Modelling the Quiescent keV Emission from Magnetars

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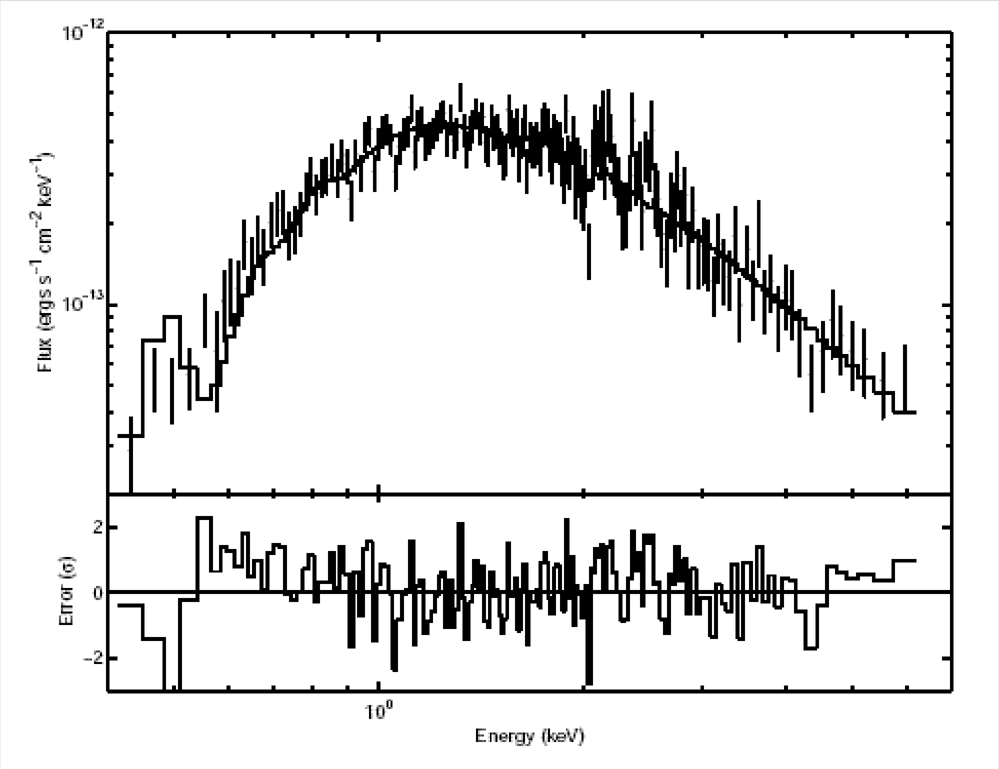
Chris Thompson CITA

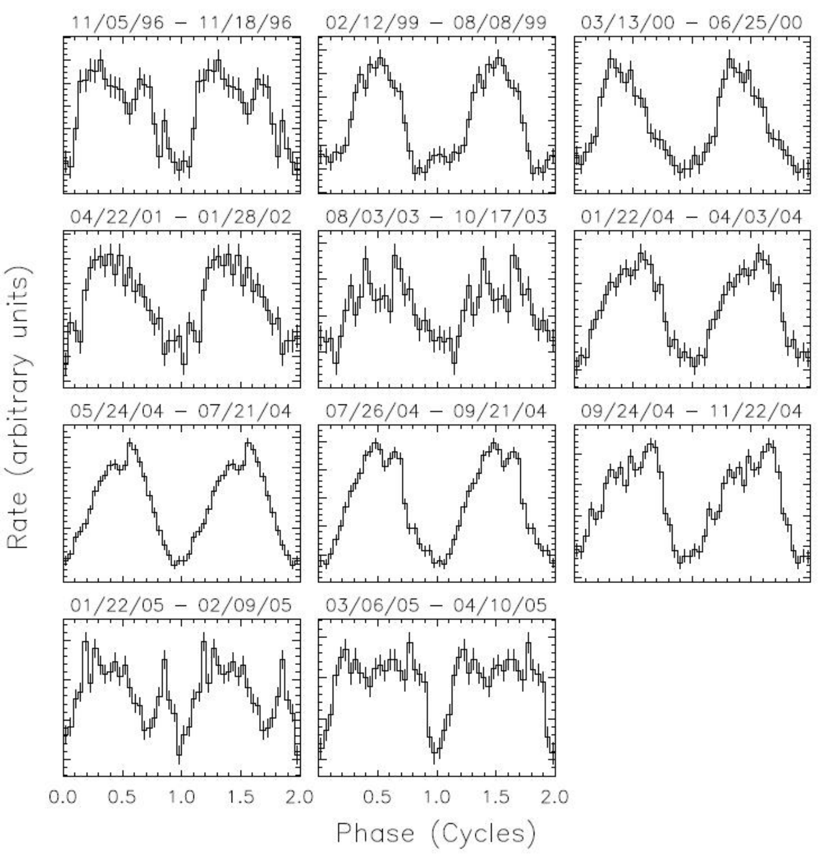
Outline

1) The Model
2) Results
3) Limitations / Extensions

Observations (1-10 keV)

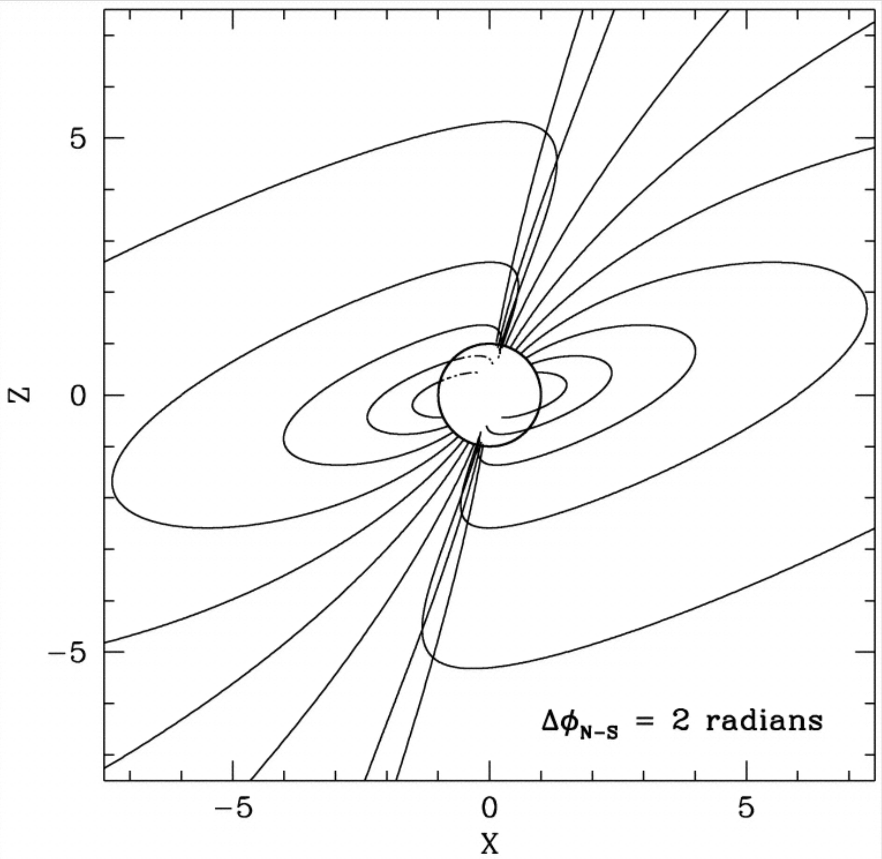


SGR 0526-66 (Kulkarni et al. 2003)



SGR 1806-20 (Woods et al. 2006)

Model of TLK (2002)



Thompson, Lyutikov, & Kulkarni (2002)

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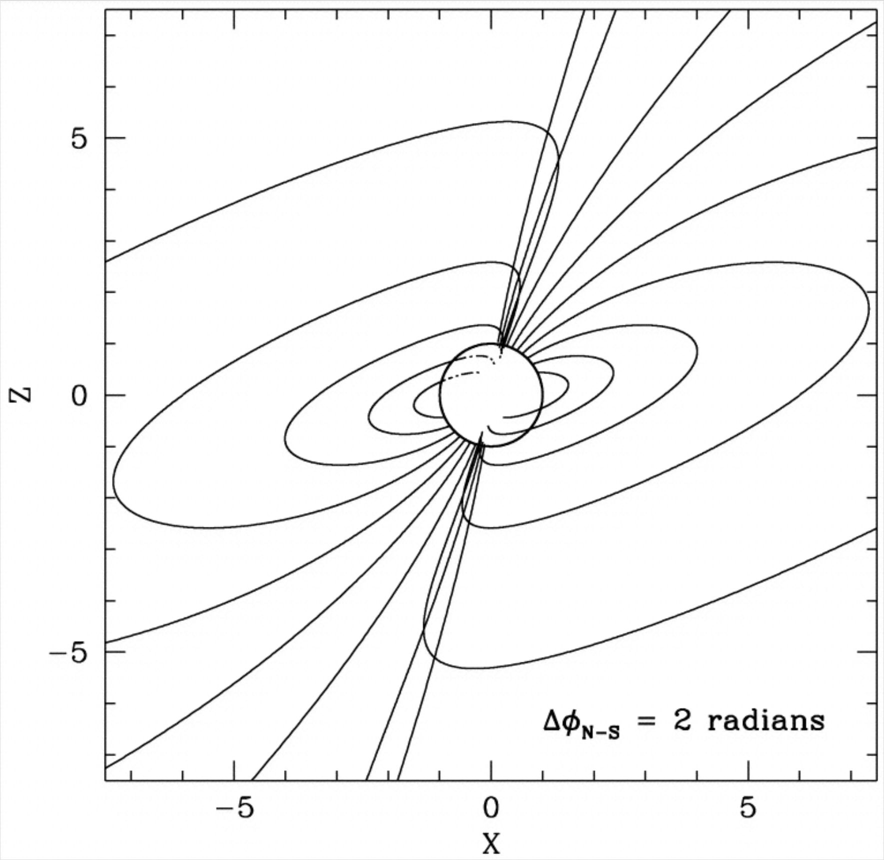

Thompson, Lyutikov, & Kulkarni (2002)

$$\nabla \times \vec{B} = \frac{4\pi}{c} \vec{j}$$

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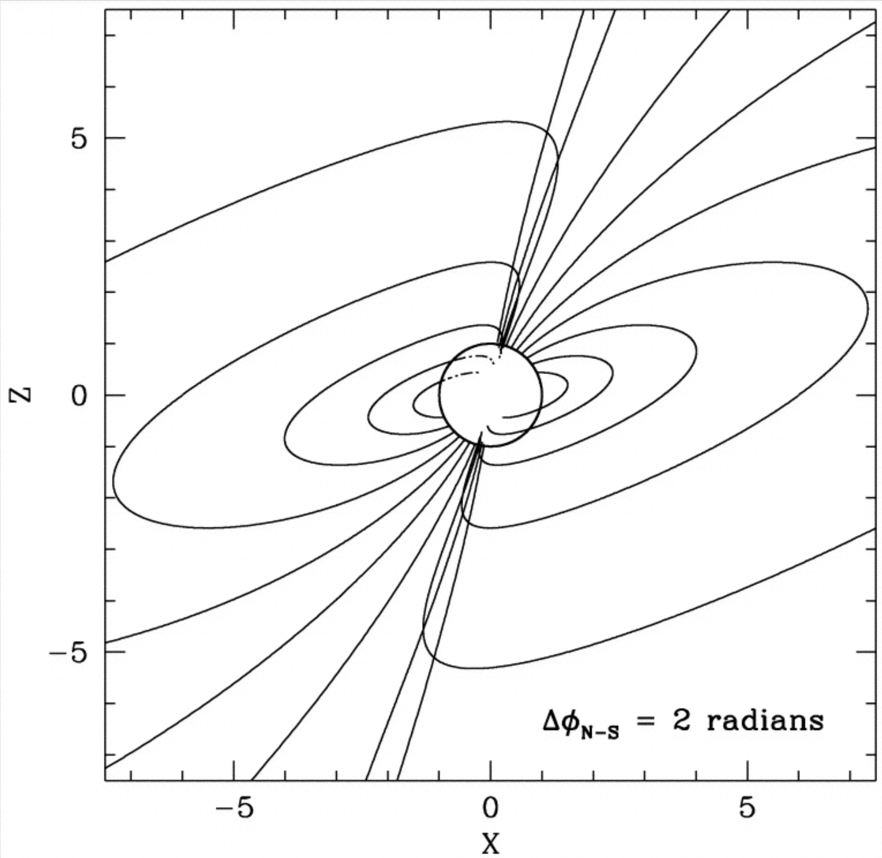

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- seed X-rays
  1) internal heating
  2) surface heating (?)

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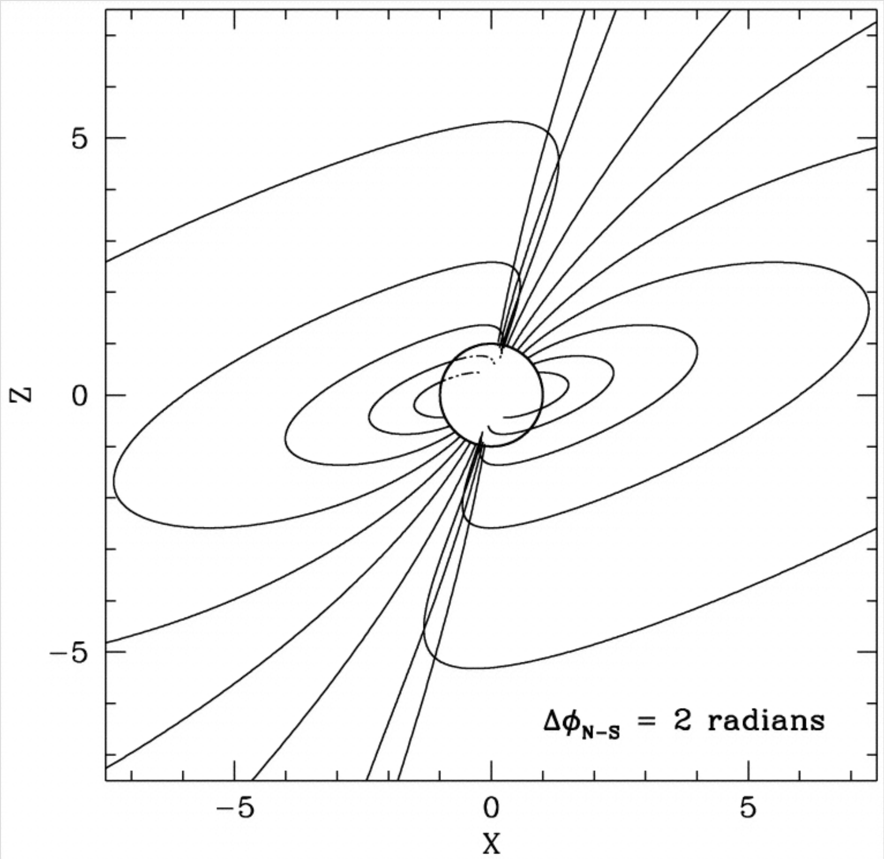

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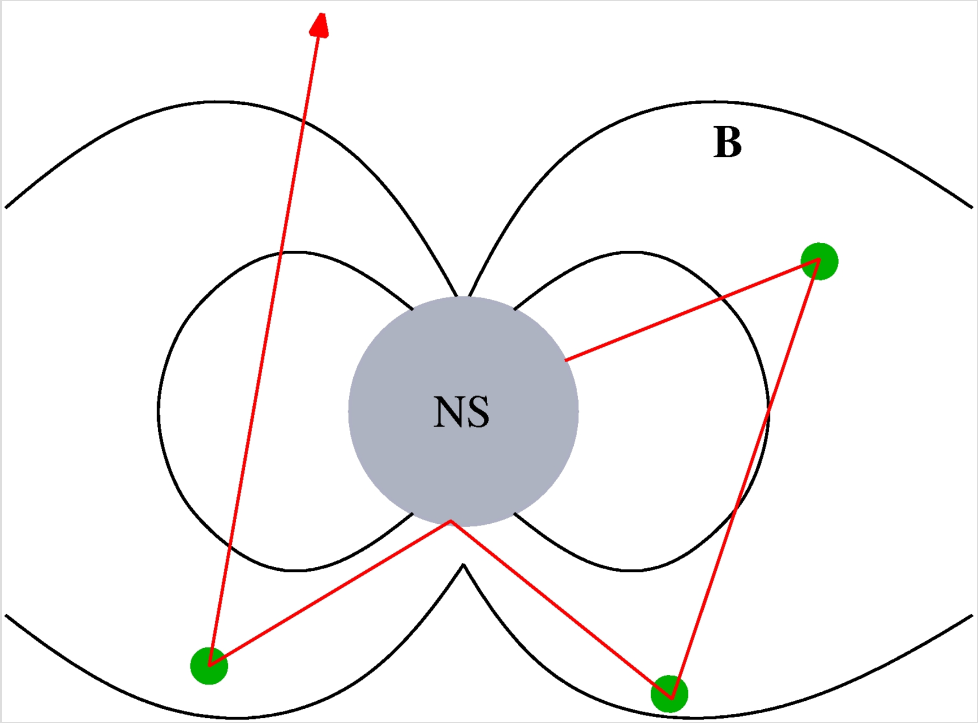
$$\nabla \times \vec{B} = \frac{4\pi}{c} \vec{j}$$

- seed X-rays
  1) internal heating
  2) surface heating (?)

- resonant cyclotron scattering

$$\tau_{\text{res}} \sim \frac{\Delta\phi_{\text{N-S}}}{\beta} \sim 1$$

Monte Carlo Simulation



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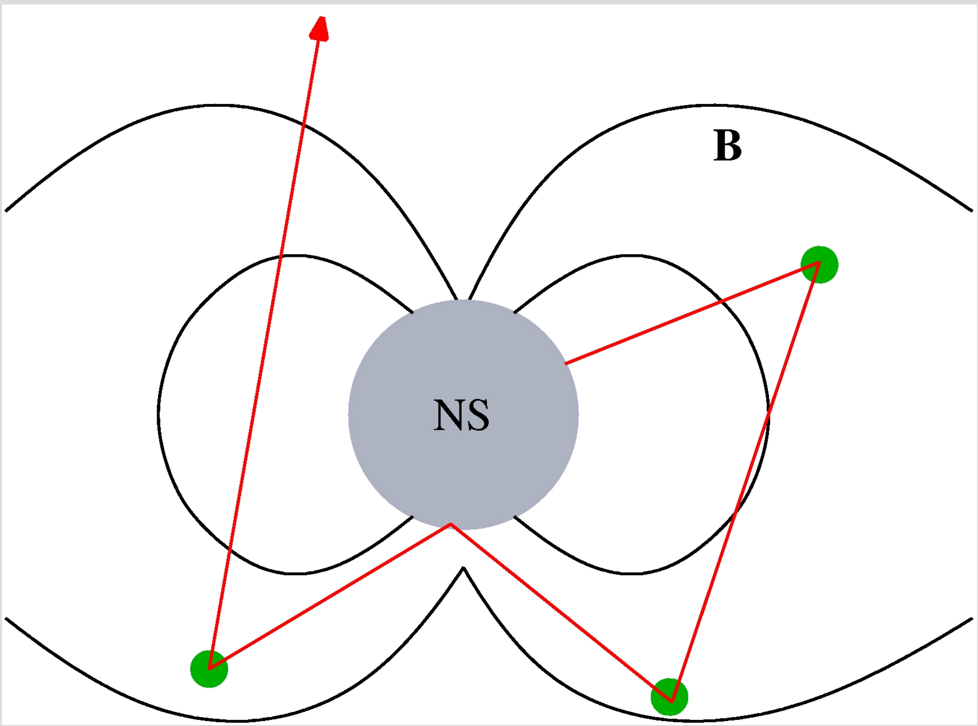
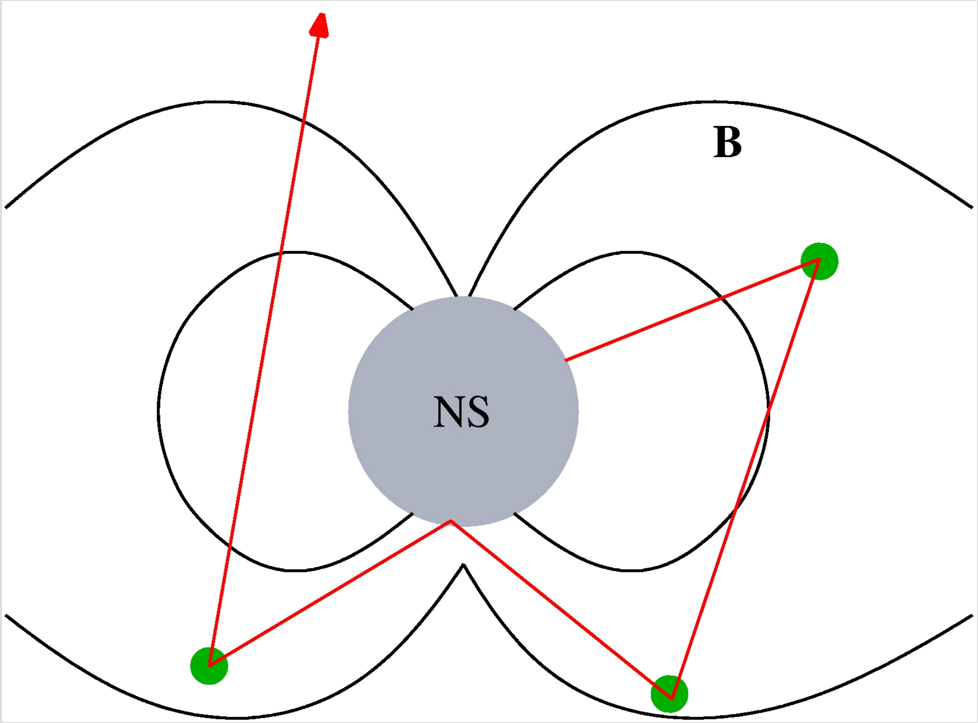


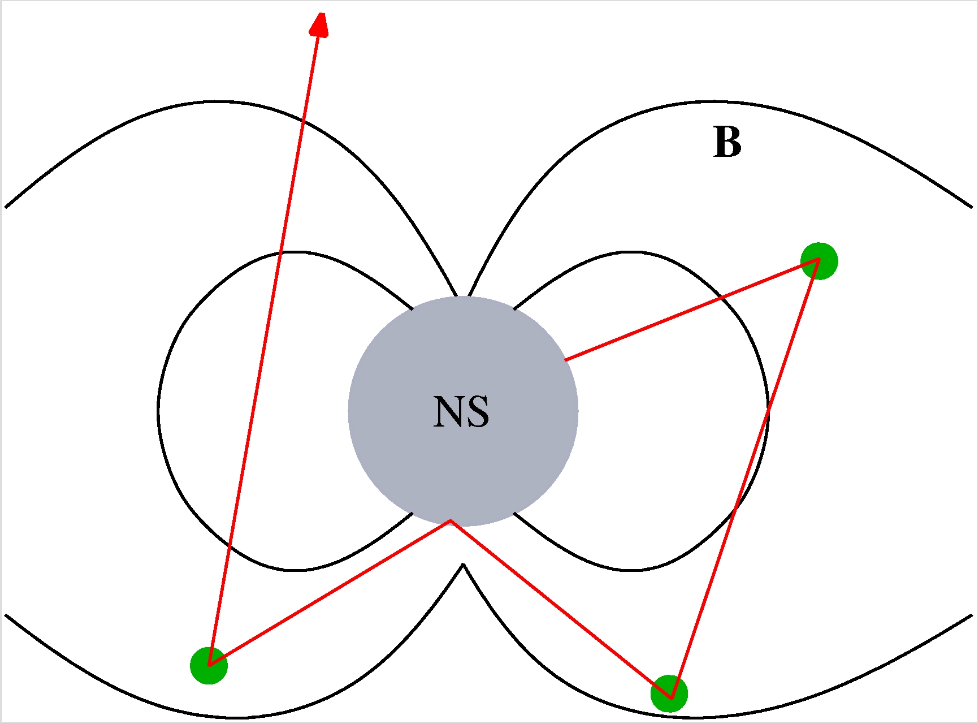
- Multiple scattering

Monte Carlo Simulation



- Multiple scattering
- 3D, TLK02

Monte Carlo Simulation



- Multiple scattering
- 3D, TLK02
- Doppler effect

$$\omega = \frac{\omega_c(r)}{\gamma(1-\beta\mu)}$$

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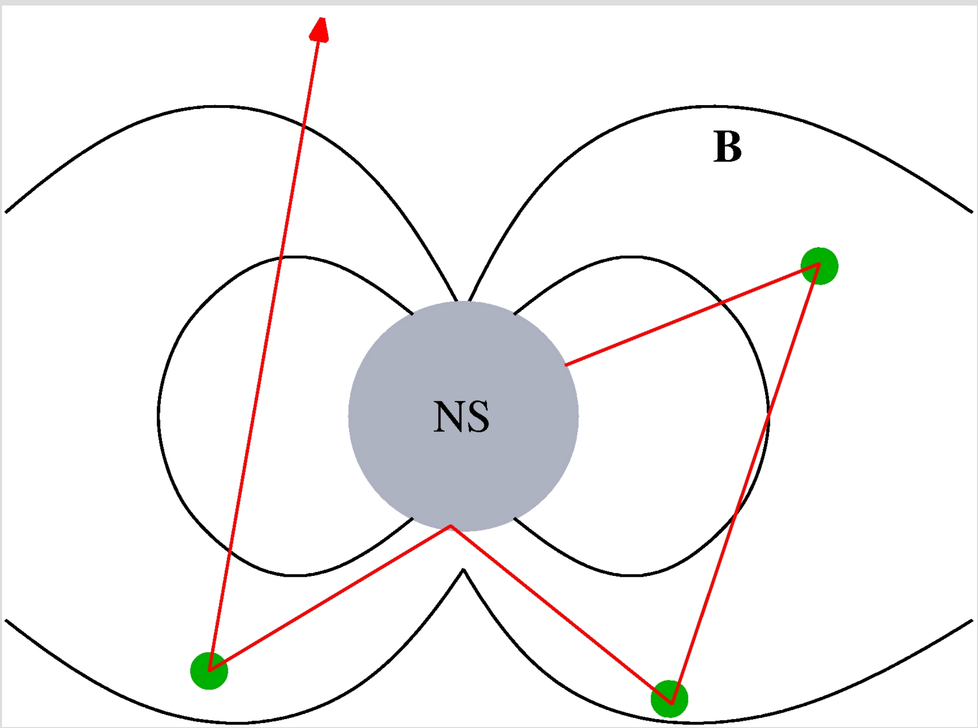

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- Multiple scattering
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- polarization

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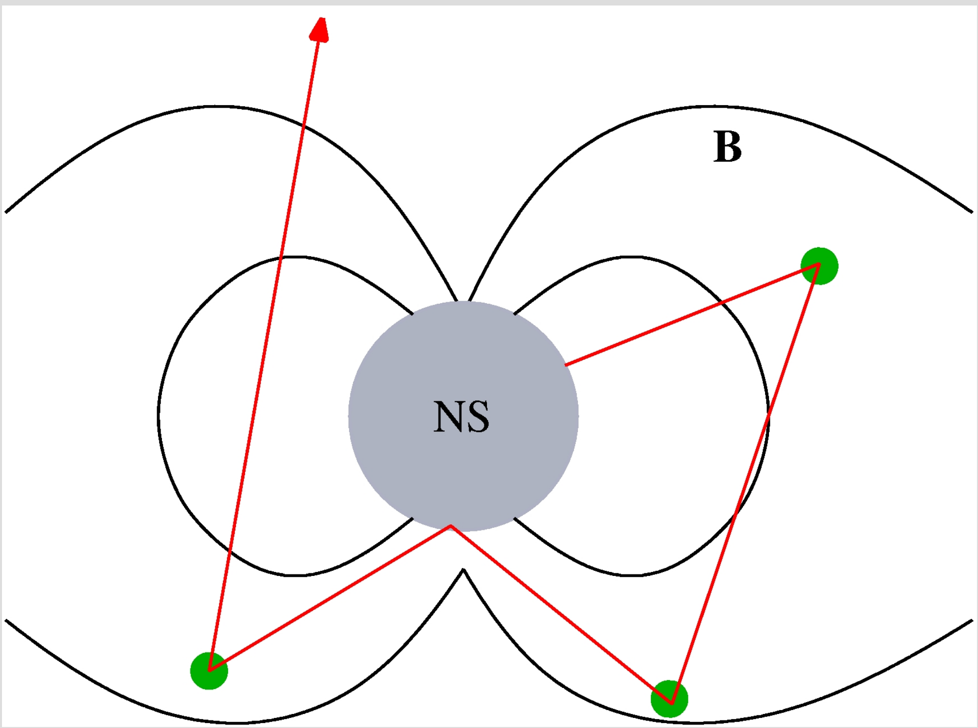

- Multiple scattering
- 3D, TLK02
- Doppler effect
- polarization
- orientation

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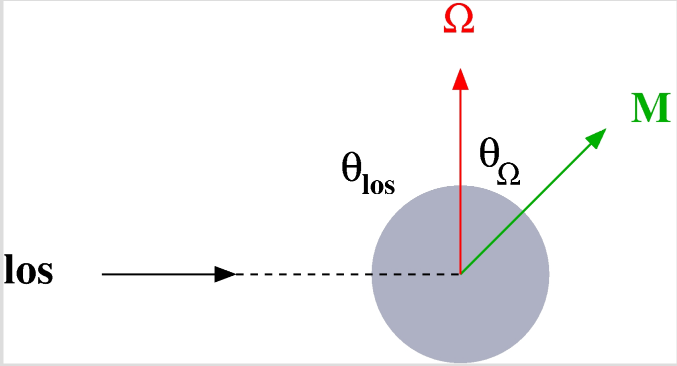

Results

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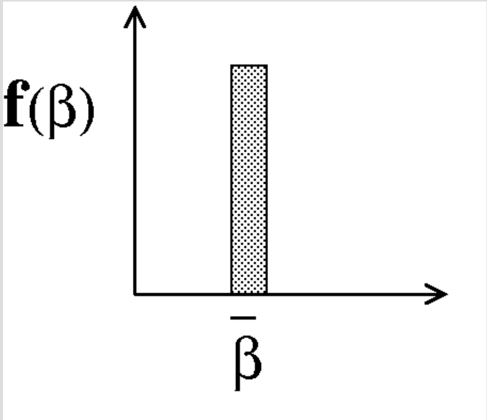

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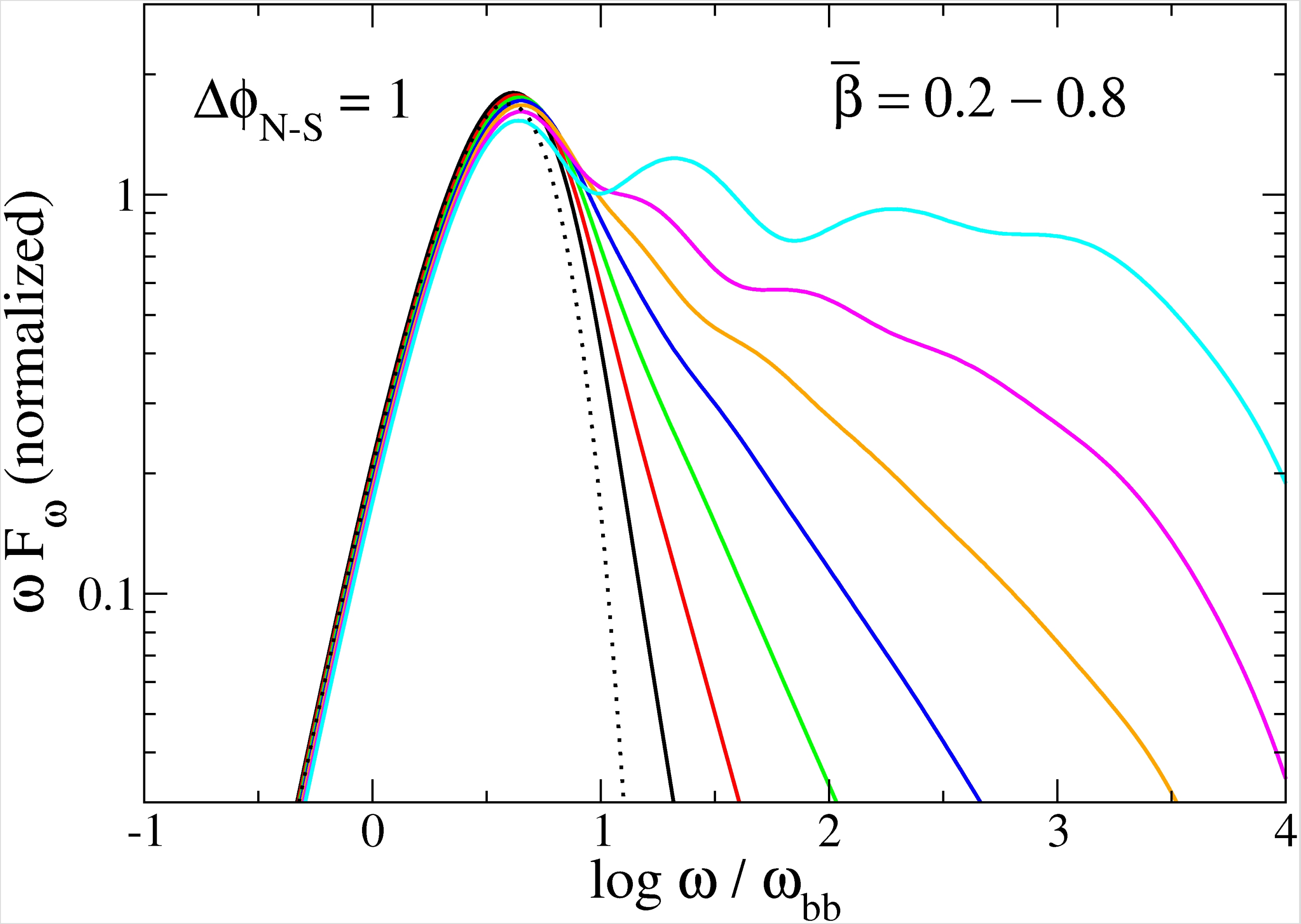

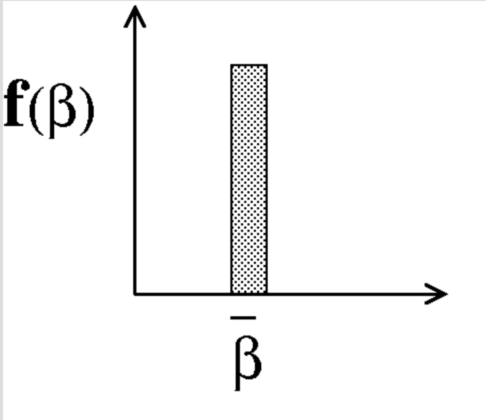

Fernández & Thompson (2006), in prep.

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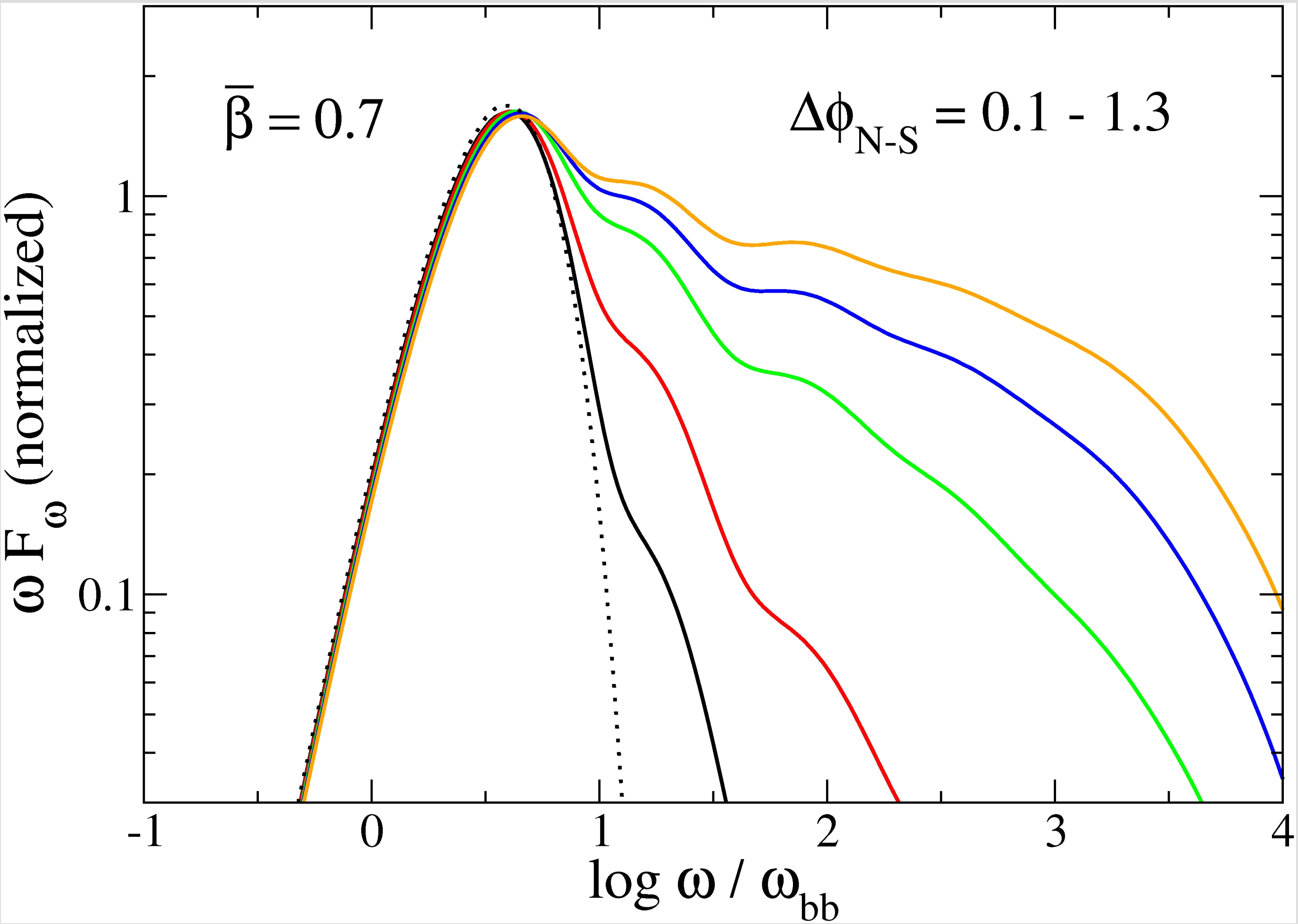

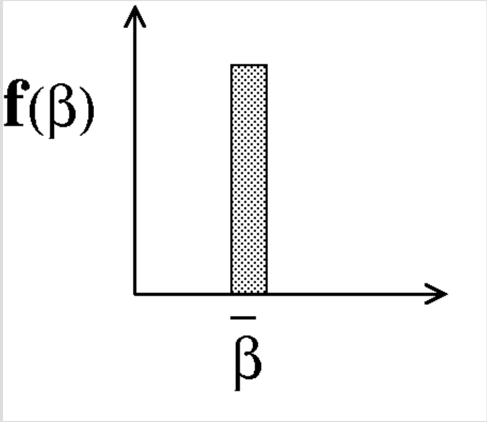

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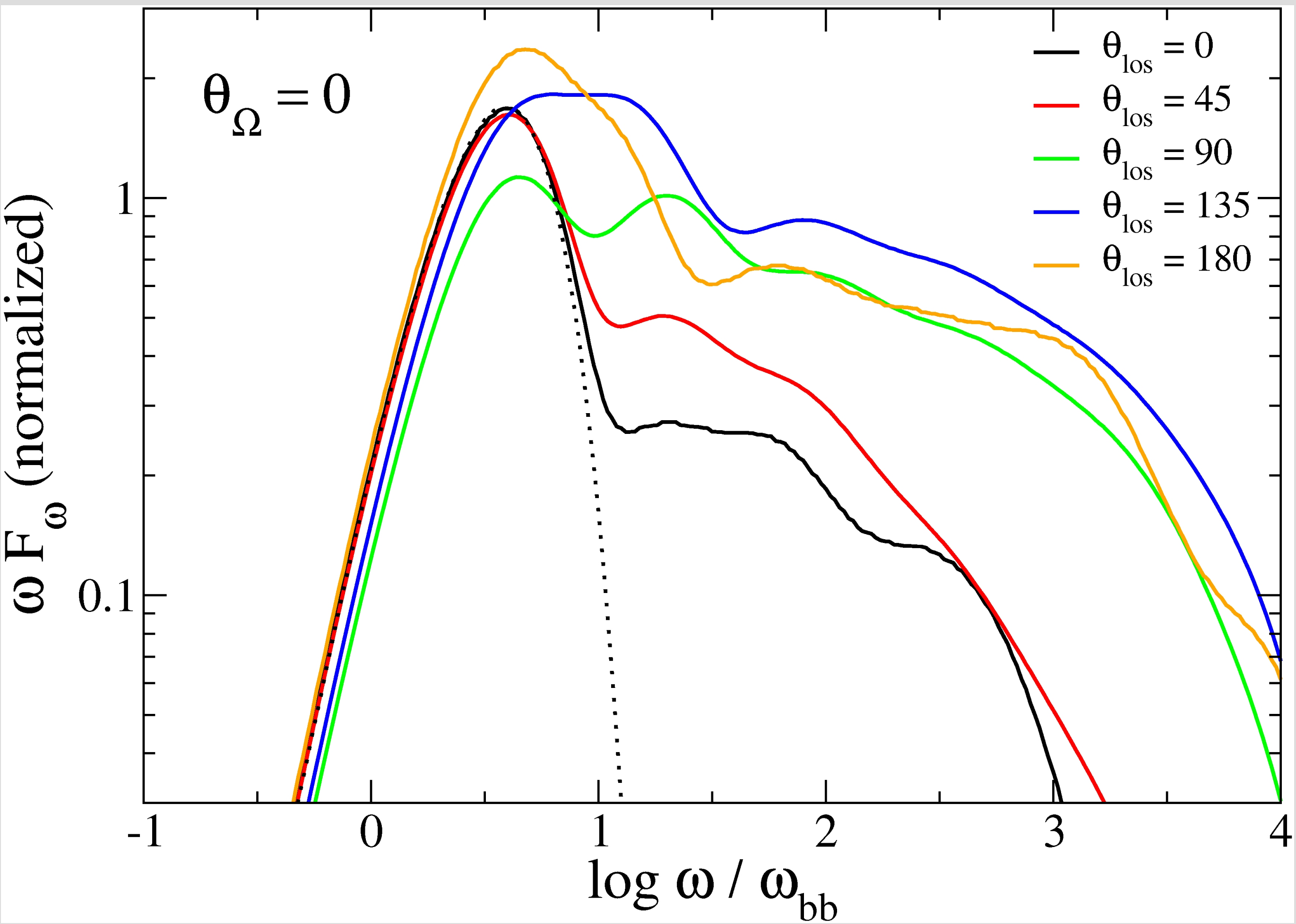

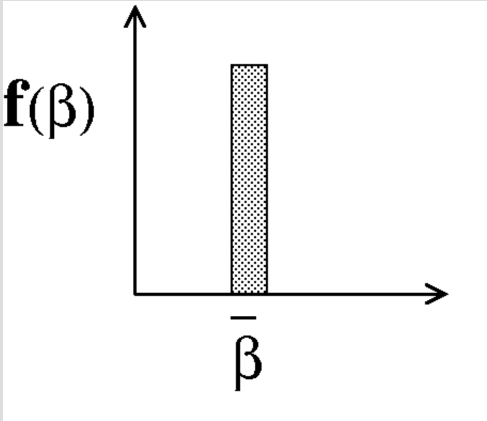

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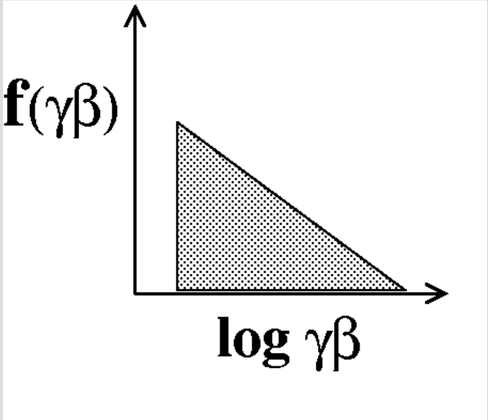

$$f(\gamma\beta) \propto (\gamma\beta)^{\alpha}$$

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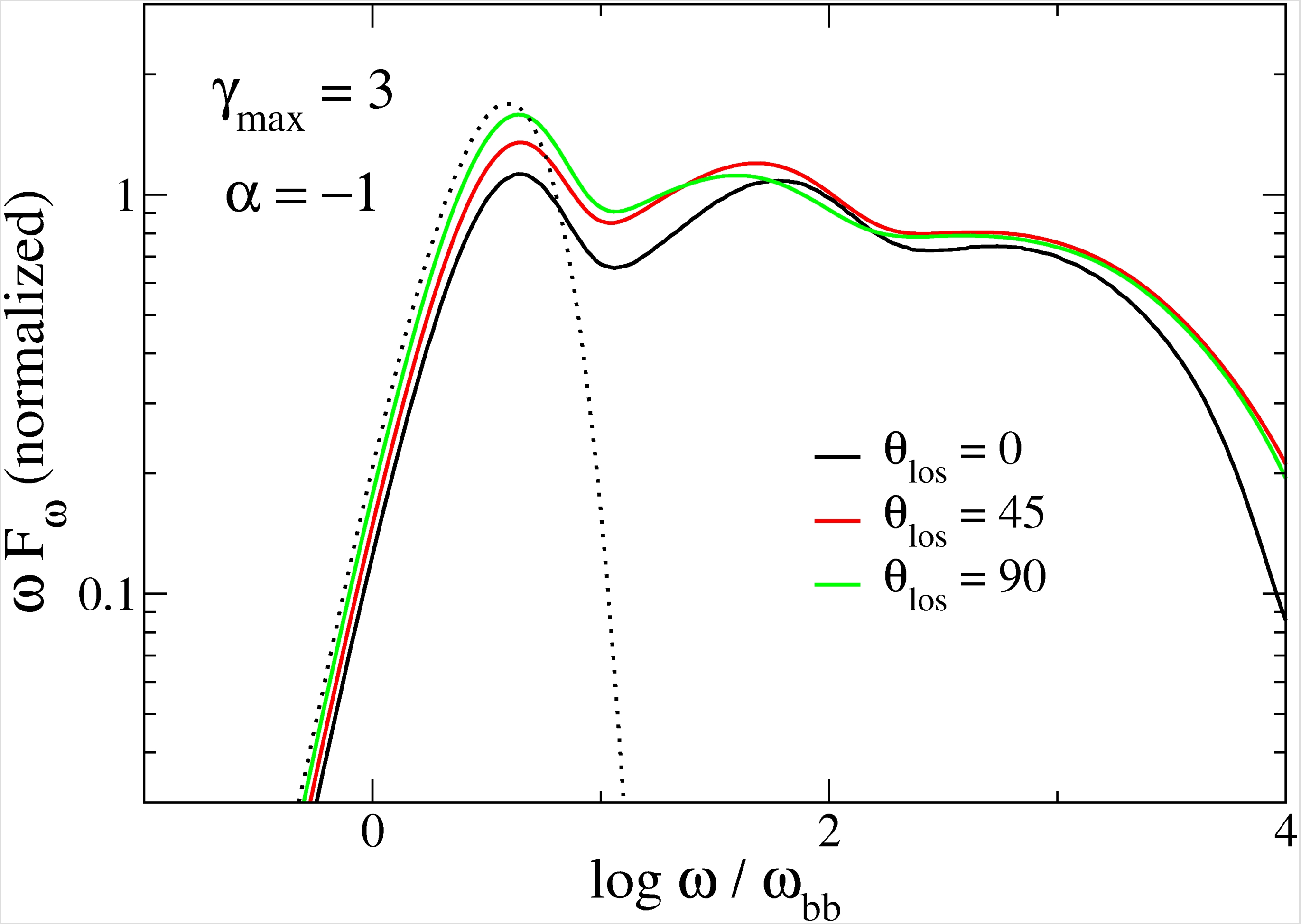

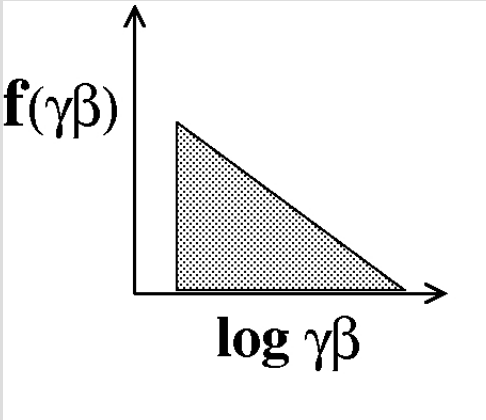

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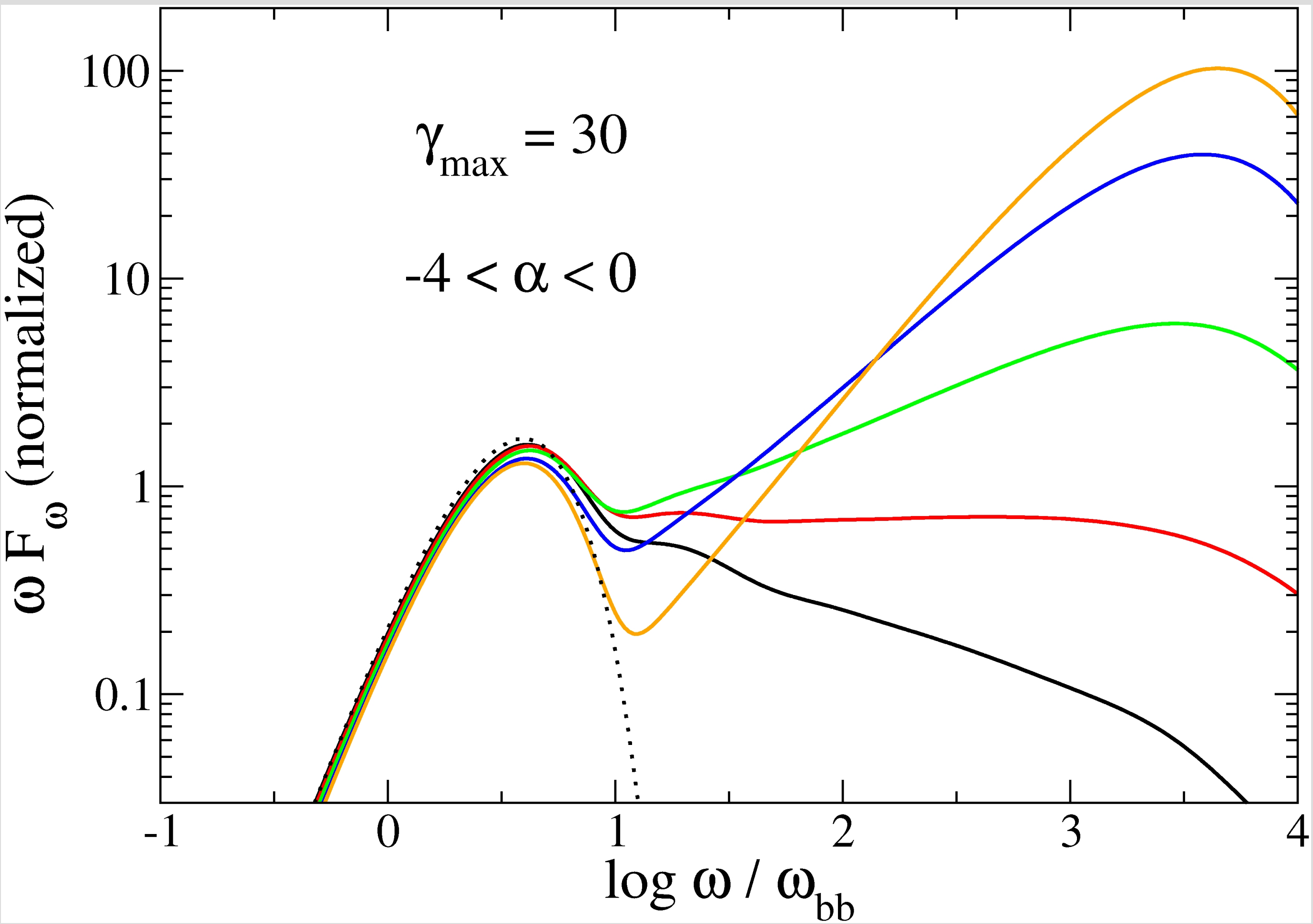

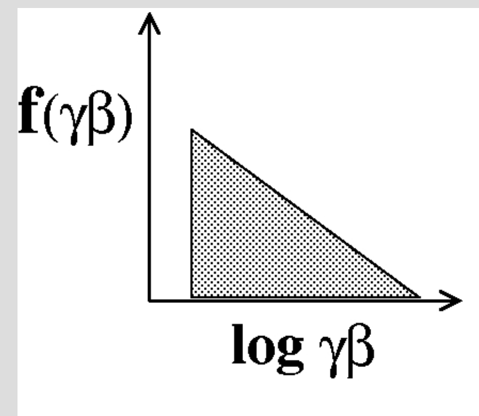

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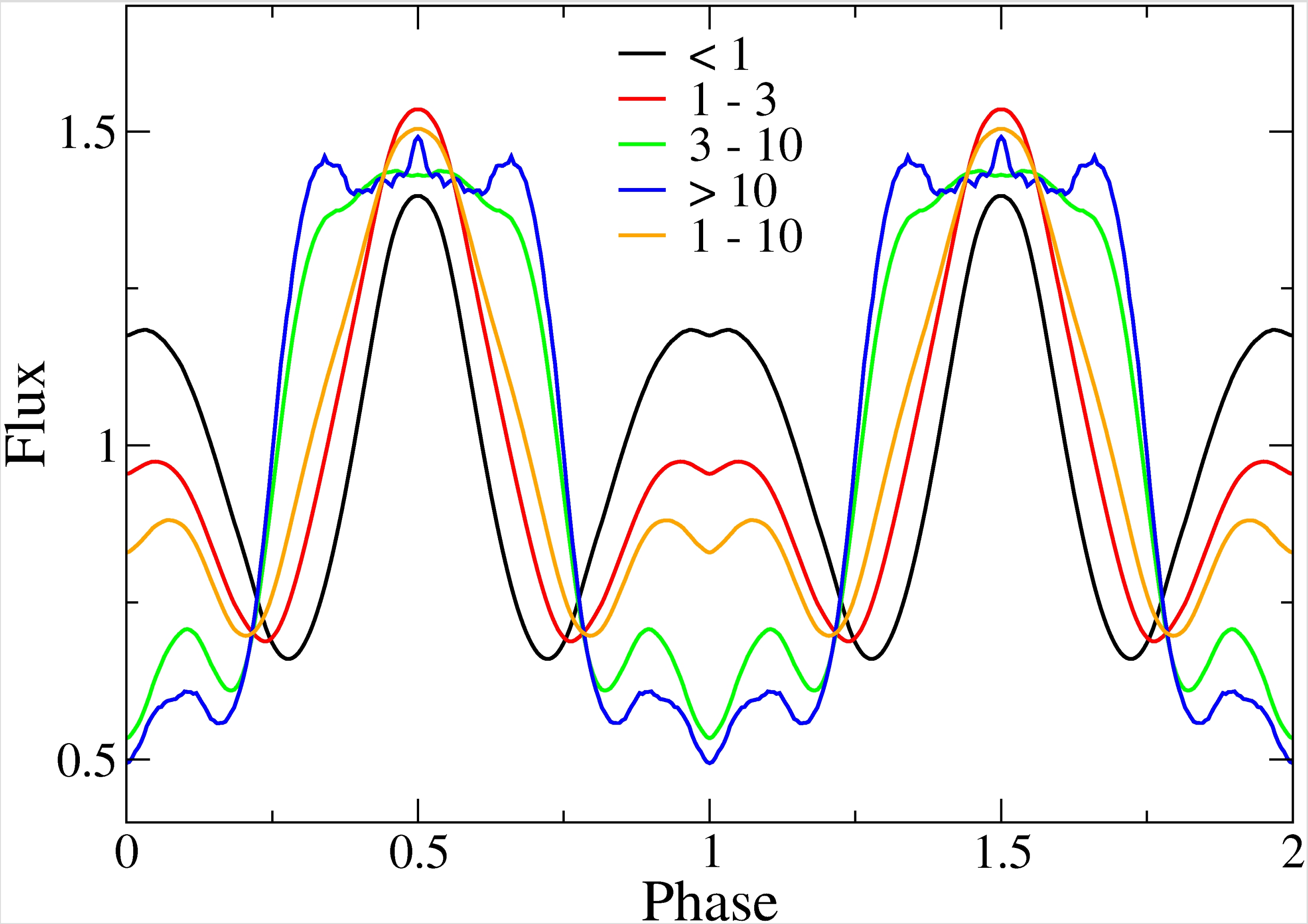

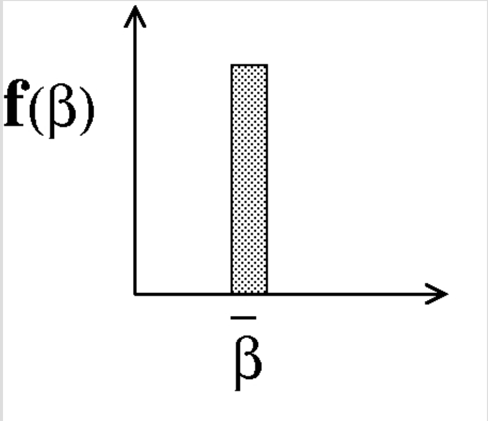

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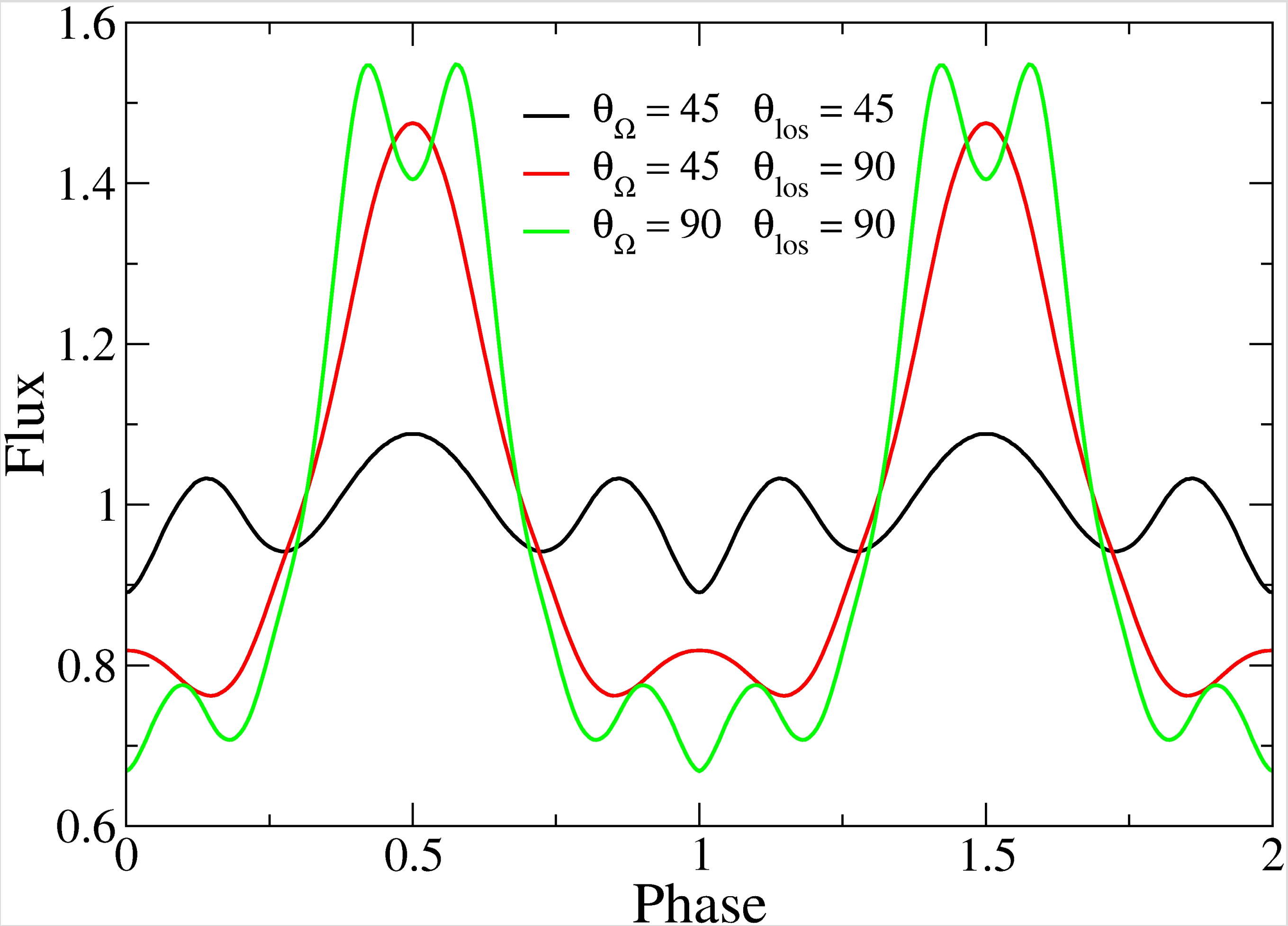

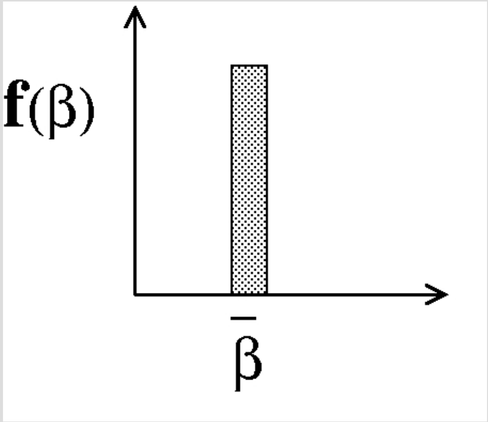

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Results

- Photon indices:

$$\Gamma \geq 0.5$$

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$$\Gamma \geq 0.5$$

- Pulsed fractions from magnetospheric transfer (T_s = constant!)

$$\leq 50\,\%$$

Summary

- Optical depth regulated to ~ $\Delta\phi_{N\text{-}S}/\beta$ (both modes)
- Spindown-Hardness correlation: $\Delta\phi_{N\text{-}S}$
- Substantial magnetospheric beaming
- Orientation effects are important

Limitations

- Sensitive to uncertain $f(\beta,r)$ $\rightarrow$ future work
- Electron recoil
- Light bending
- Inhomogeneous surface T

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