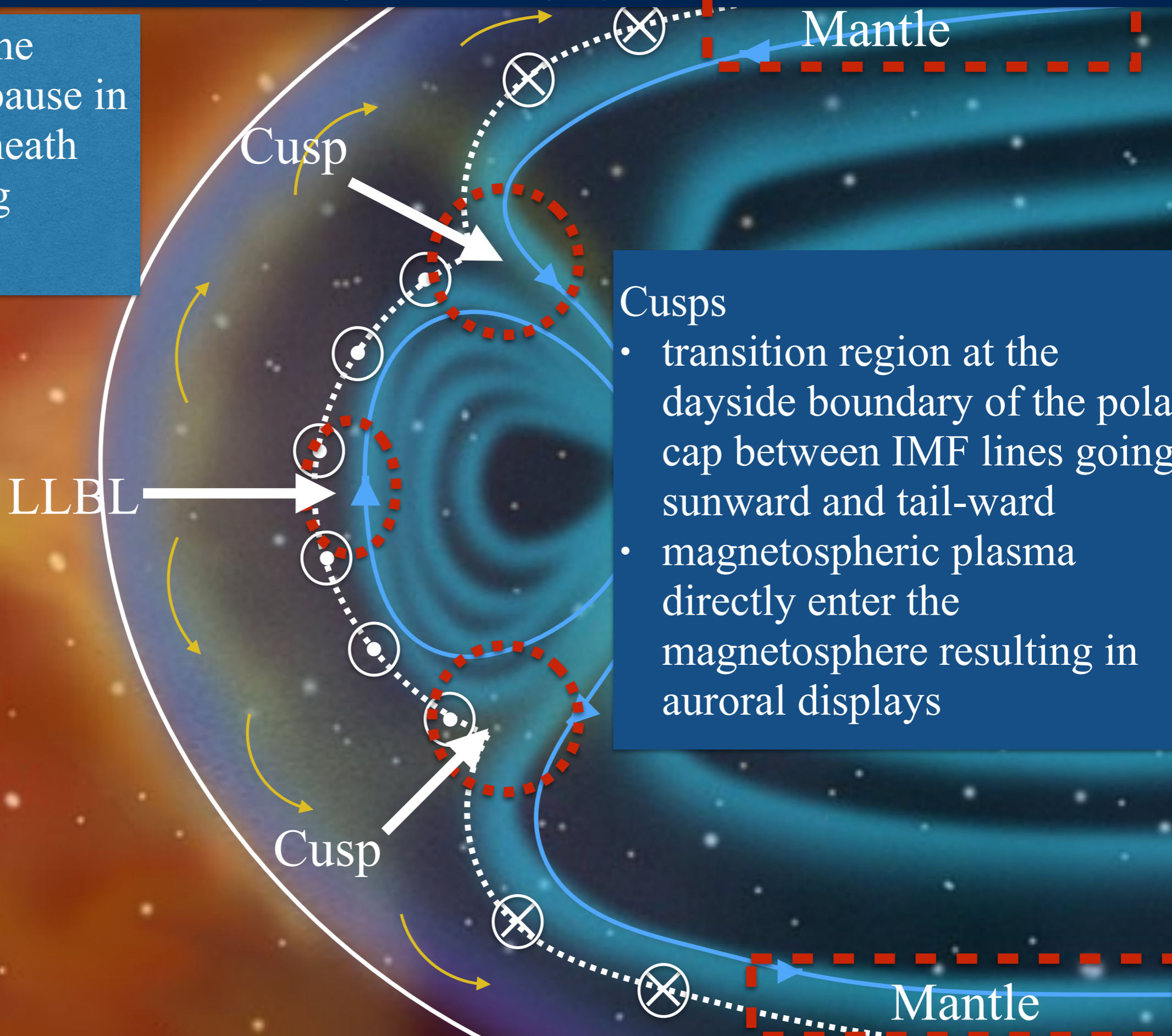
Mantle

Mantle



Magnetospheric Boundary Layers

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



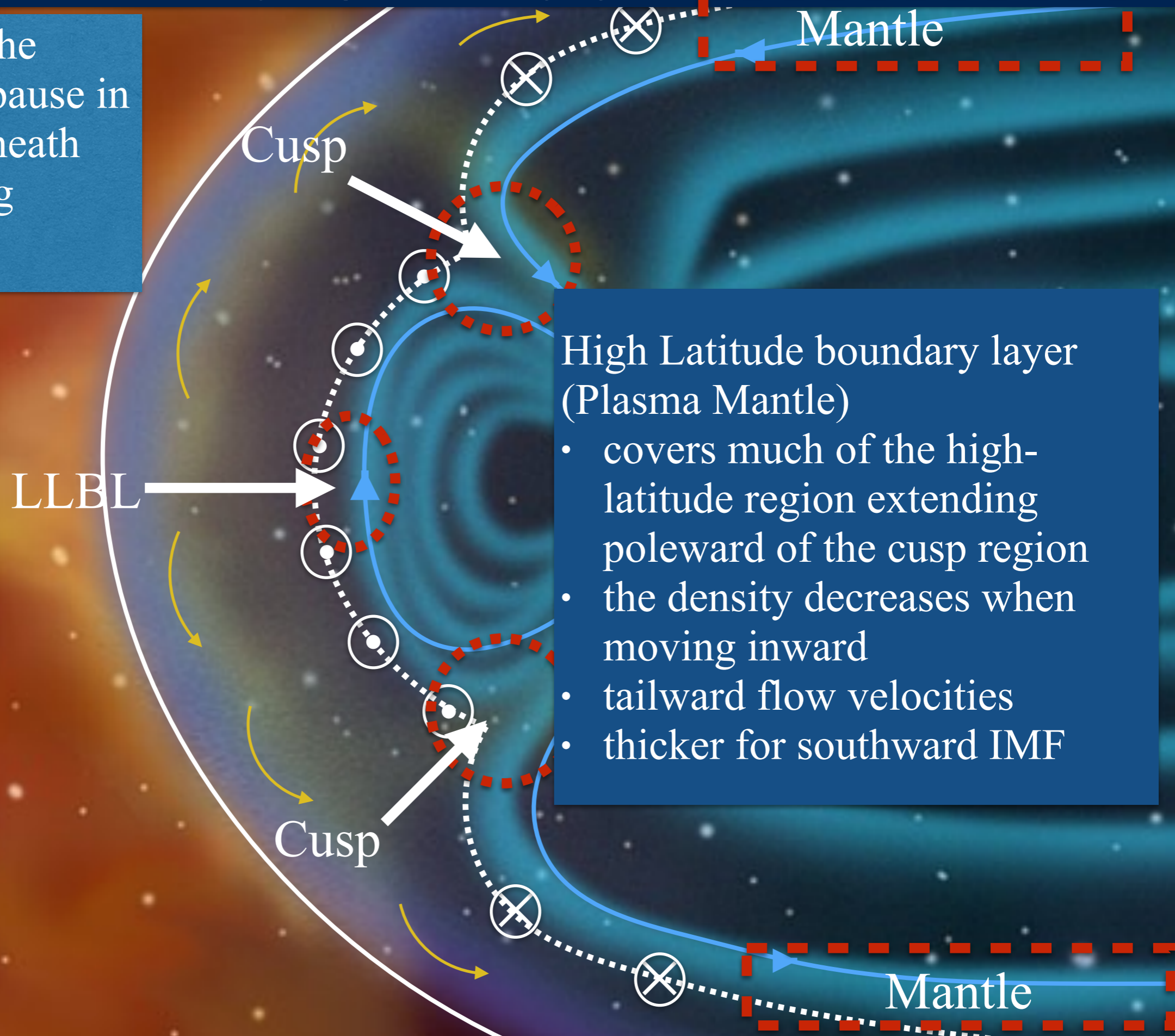
Cusps

- 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

Mantle

Magnetospheric Boundary Layers

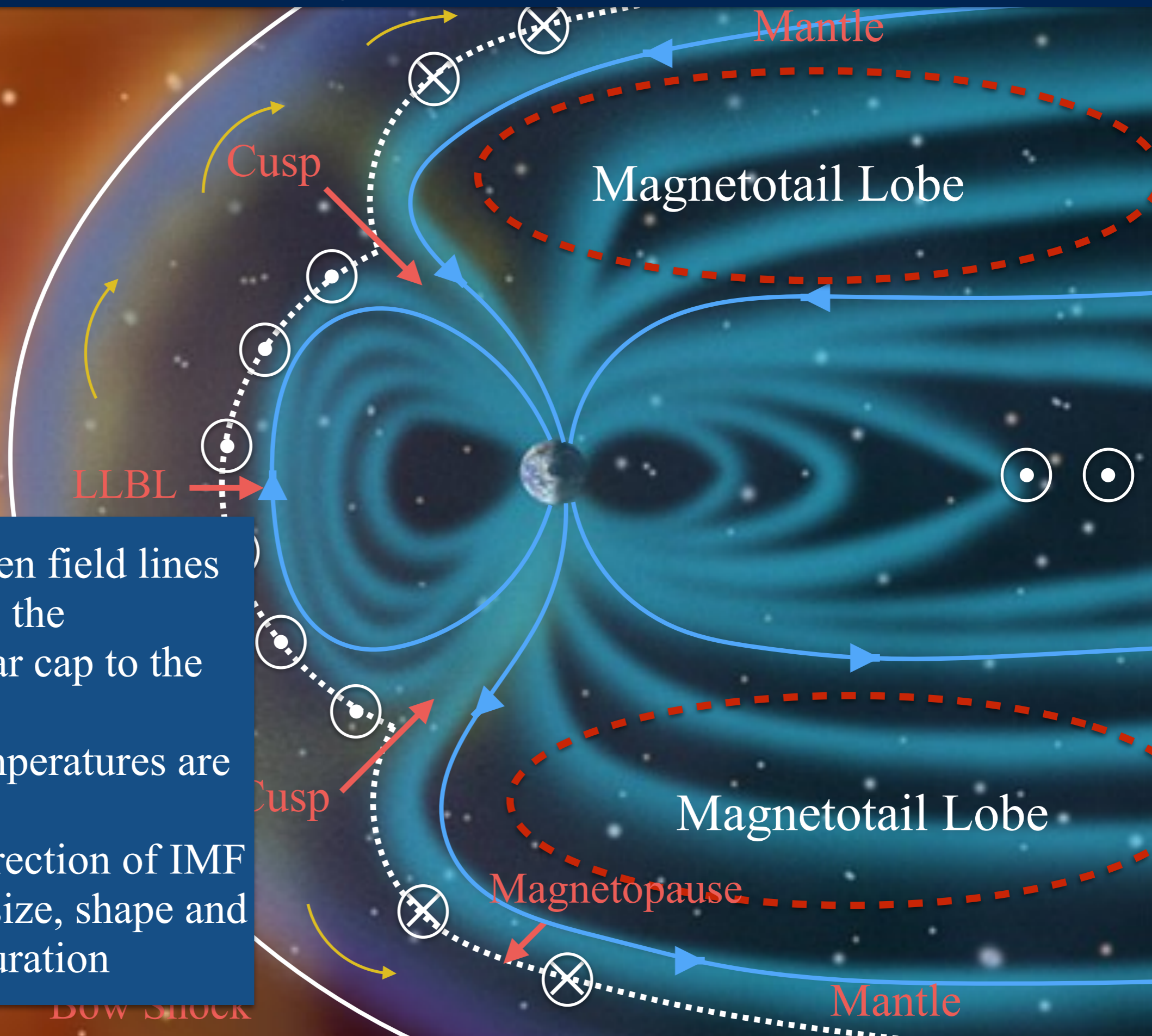
Region close to the Earth's magnetopause in which magnetosheath plasma has strong influence



High Latitude boundary layer (Plasma Mantle)

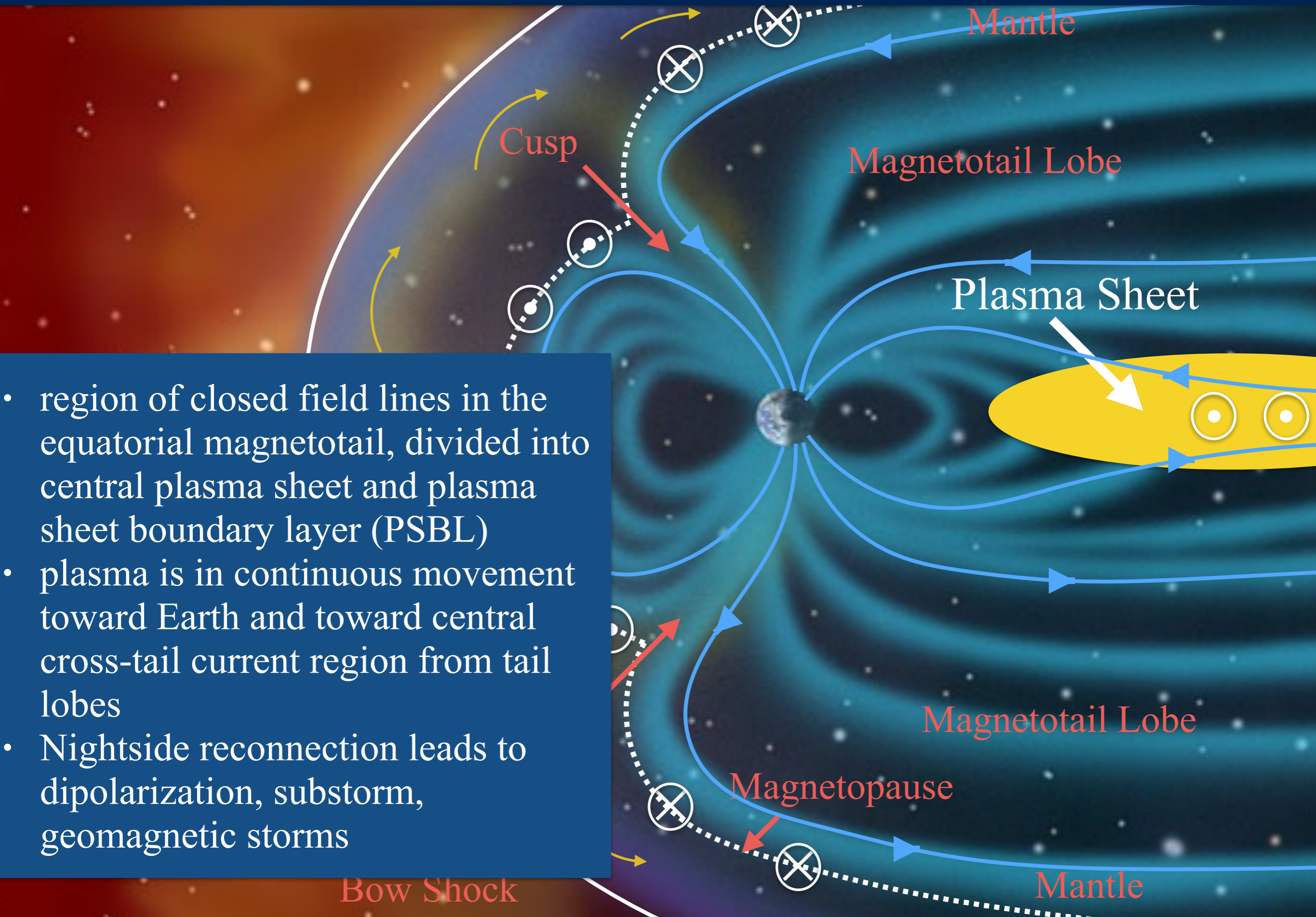
- covers much of the high-latitude region extending poleward of the cusp region
- the density decreases when moving inward
- tailward flow velocities
- thicker for southward IMF

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

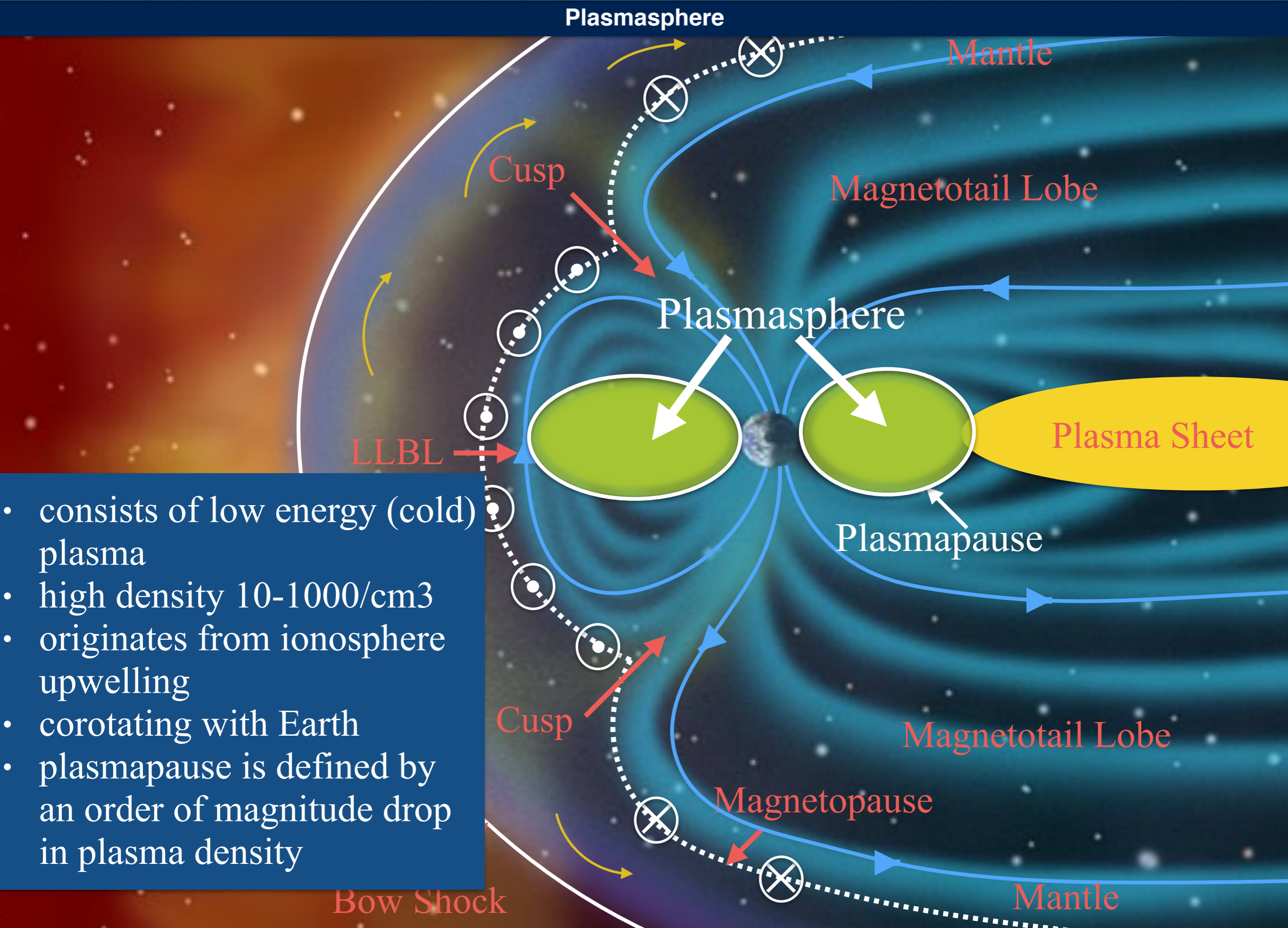
Plasma Sheet



- 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

Bow Shock

Mantle



- 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

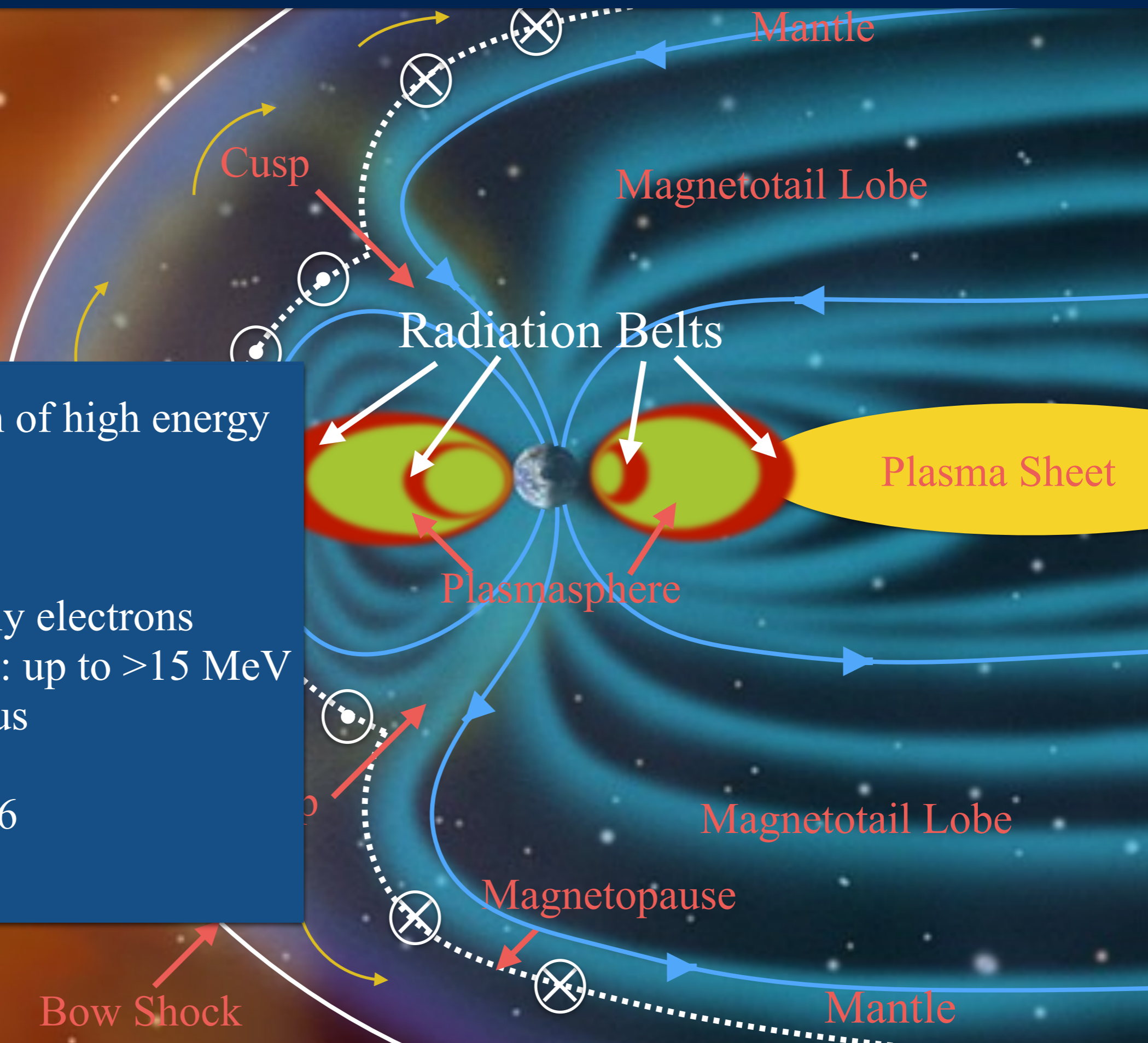
Radiation Belts

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 $L=3-6$

Bow Shock



Mantle

Magnetotail Lobe

Magnetopause

Plasmasphere

Plasma Sheet

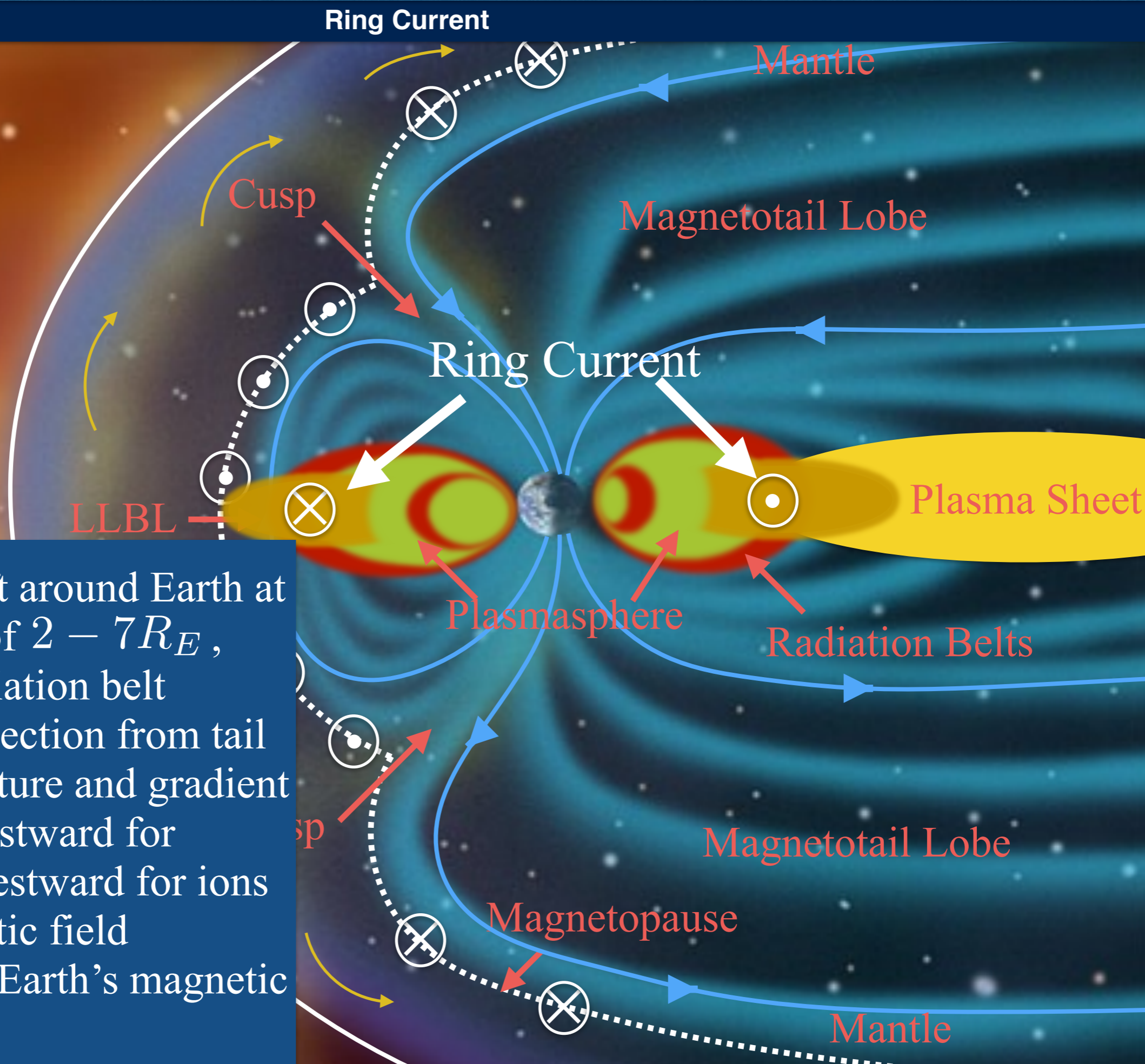
Radiation Belts

Magnetotail Lobe

Mantle

Cusp

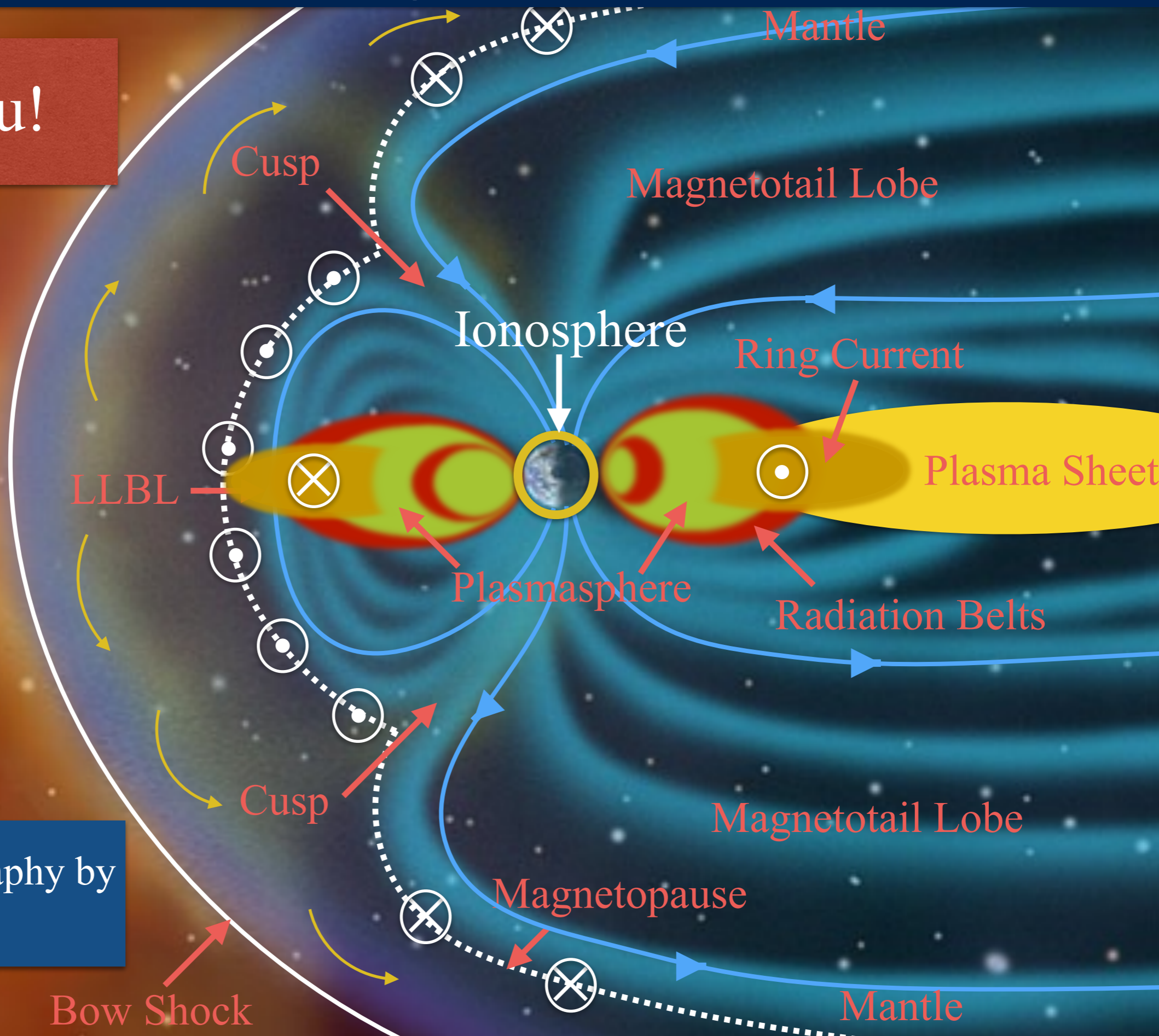
Radiation Belts



- 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

Ionosphere

Thank you!



Ionospheric Geography by
Bea