

# Relativistic effects on polarization properties of the black-hole accretion disc radiation

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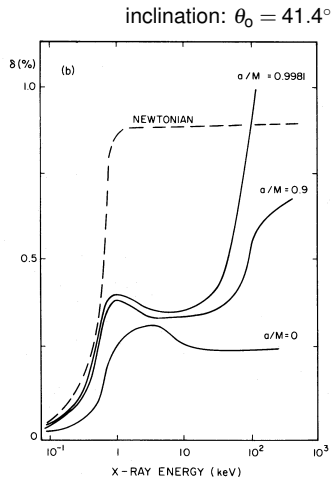
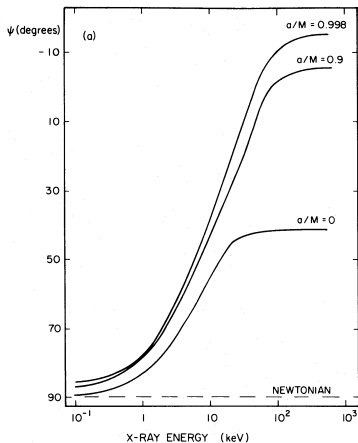
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# Historical note

Polarization computations in Kerr metric — late 1970s:  
*Stark & Connors (1977), Connors & Stark (1977)*

Connors, Piran & Stark (1980)



# Special relativistic effects

- ▶ due to high velocity of the matter close to the black hole — orbiting, falling into or being ejected from the centre
- ▶ direction of motion with respect to the observer
- ▶ observed effects:
  - ▶ **Doppler shift** (energy)
  - ▶ **aberration** (angles — emission angle, polarization angle)
    - **beaming** (intensity)
  - ▶ **time delay** (spots)

# General relativistic effects

- ▶ due to high gravity of the compact central body
- ▶ inclination angle of the observer
- ▶ spin of the black hole
- ▶ observed effects:
  - ▶ **gravitational redshift** (energy, intensity)
  - ▶ **light bending** (angles — emission angle, polar. angle)
    - **lensing effect** (intensity)
  - ▶ **time delay** (spots)

# Stokes parameters

Stokes parameters at infinity:

$$\Delta I(E) = \int_{\Sigma} dS G I_{\text{loc}}(E/g)$$

$$G = g^3 \ell \mu_e$$

$$\Delta Q(E) = \int_{\Sigma} dS G P_{\text{loc}}(E/g) I_{\text{loc}}(E/g) \cos 2[\chi_{\text{loc}}(E/g) + \psi]$$

$$\Delta U(E) = \int_{\Sigma} dS G P_{\text{loc}}(E/g) I_{\text{loc}}(E/g) \sin 2[\chi_{\text{loc}}(E/g) + \psi]$$

$$P = \frac{\sqrt{(\Delta Q)^2 + (\Delta U)^2}}{\Delta I} \quad \tan 2\chi = \frac{\Delta U}{\Delta Q}$$

# Energy shift

Emission angle

## Change of polarization angle and transfer function



# Summary

- ▶ Relativistic effects change considerably the spectra and polarization of emitted radiation
- ▶ Polarimetric observations could be used for determining the properties of the system — inclination, spin
- ▶ Some effects not covered in the talk:
  - ▶ time delay
  - ▶ higher order images (of the disc)
  - ▶ self-irradiation of the disc
  - ▶ caustics
  - ▶ ...