

**Solar wind  
&  
Its Interaction with Geomagnetosphere**

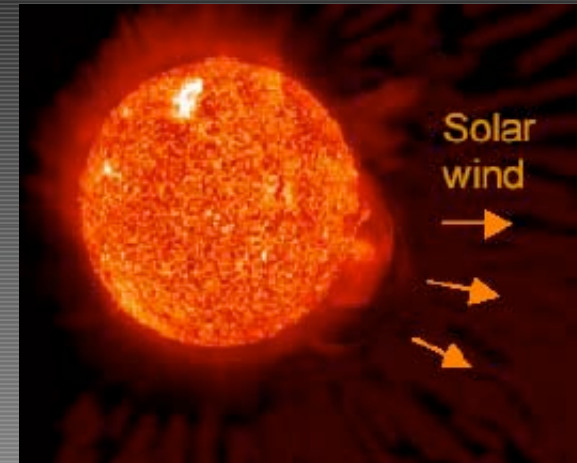
## ***Topics discussed in this section...***

- Models of solar wind
- Interplanetary magnetic field (IMF)
- Disturbances in IMF (ICME, CIR)
- Interaction between IMF and terrestrial magnetic field
- Space weather
- Space climate

**Solar wind  
&  
Interplanetary magnetic field**

## Solar wind

... an outflow of solar atmospheric plasmas



### Brief history:

1859... R. Carrington found a flare on the Sun (he supposed an energy flow from the Sun).

1916... K. Birkeland predicted flows of electrons and positive ions from the Sun.

1919... F. Lindemann suggested that both electrons and protons come from the Sun.

1950s... S. Chapman suggested that coronal plasma should extend over the orbit of the Earth.

1951... L. Biermann investigated the tails of comets and postulated that the Sun emits a steady stream of particles pushing the tails away.

1958... E. Parker developed a hydrodynamic model of solar wind.

# Physical properties of solar winds

Components: **electrons, protons**

Energy: **10 – 100 eV (1 eV ~ 10<sup>4</sup> K for thermal plasma)**

Speed (near the Earth): **400 km/s (slow wind 1.5 × 10<sup>6</sup> K, coronal composition)**

**750 km/s (fast wind 8 × 10<sup>5</sup> K, photospheric composition)**

(cf. escape velocity: 618 km/s, coronal thermal velocity: 150 km/s)

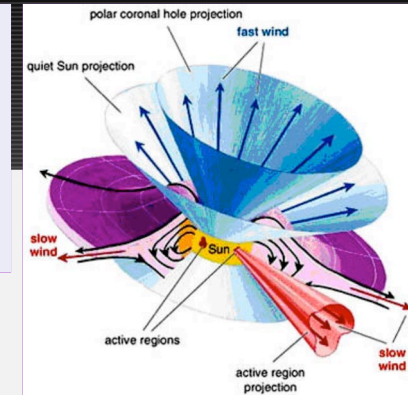
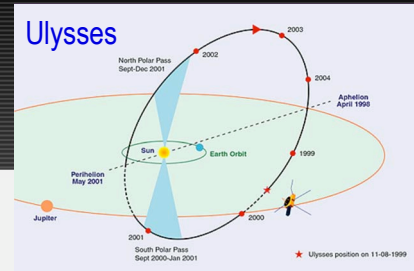
Source region: **low latitude, from closed-field region (slow wind)**

**high latitude, from open-field region (fast wind)**

Mass flux (loss rate of solar mass):  **$\dot{M} \sim 10^{12}$  g/s ( $\sim 10^{-14} M_{\odot}$  / yr)**  $M_{\odot} \sim 2 \times 10^{33}$  g

Angular momentum flux (loss rate of solar angular momentum):

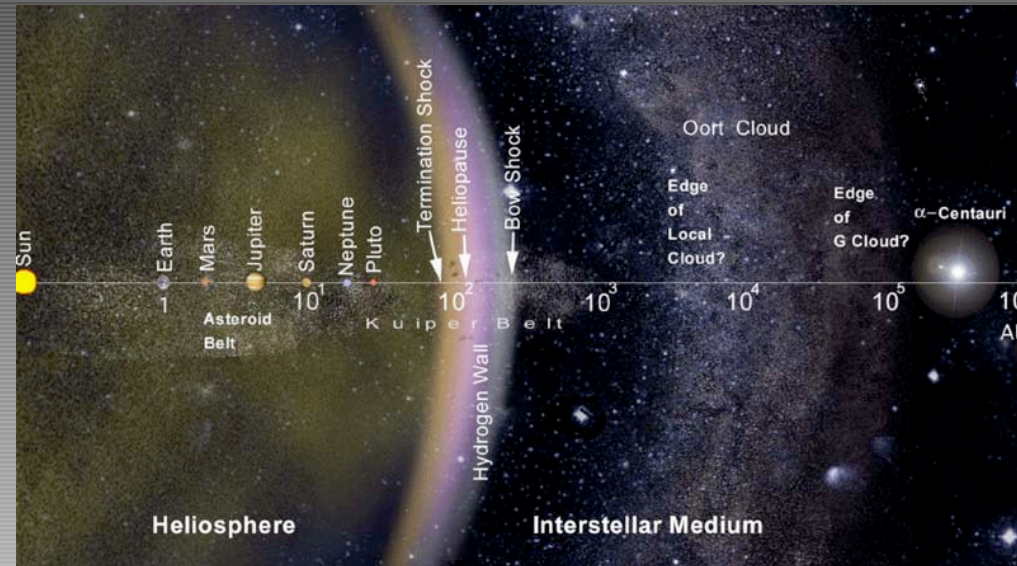
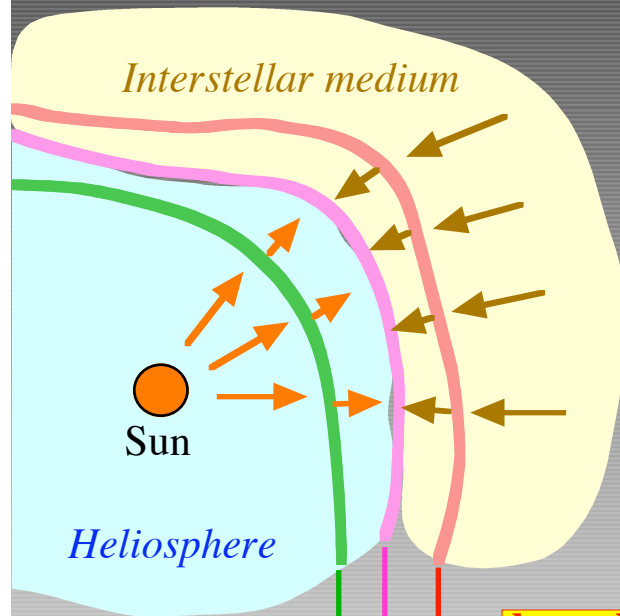
**$J \sim 7 \times 10^{29}$  g cm<sup>2</sup>/s<sup>2</sup> ( $\sim 10^{-11} J_{\odot}$  / yr)**  $J_{\odot} \sim 2 \times 10^{48}$  g cm<sup>2</sup>/s



# Where does solar wind end?

territory of the Sun

# Heliosphere... the region over which solar wind extends



**bow shock**

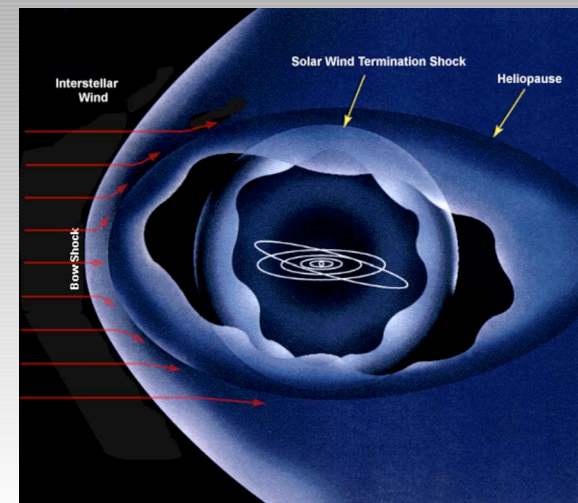
Interstellar wind becomes subsonic.

**heliopause**

Solar wind stops.

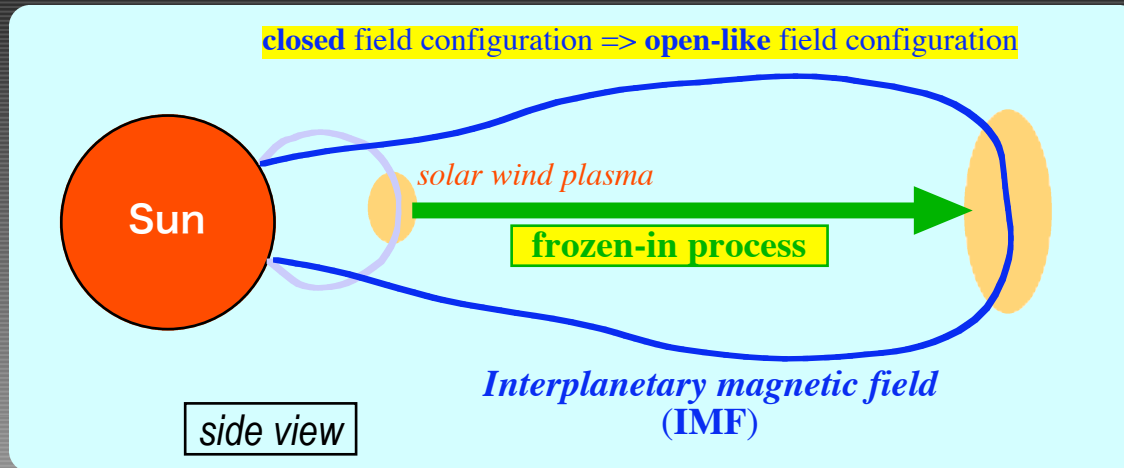
**termination shock**

Solar wind becomes subsonic.



# Interplanetary magnetic field

*Solar wind carries magnetic field into the interplanetary space...*



Because of solar rotation, IMF assumes a spiral configuration (called *Archimedean spiral*).

