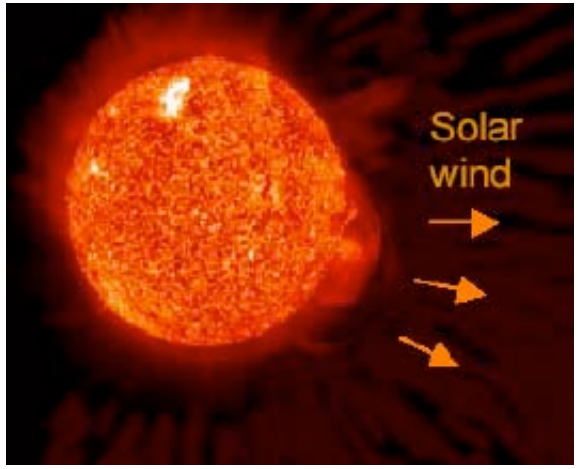
Solar wind and its interaction with geomagnetosphere

Topics 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

... an outflow of plasma from the Sun



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.

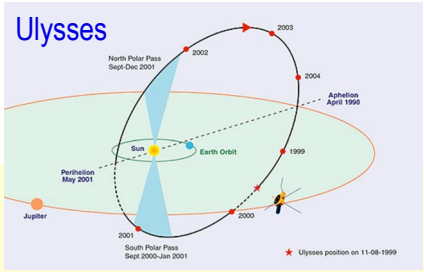
1919... F. Lindemann suggested that both electrons and protons come from the Sun.

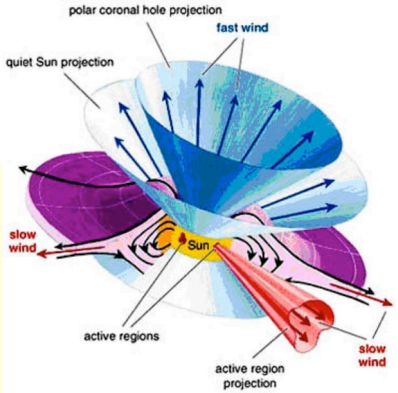
1950s... S. Chapman suggested that coronal plasma should extend over the orbit of the Earth.

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 ~ 10^4 K for thermal plasma)

Speed (near the earth): **400 km/s** (*slow wind* 1.5×10^{6} K, coronal composition)

750 km/s (*fast wind* 8×10^{5} K, photospheric composition)

(c.f. 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 of mass): $\dot{M} \sim 10^{12}$ g/s ($\sim 10^{-14}$ $M_\odot$ / yr) $M_\odot \sim 2\times10^{33}$ g

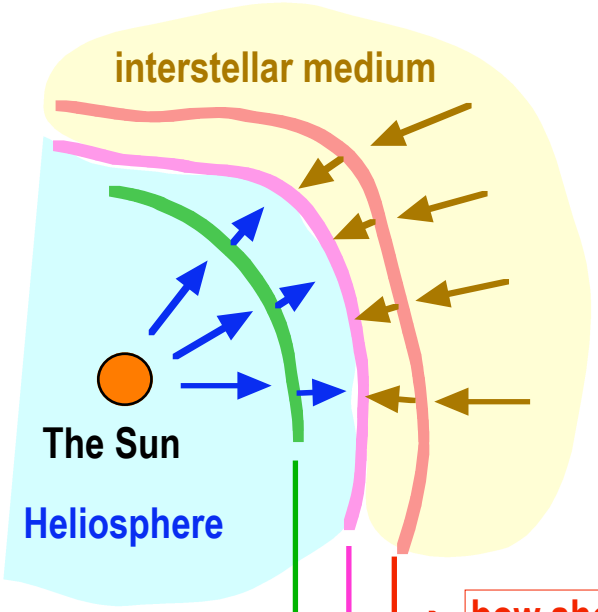
Angular momentum flux (loss of angular momentum):

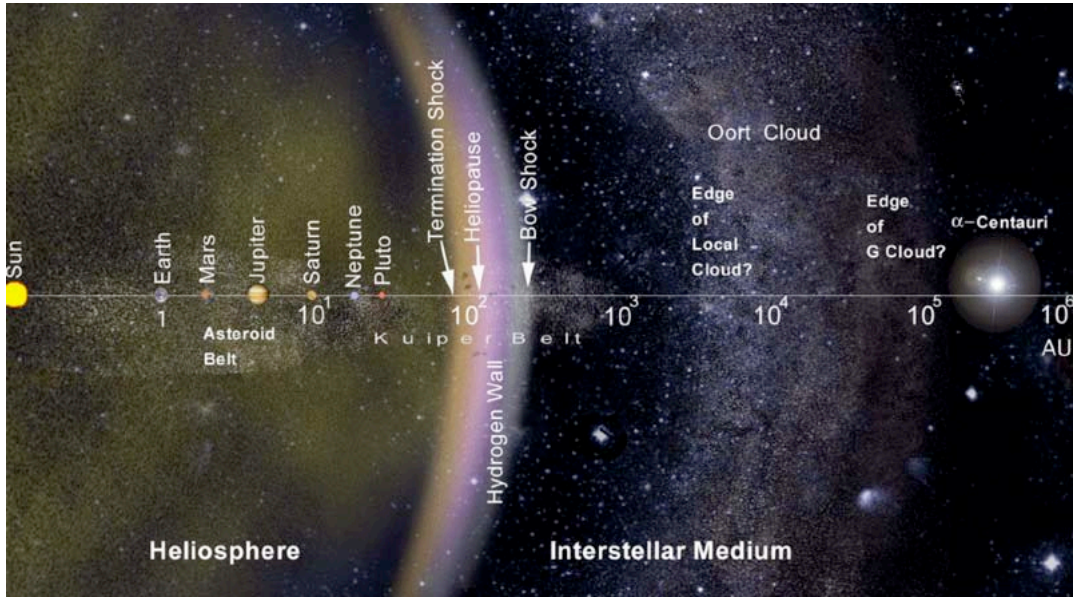
$\dot{J} \sim 7\times10^{29}$ g cm^2/s^2 ($\sim 10^{-11}$ $J_\odot$ / yr) $J_\odot \sim 2\times10^{48}$ g cm^2/s

Where does the solar wind end?

territory of the Sun

Heliosphere... the region over which solar wind extends



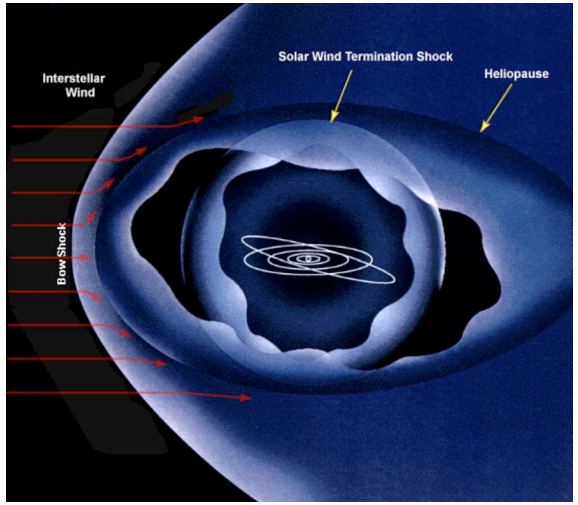


bow shock Interstellar wind becomes subsonic.

heliopause Solar wind stops.

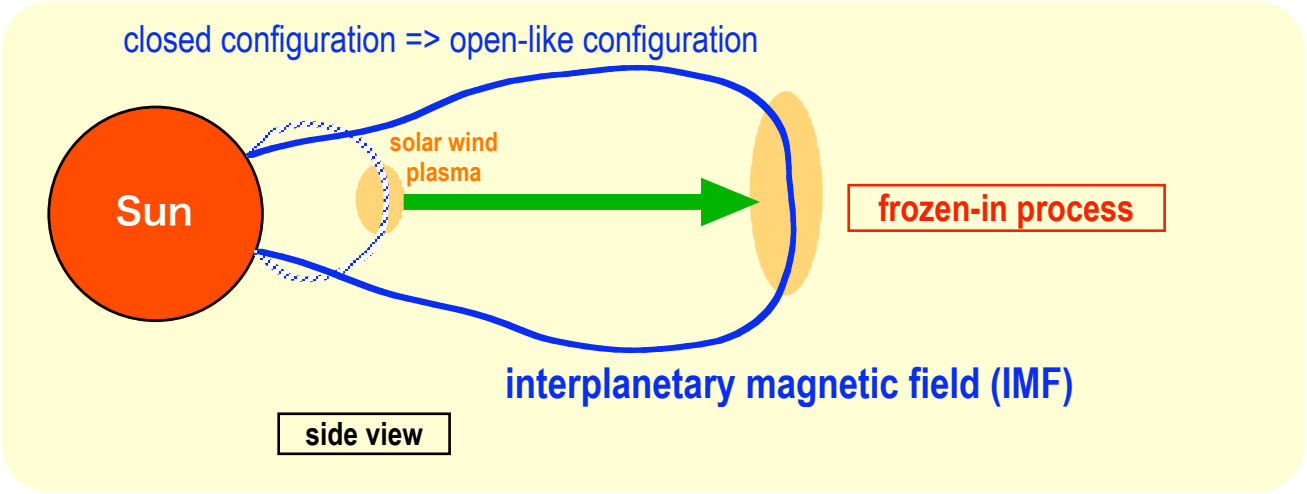
termination shock

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**).