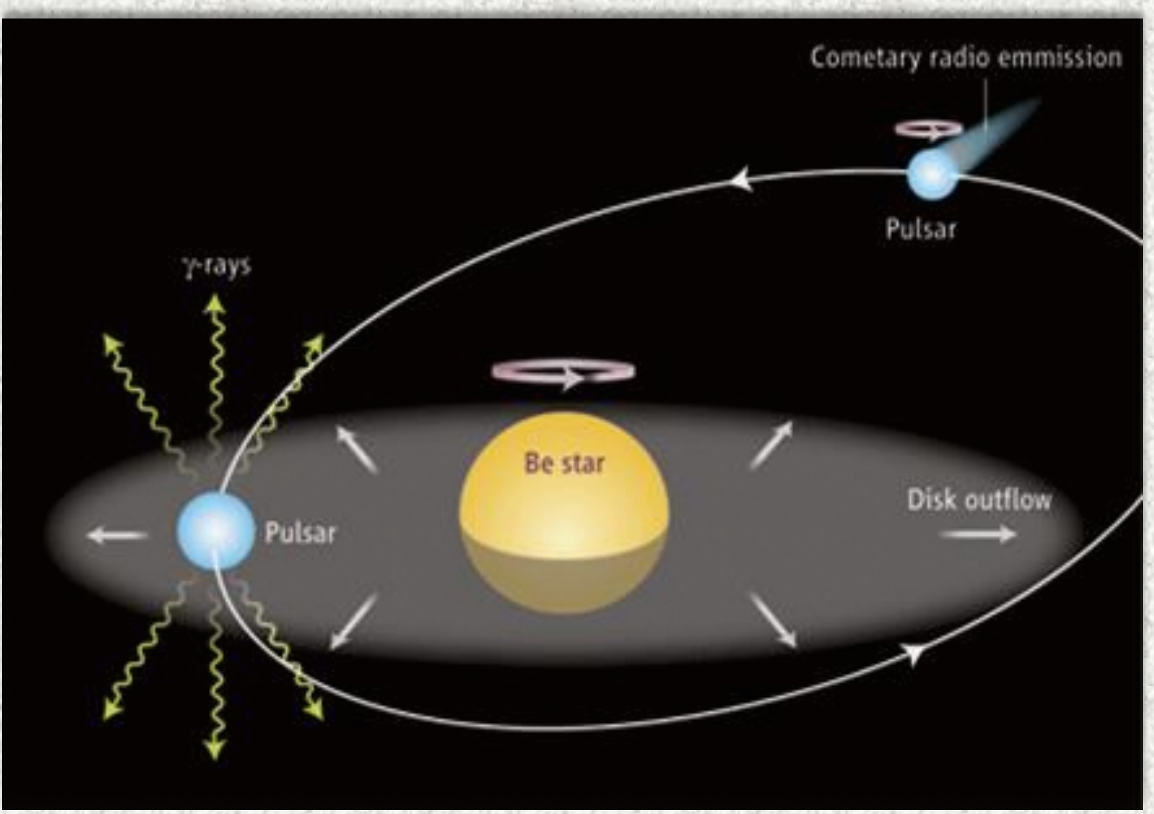
香 港 大 學
THE UNIVERSITY OF HONG KONG

A NEW APPROACH TO THE GeV FLARE OF PSR B1259-63/LS2883



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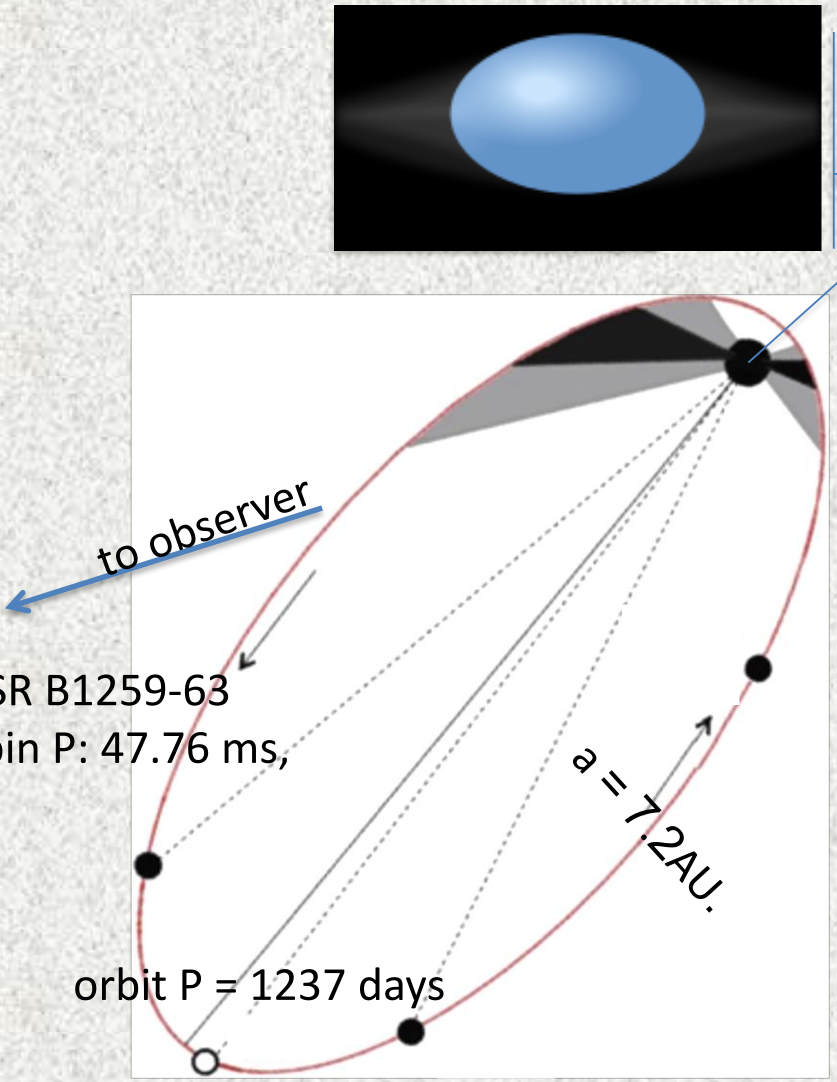
Introduction of the system



LS2883
31 M_solar

to observer

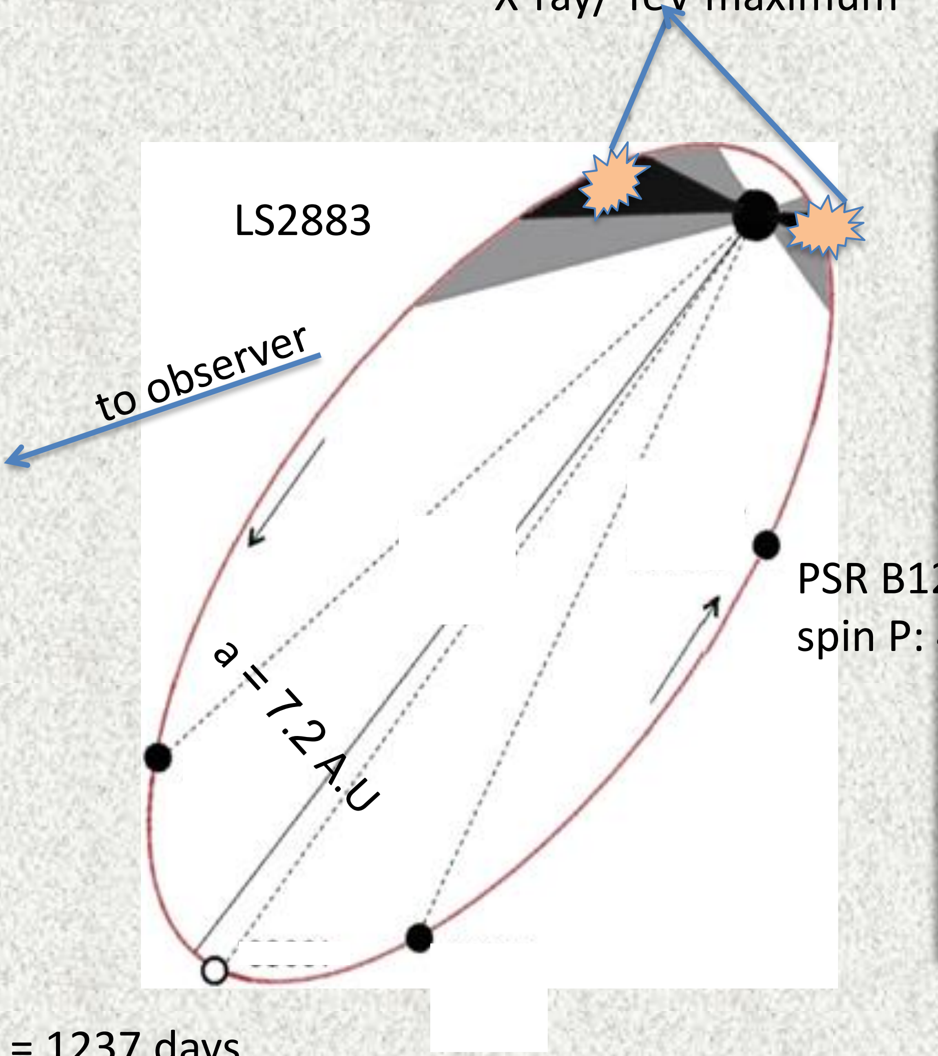
PSR B1259-63
spin P: 47.76 ms,

a = 7.2AU.

orbit P = 1237 days

George G. Pavlov et al. 2015

X-ray/TeV emission



X-ray/ TeV maximum

LS2883

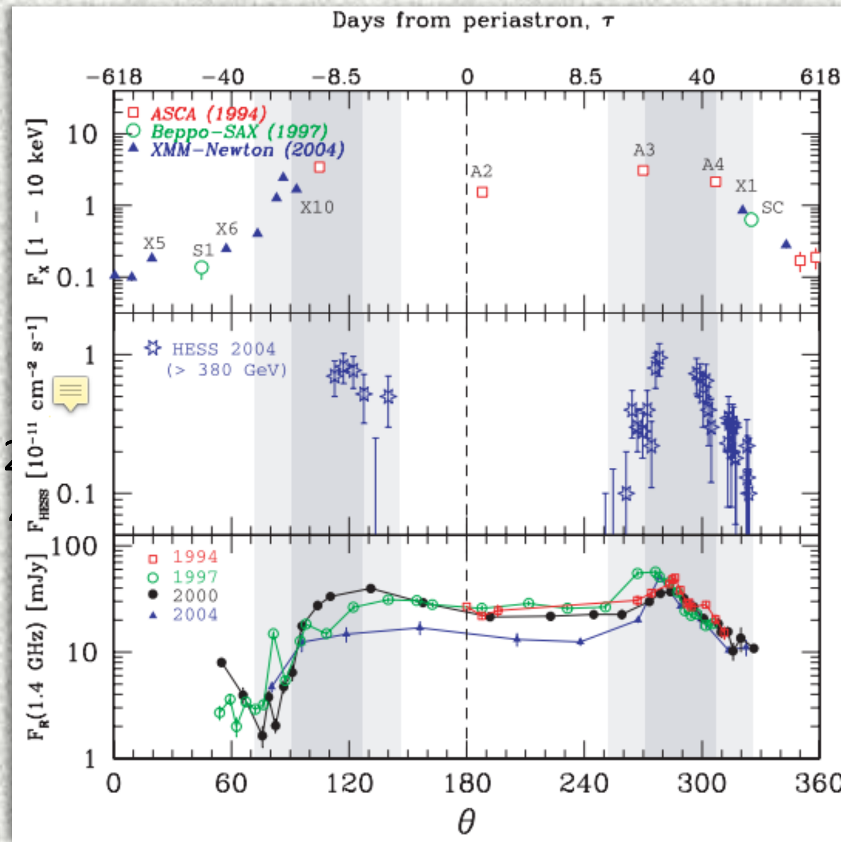
to observer

a = 7.2 A.U

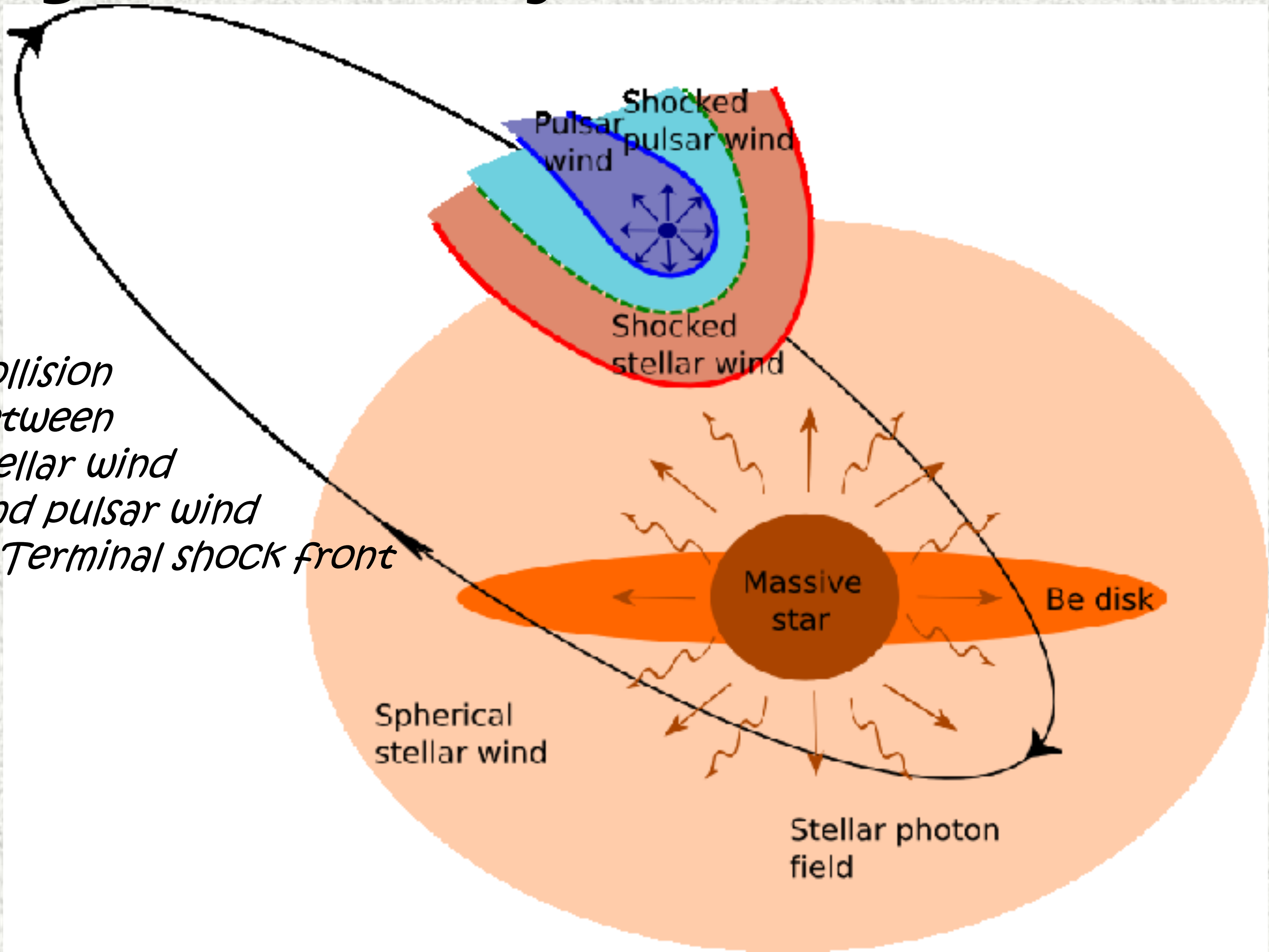
PSR B12

spin P:

orbit P = 1237 days

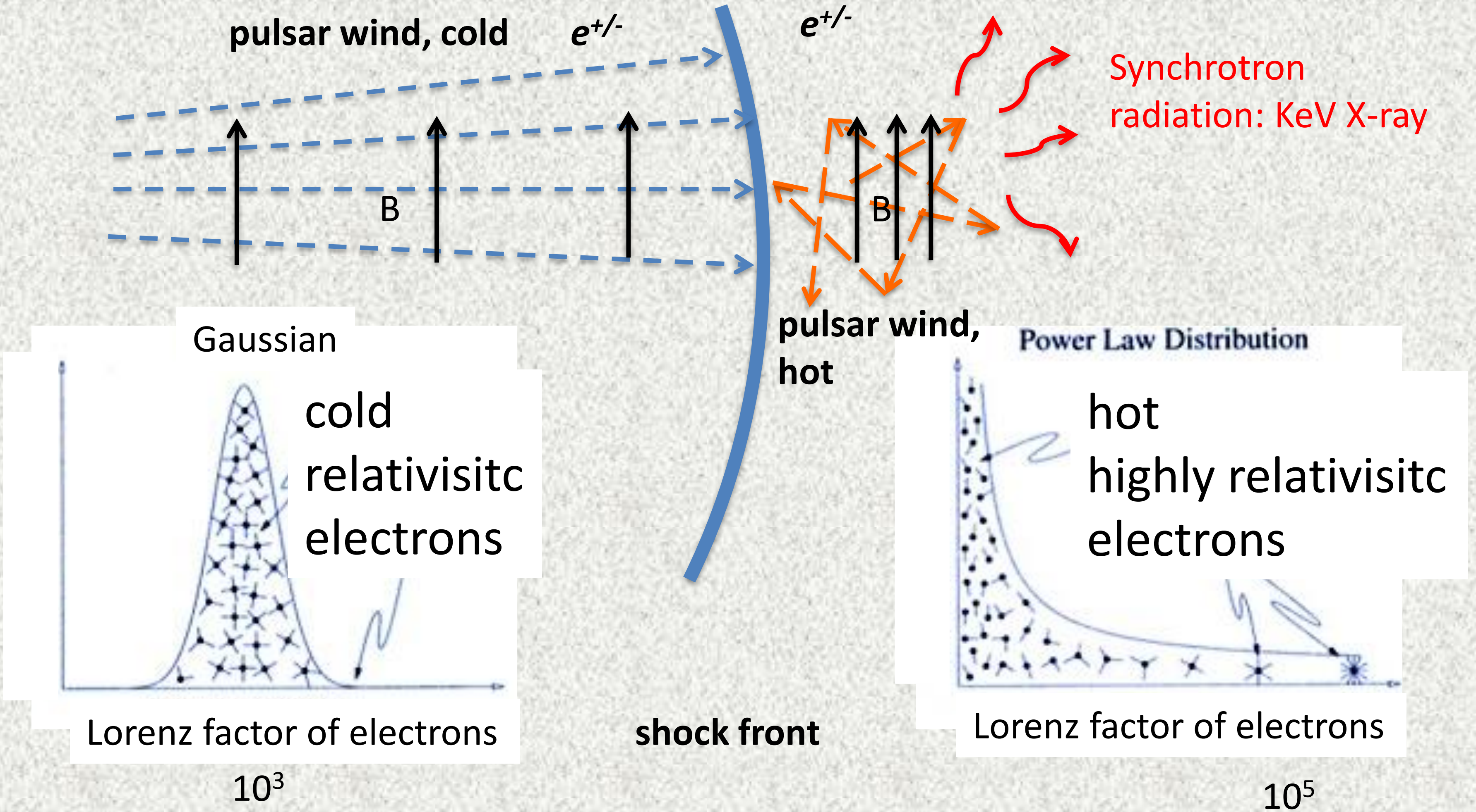


Origin of the X-ray/TeV emission



*Collision
Between
Stellar wind
And pulsar wind
→ Terminal shock front*

Origin of the X-ray/TeV emission



pulsar wind, cold $e^{+/-}$

B

$e^{+/-}$

Synchrotron radiation: KeV X-ray

B

pulsar wind, hot

Gaussian

cold relativisitc electrons

Lorenz factor of electrons

10^3

shock front

Power Law Distribution

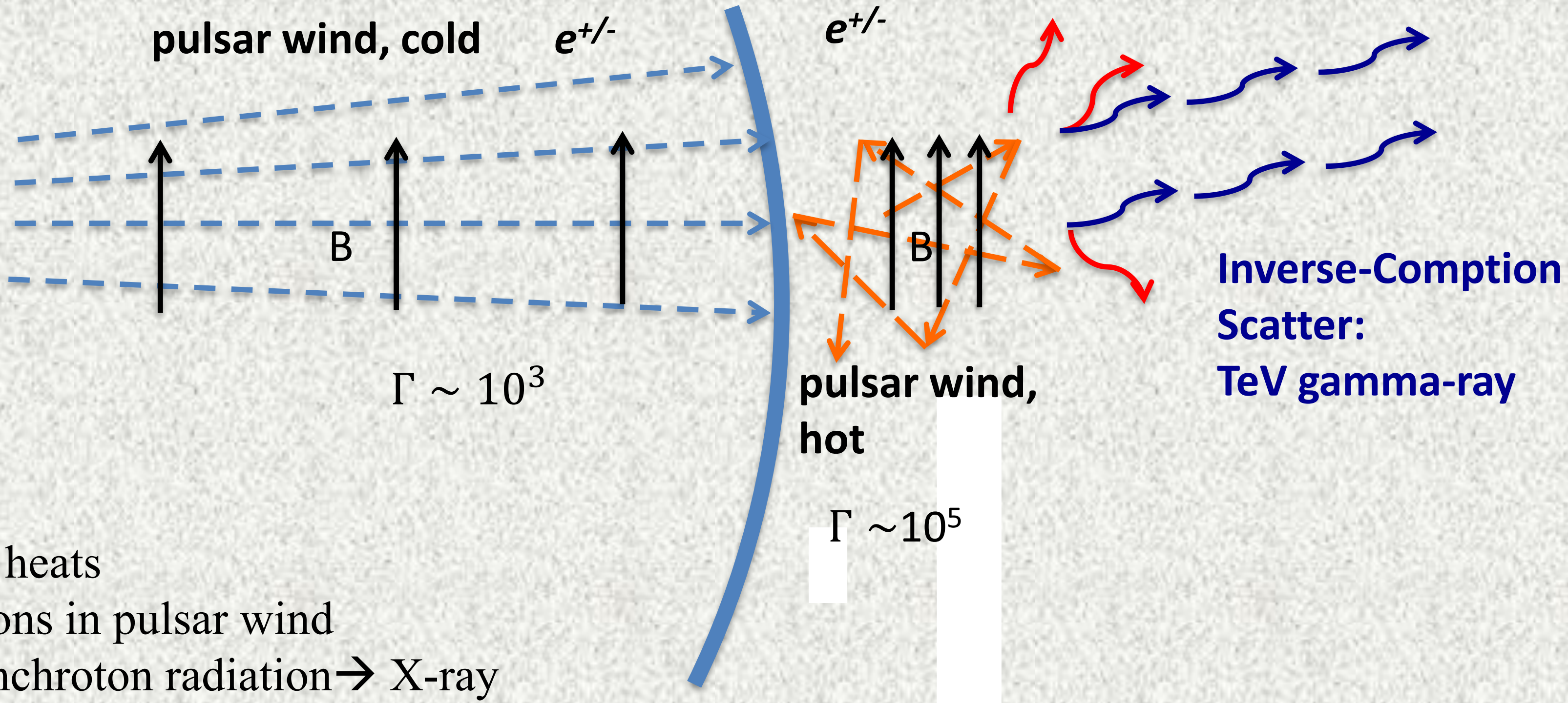
hot highly relativisitc electrons

Lorenz factor of electrons

10^5

Kong et al. 2011

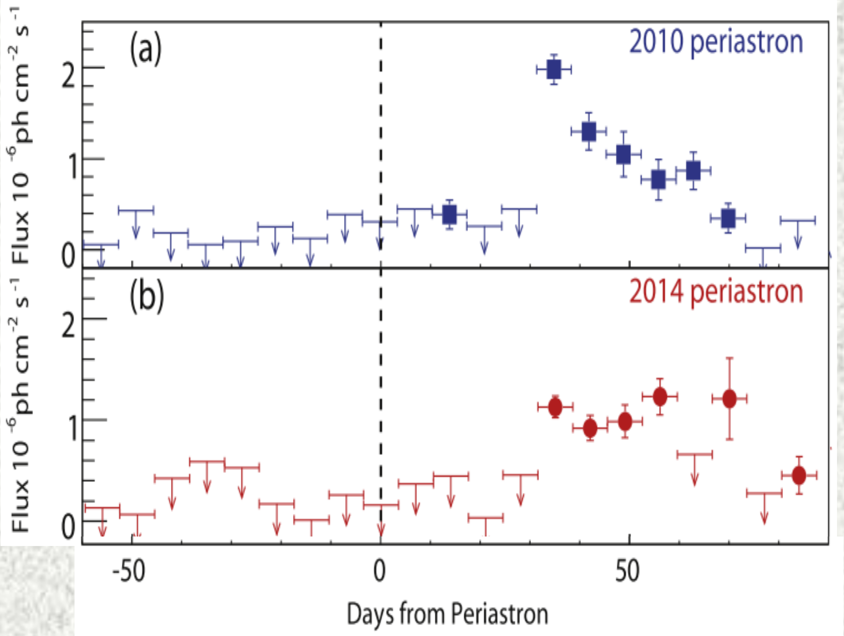
Origin of the X-ray/TeV emission

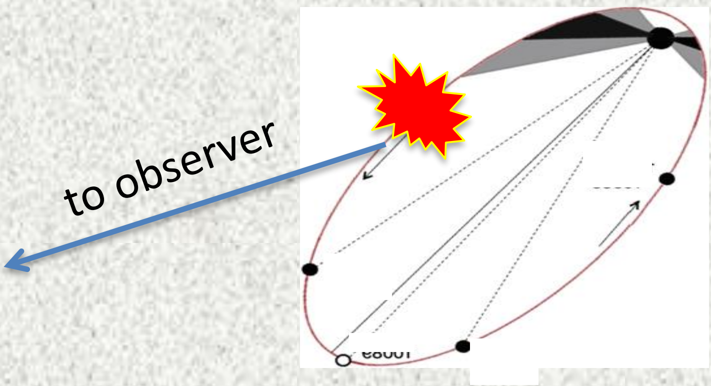


Shock heats
Electrons in pulsar wind
→ synchroton radiation→ X-ray
→ IC by hot electron (SSC or IC of starlight)→ TeV

Kong et al. 2011

Emission in 100 MeV-100 GeV



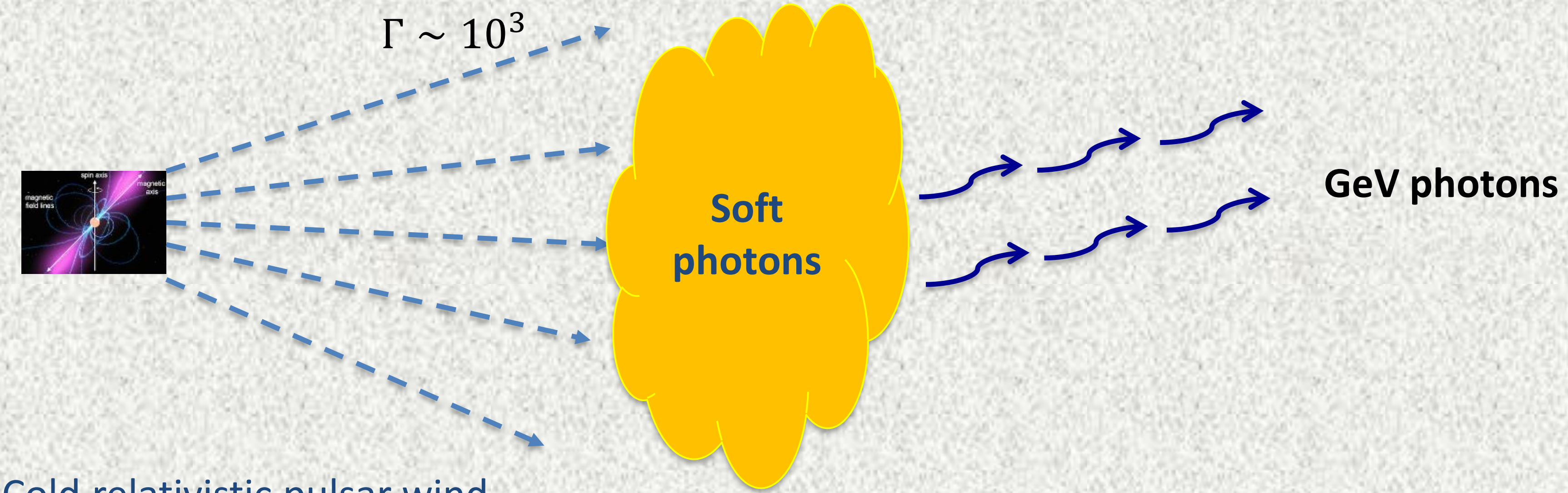


GeV flare at un-expected orbital phase

Tam 2011, Abdo 2011, Caliandro 2015

Models for GeV emission

- Inverse Compton scattering: first come-to-mind mechanism for GeV emission



$\Gamma \sim 10^3$

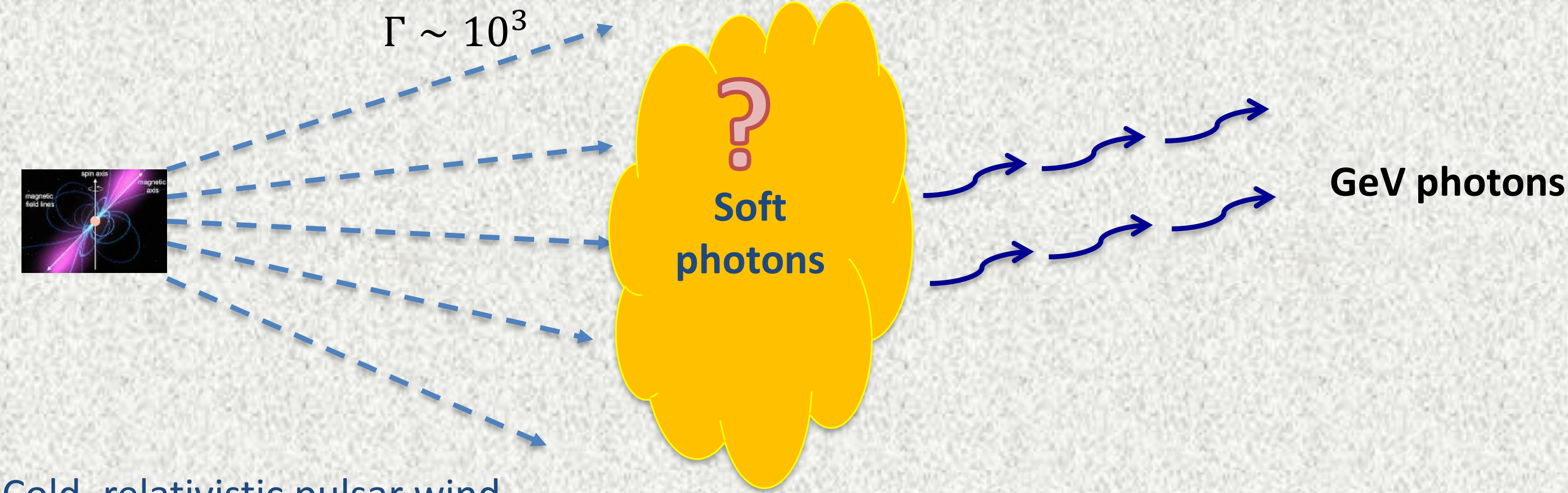
Soft photons

GeV photons

Cold,relativistic pulsar wind

Models for GeV emission

- Inverse Compton scattering
- Problem: where comes the soft photons (target)?



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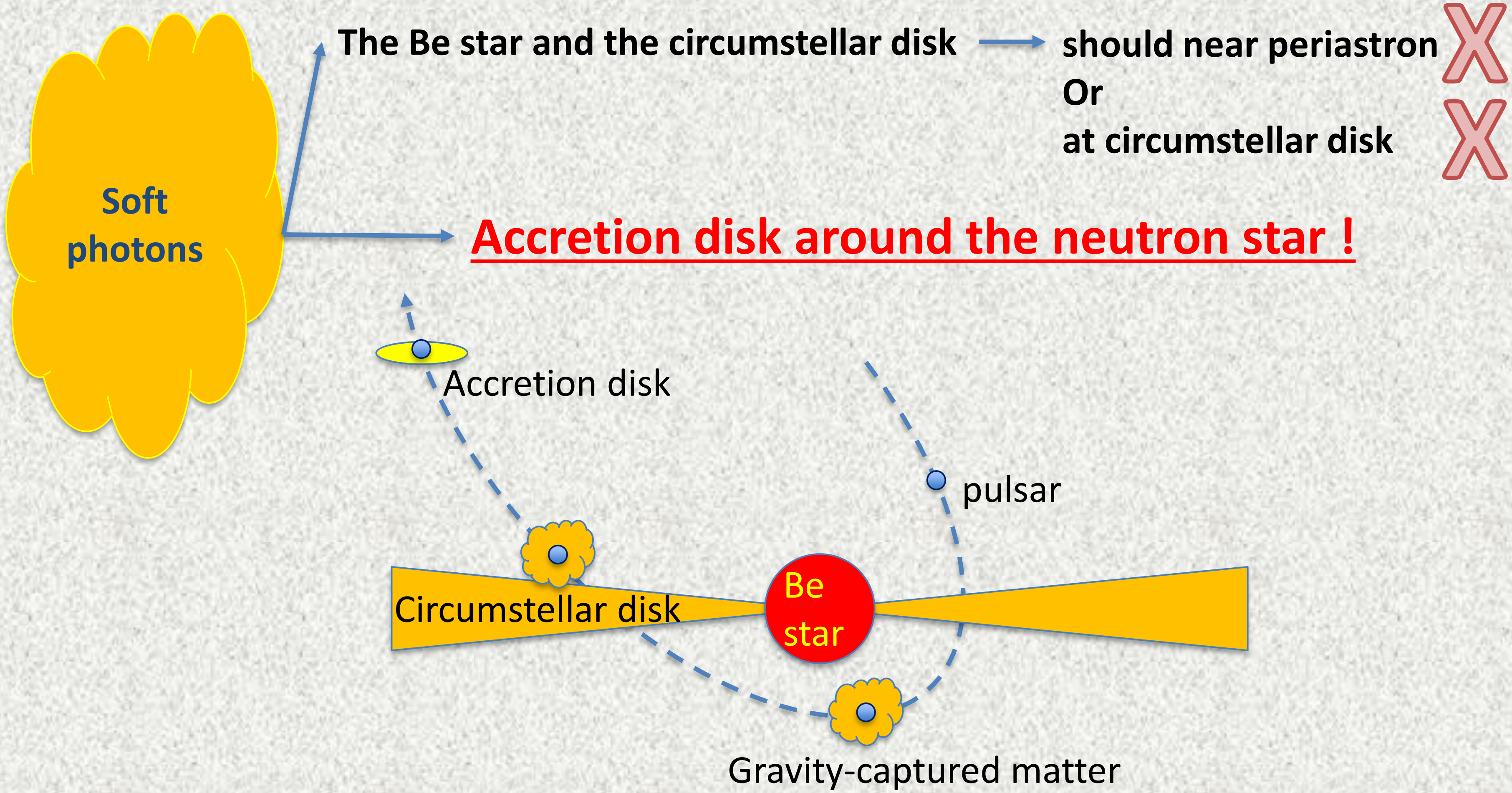


Soft photons

The Be star and the circumstellar disk → **should near periastron** ✗
Or
at circumstellar disk ✗

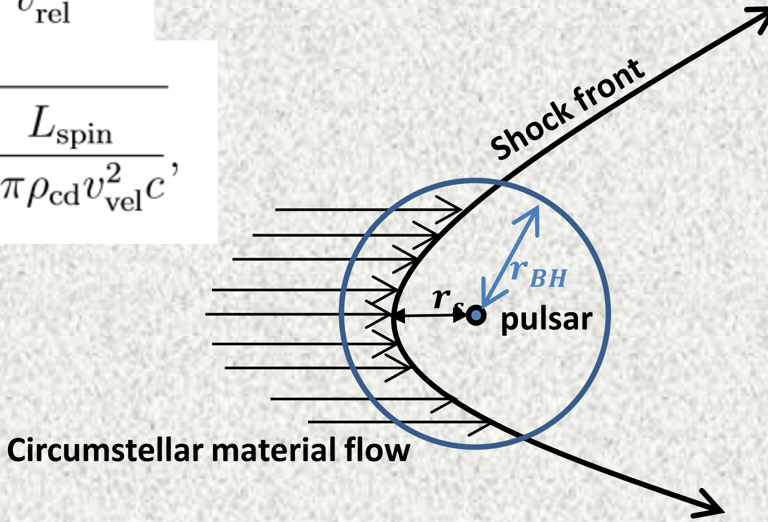
Accretion disk around the neutron star !

Condition of mass transfer from optical companion

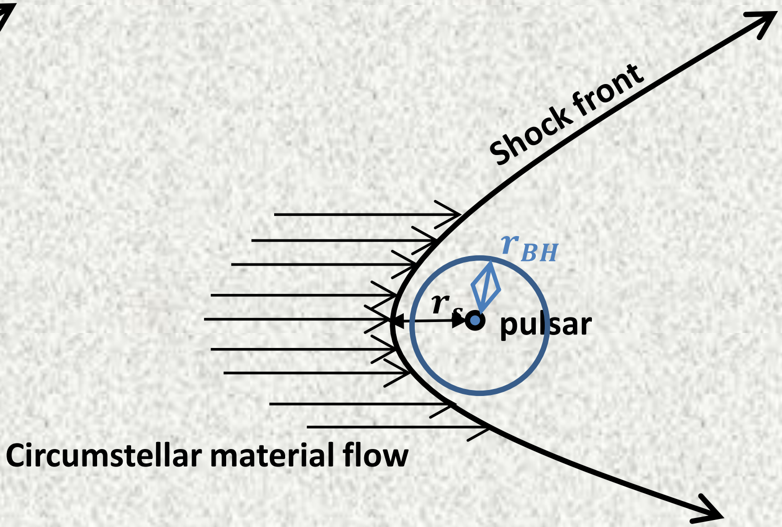
Shock from should inside the Bondi-Hoyle sphere

$$r_{\mathrm{BH}} = \frac{2GM_{\mathrm{p}}}{v_{\mathrm{rel}}^2},$$

$$r_{\mathrm{s}} = \sqrt{\frac{L_{\mathrm{spin}}}{4\pi\rho_{\mathrm{cd}}v_{\mathrm{vel}}^2 c}},$$

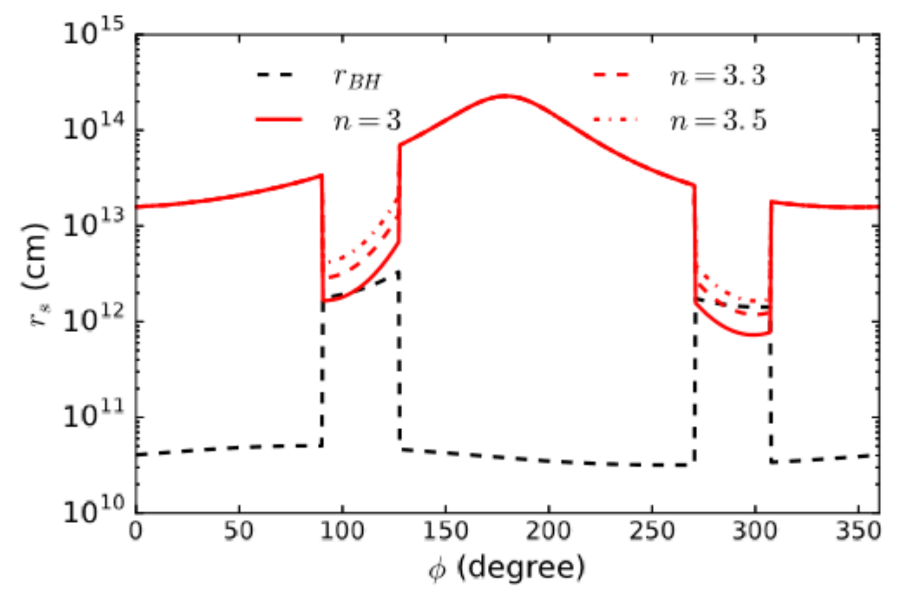


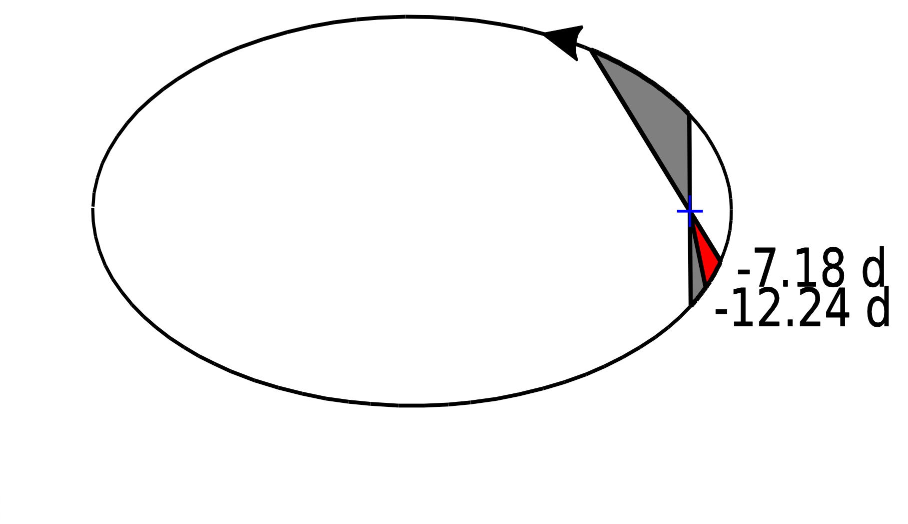
Mass can transfer



Mass can NOT transfer

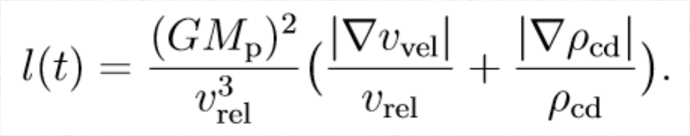
Location of the circumstellar disk, and phases of mass transfer





Condition of the formation of accretion disk

- The transferred material should have enough specific angular momenta: $r_{circ} > r_{lc}$
- $r_{circ} = \frac{l^2}{GM_p}$
- The angular momenta of the transferred material are due to the density and velocity gradient of the circumstellar disk.



$$l(t) = \frac{(GM_{\rm p})^2}{v_{\rm rel}^3}\left(\frac{|\nabla v_{\rm vel}|}{v_{\rm rel}} + \frac{|\nabla \rho_{\rm cd}|}{\rho_{\rm cd}}\right).$$

Formation of the accretion disk

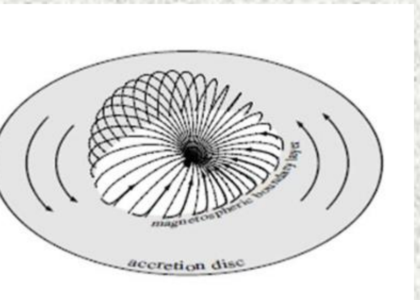
- Phase I: matter kinetic energy redistribution → torus

- Phase II: torus → accretion disk

- Phase III: inner edge of accretion disk decrease until it reaches the inner most radius
- Phase IV: mass and accretion rate decrease

Fastness Parameter:

$$\omega_* = \frac{\Omega_*}{\Omega_{K(R_A)}} > 1$$



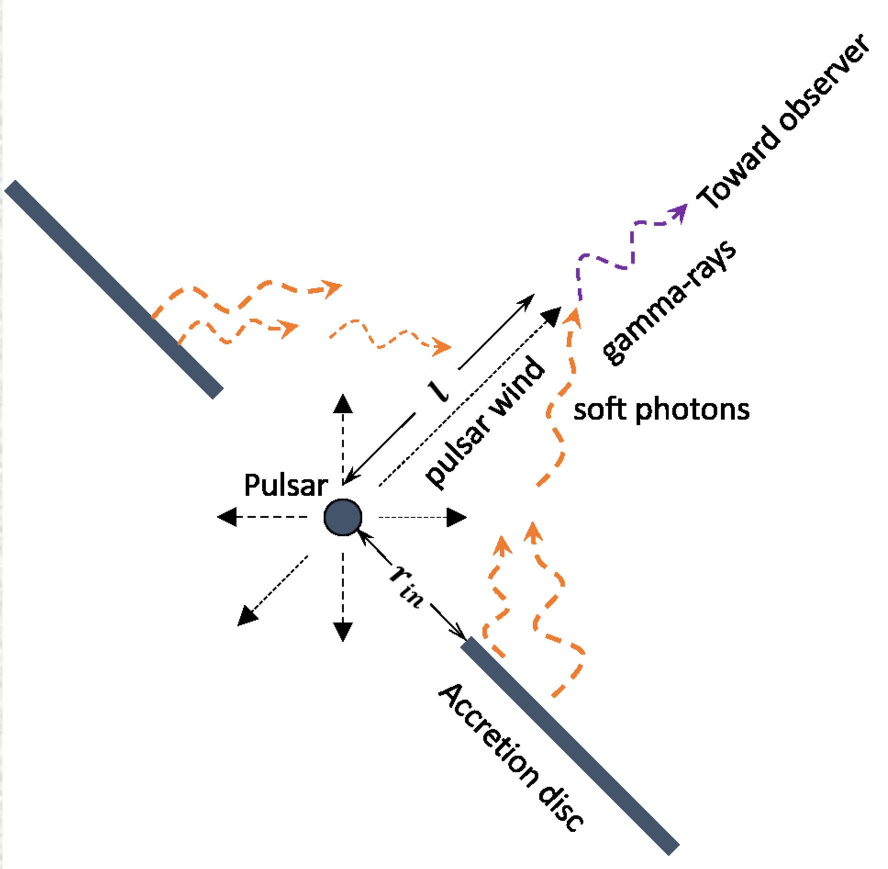
Propeller effect. Will not accretion on neutron

Viscosity time scale

$$\tau \approx \frac{R_{\rm circ}}{v_r} \approx \frac{1}{2.7}\alpha^{-4/5}\dot{M}_{\rm acc,16}^{-3/10} m_{\rm p}^{1/4} R_{\rm circ}^{5/4} \times 10^6 \text{ s.}$$

Evolution of the accretion disk

$$T = 1.4 \times 10^4 \alpha^{-1/5} \dot{M}_{\rm acc,16}^{3/10} m_{\rm p}^{1/4} r_{\rm in,10}^{-3/4}\,{\rm K},$$



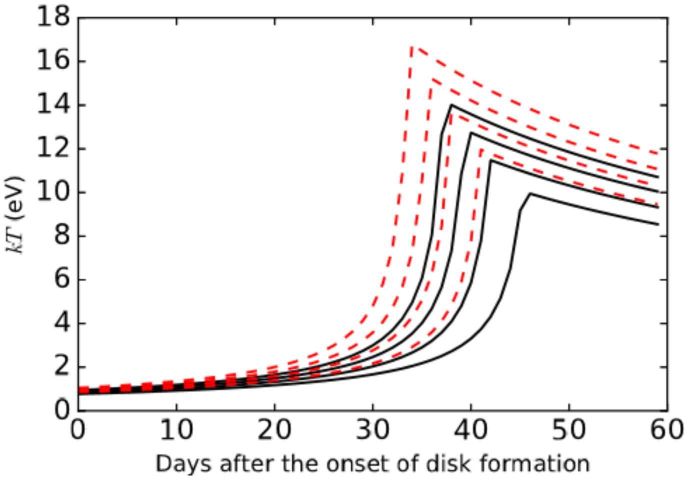


Figure 3. The temperature of the inner most region of the accretion disk, as a function of the time after the formation of the accretion disk: From left to right correspond to

Evolution of SED

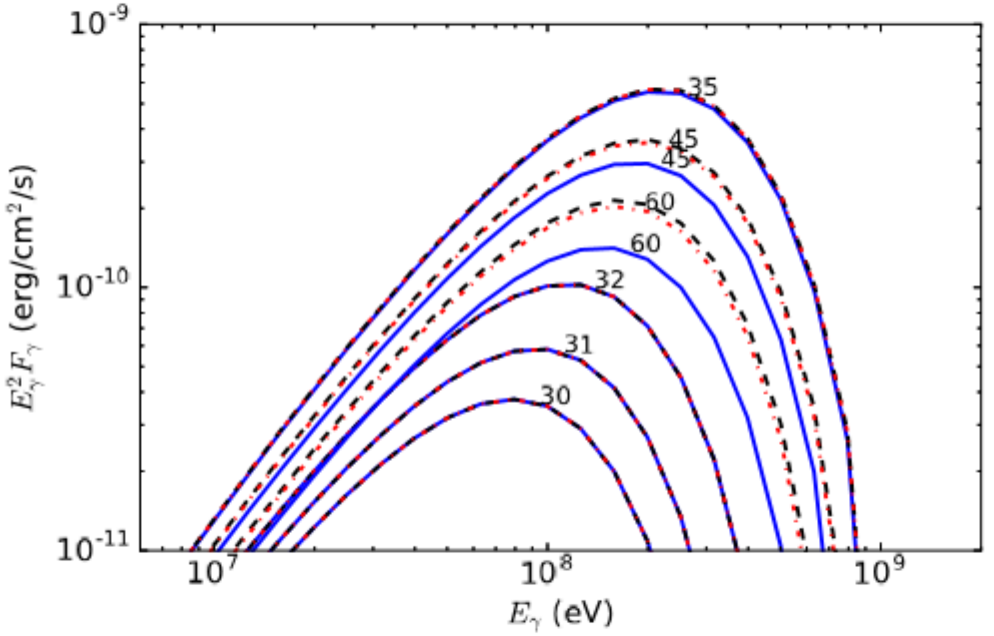
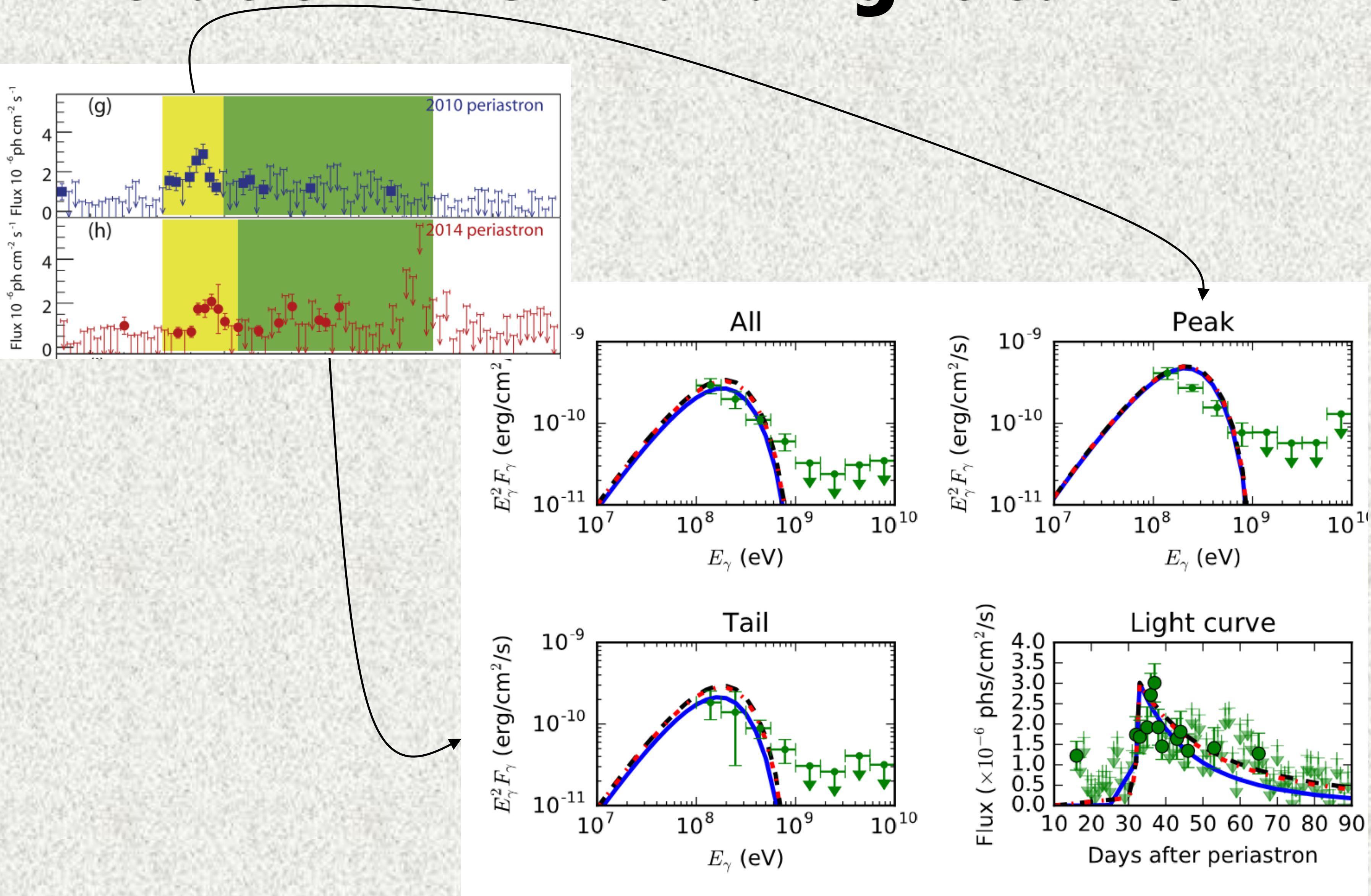
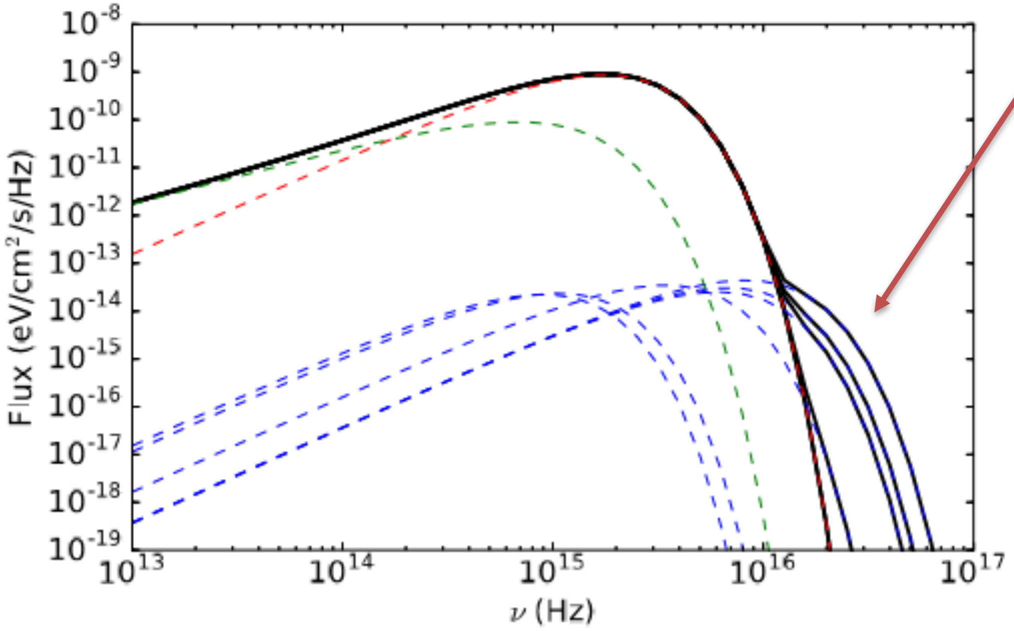


Figure 5. The evolution of the SED of IC:

Evolution of SED and light curve



Predication

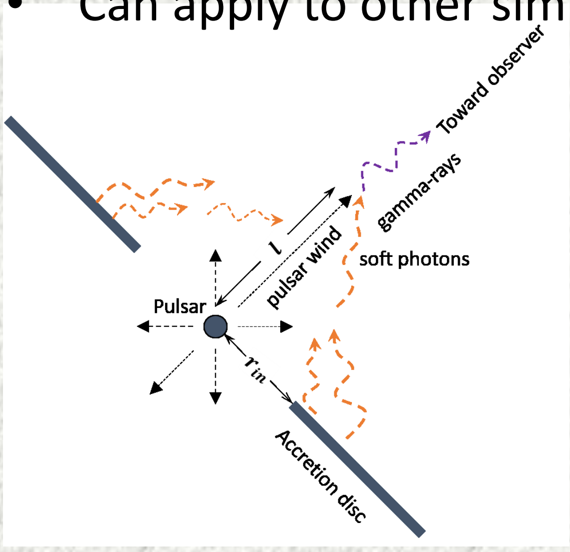


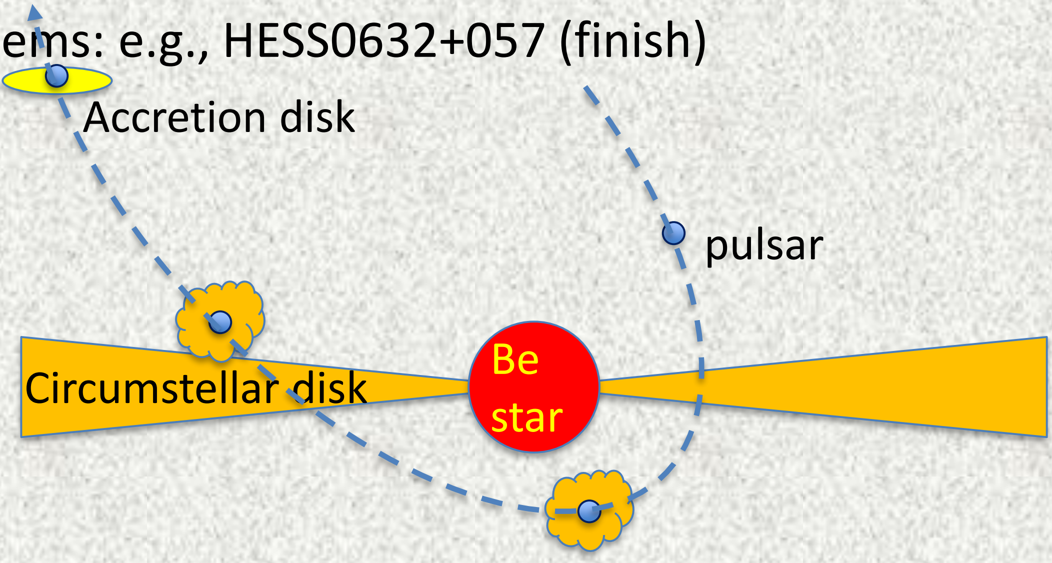
UV excess from the accretion disk

Figure 8. IR/Optical/UV SED from the sys-

Summary of the model

- Matter from circumstellar disk captured by gravity of pulsar
- An accretion disk forms.
- Pulsar wind inverse-Compton scatter the soft photon from accretion disk
- Can apply to other similar systems: e.g., HESS0632+057 (finish)




Accretion disk

pulsar

Circumstellar disk

Be star

Gravity-captured matter