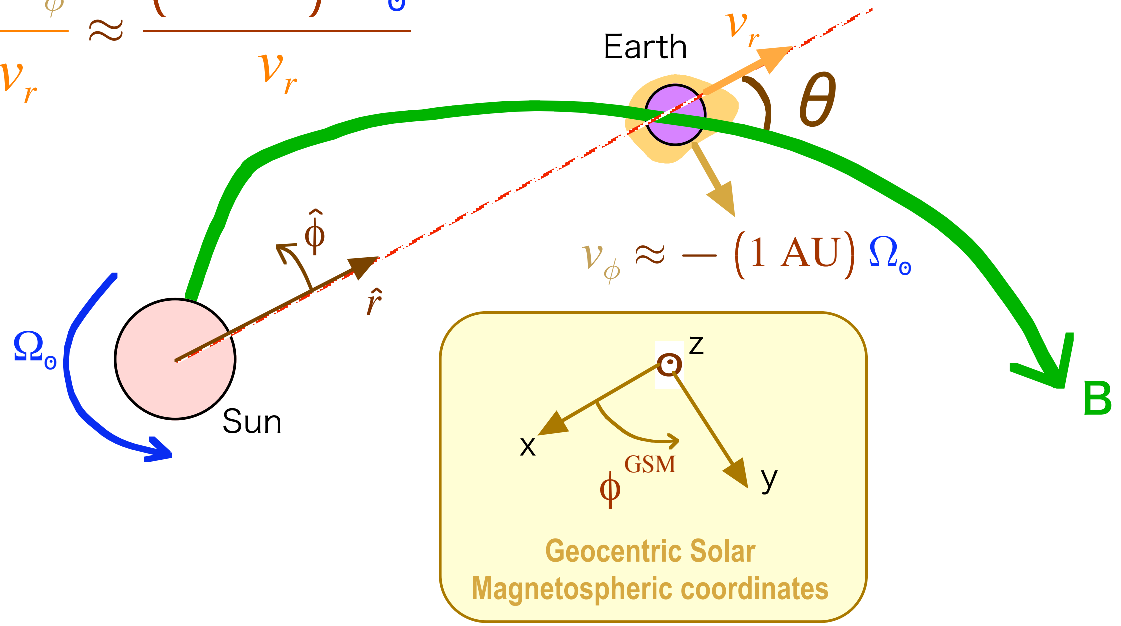
Spiral angle of IMF near an Earth orbit

$$\tan\theta \equiv \frac{-B_\phi}{B_r} = \frac{-v_\phi}{v_r} \approx \frac{(1\ \mathrm{AU})\,\Omega_\odot}{v_r}$$

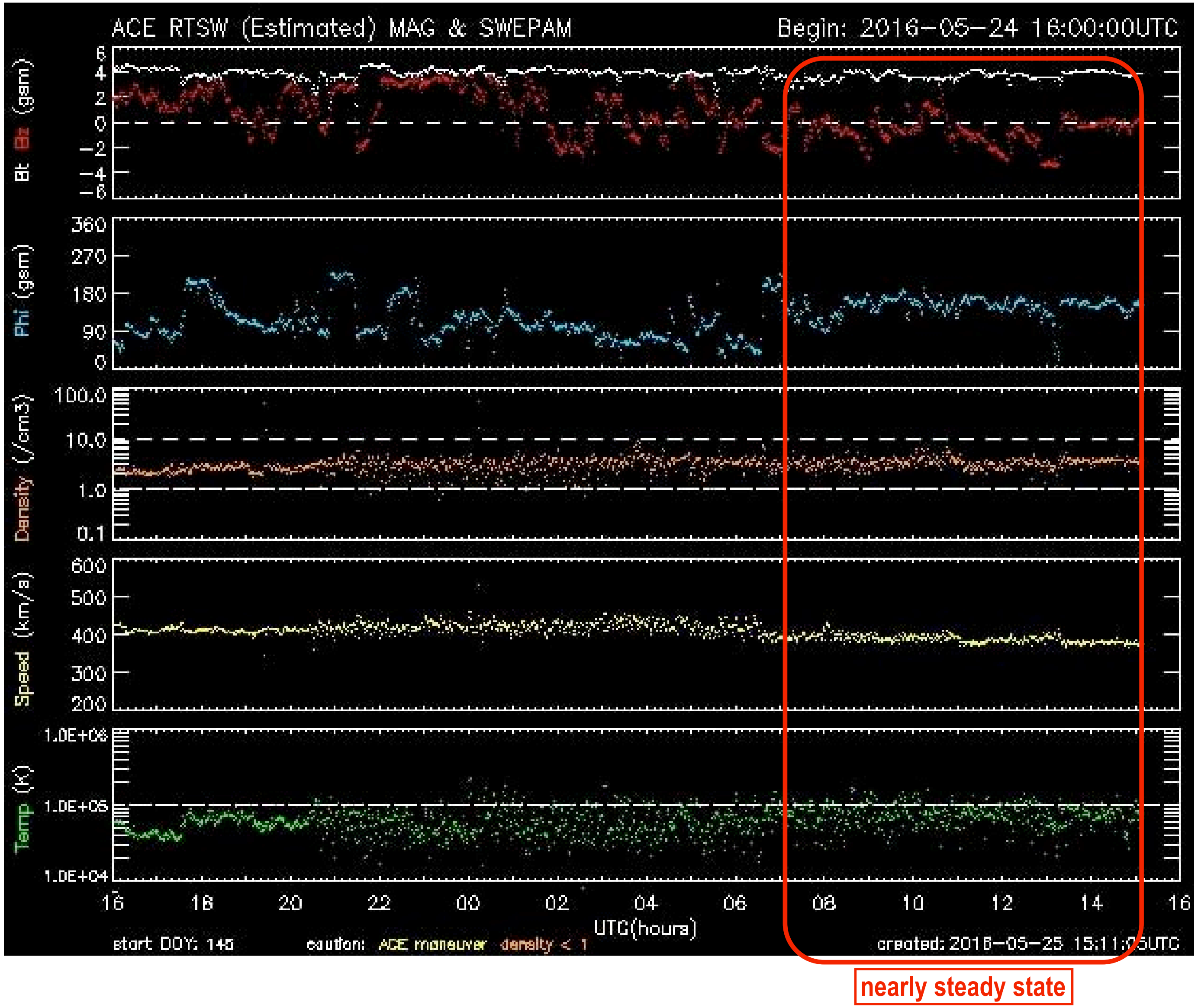


Near an Earth orbit, the spiral angle is

$$\tan\theta = \frac{-v_\phi}{v_r} \approx \frac{(1\ \mathrm{AU})\,\Omega_\odot}{v_r} \sim \frac{1.5\times10^{8}\ \mathrm{km} \times \left(2.87\times10^{-6}\ \mathrm{rad\ s^{-1}}\right)}{400\ \mathrm{km\ s^{-1}}} = 1.07$$

$$\Rightarrow \theta \sim 47^\circ \quad \left(\phi^{GSM} \sim 133^\circ\right)$$

Steady solar wind observed near an Earth orbit

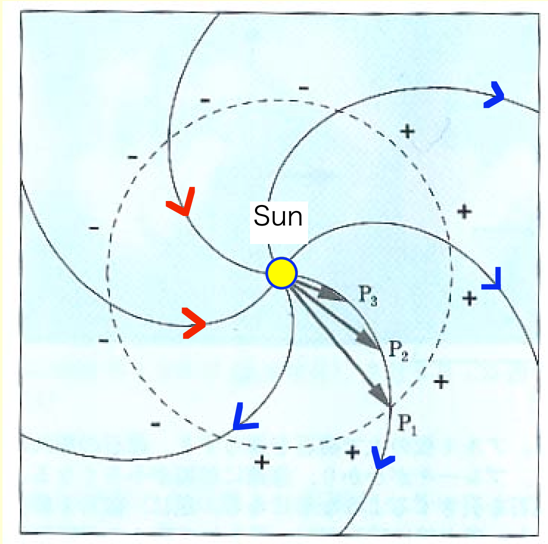


Sector structure of IMF

Inward IMF area

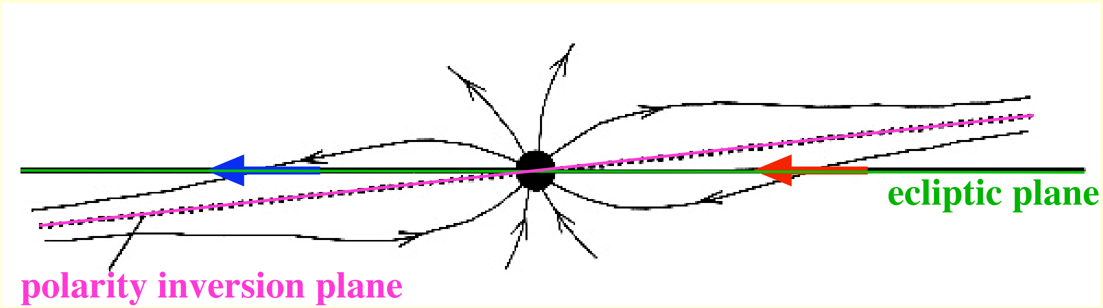
Outward IMF area

Sector structure



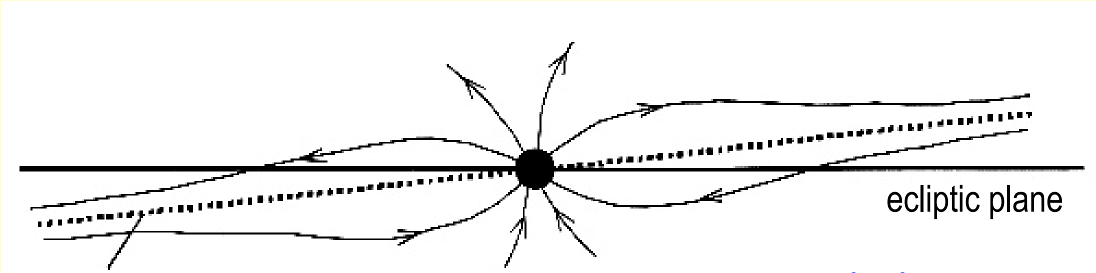
Origin of sector structure...

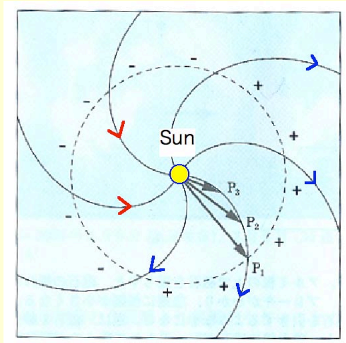
Polarity inversion plane is not coincident with **ecliptic plane**.



Time variation of the sector structure...

Two-sector structure

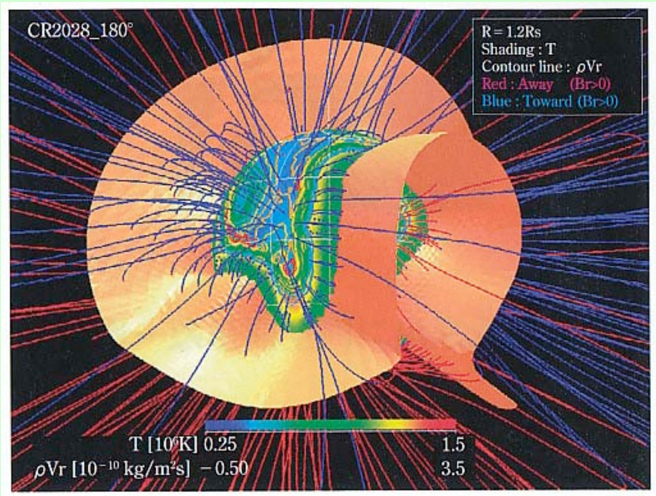




... solar minimum

Polarity inversion plane is **almost flat**.

Multi-sector structure



From T. Tanaka

... solar maximum

Polarity inversion plane is **strongly rippled** because a number of solar active regions exist.

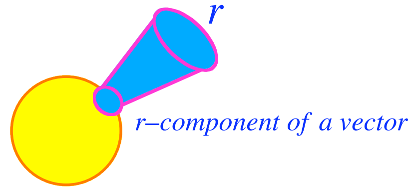
Solar wind model

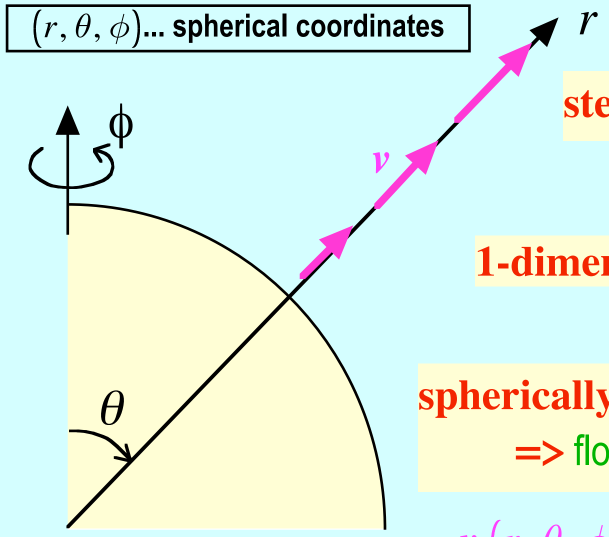
Hydrodynamic model

Parker's 1-dimensional model

(depends on r, *r–component of a vector* is considered)

(spherically symmetric, isothermal, steady, no rotation)





steady => $\frac{\partial}{\partial t} = 0$ (time-independent)

1-dimensional model => all quantities depend only on r

spherically symmetric (isotropic) outflow

=> flow velocity has only a radial component (v_r)

$$\boldsymbol{v}\left(r,\theta,\phi\right) = v_r\left(r,\theta,\phi\right)\hat{\boldsymbol{r}} + v_\theta\left(r,\theta,\phi\right)\hat{\theta} + v_\phi\left(r,\theta,\phi\right)\hat{\phi}$$

$$\longrightarrow v_r\left(r\right)\hat{\boldsymbol{r}}$$

isothermal

=> $T = const.$

thermal conduction efficiently works to make temperature uniform