Accretion onto stellar-mass black holes

2010-11-15

Anthony Rushton
ESO fellow
(Onsala Space Observatory)

Image credit: ESA

Overview of Work Group 2

Stellar-mass black holes and pulsars

- Two work group leaders:
  - Anthony Rushton (Accretion)
  - Robert Ferdman (Pulsars)

Overview of Work Group 2

- Accretion on to stellar-mass black holes.
- Pulsar timing in the orbit of a black hole.
- Synergies with other WGs:
  - Using pulsars to detect gravitational waves from super-massive black holes.
  - Microquasars to Quasars: Scale invariants, intermediate-mass BHs and their growth/evolution.

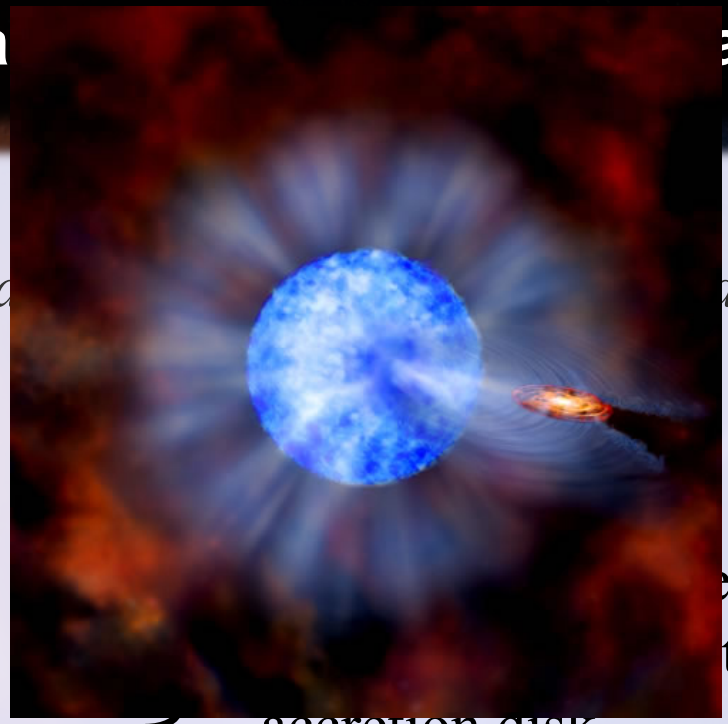
Overview of Work Group 2

- Accretion on to stellar-mass black holes.
- Pulsar timing in the orbit of a black hole.
- Synergies with other WGs:
  - Using pulsars to detect gravitational waves from super-massive black holes.
  - Microquasars to Quasars: Scale invariants, intermediate-mass BHs and their growth/evolution.

High energy stellar-ma aries

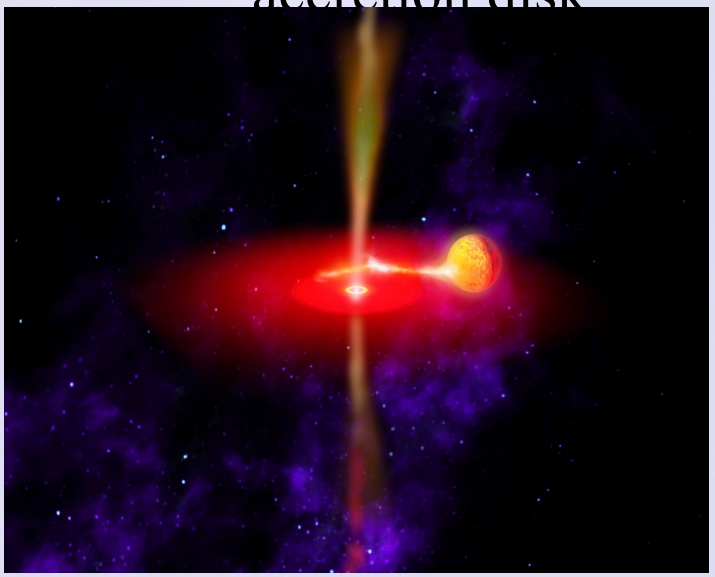
- Binary systems with a *compa ar*.

- The companion star maybe:
  - High-mass star
  - Low-mass star



e of
the

accretion disk

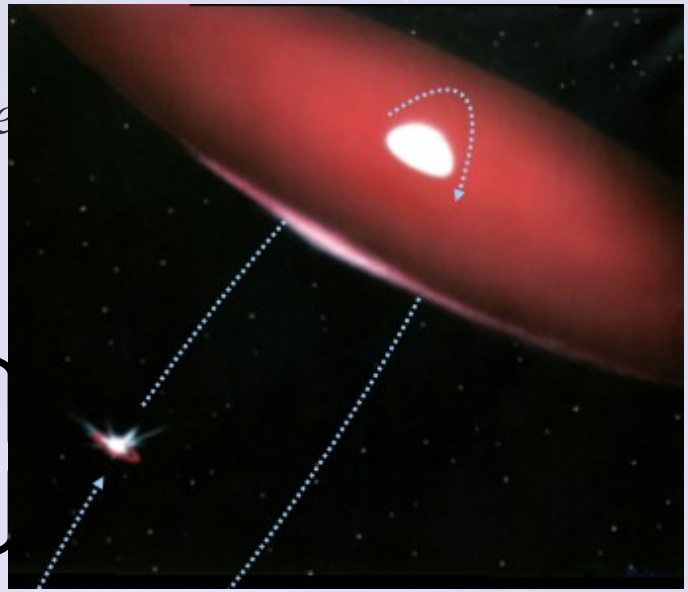


High energy stellar-mass accretion: X-ray binaries

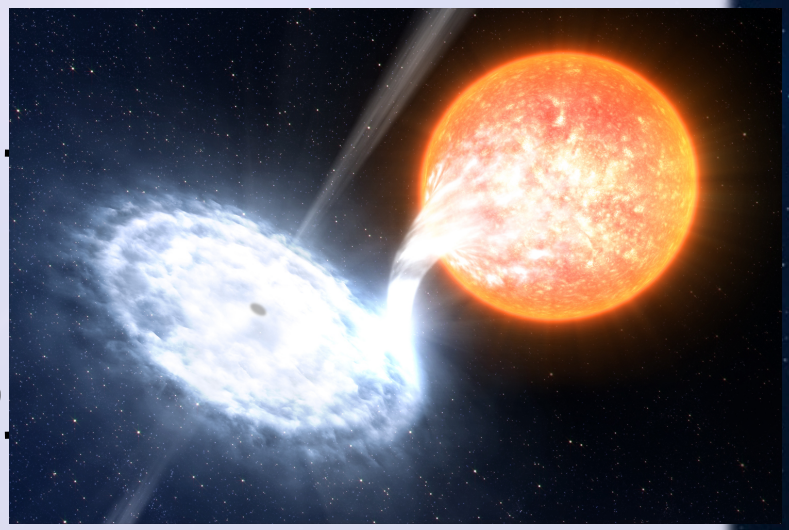
…npact obje…

…e:

- Low-mass star

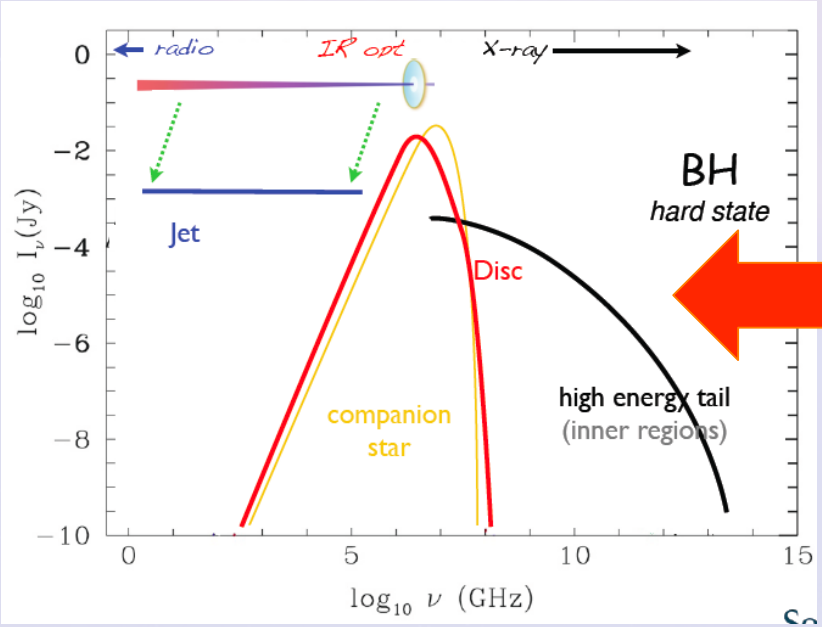


- The compact object maybe:
  - White Dwarf
  - Neutron star (possibly a pulsar)
  - Stellar-mass **Black Hole**

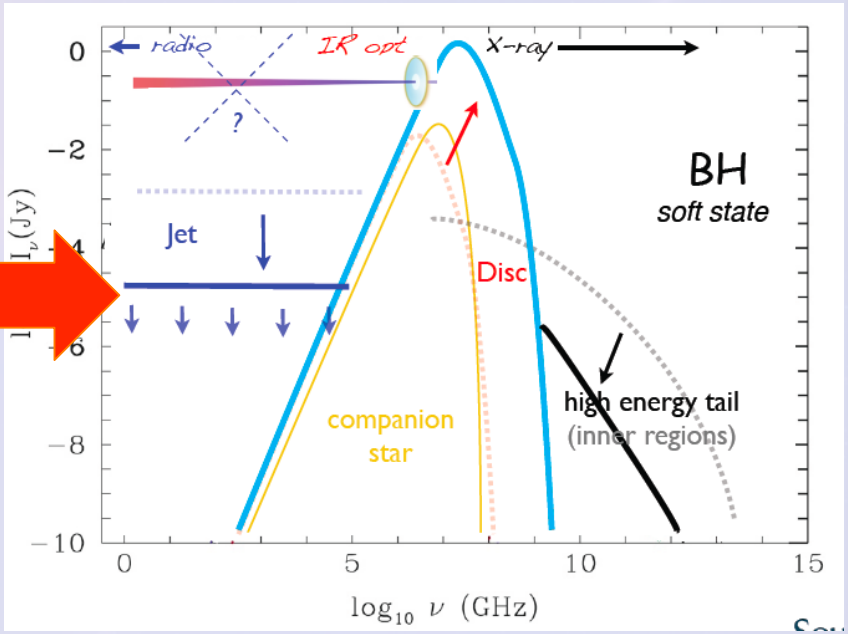


Rapid spectral variability

(low) *Hard-state* for black holes



(high) *Soft-state* for black holes

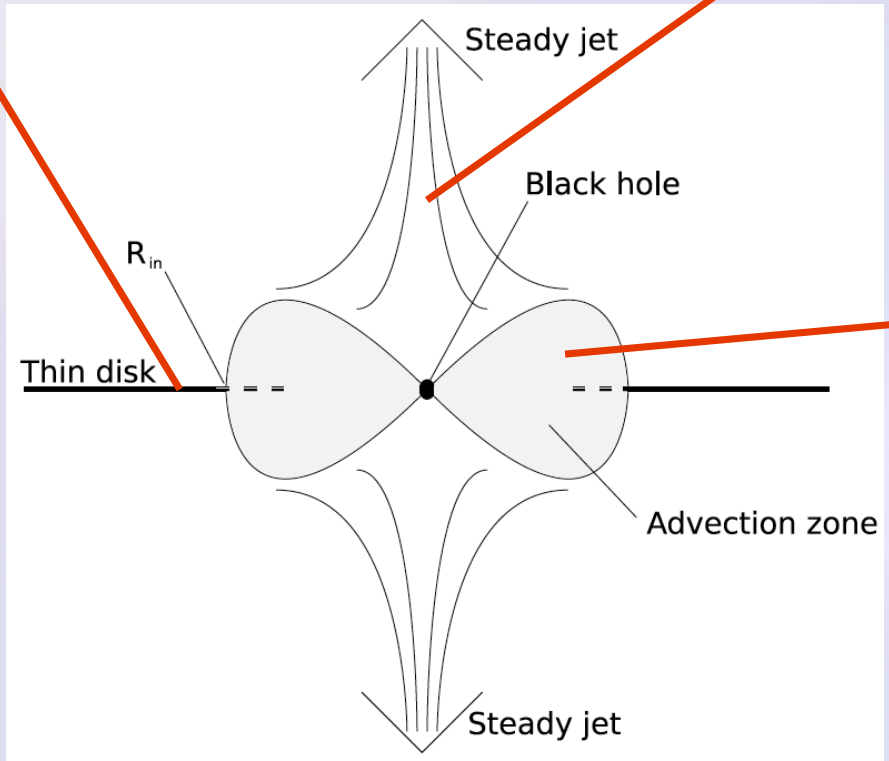


- Piergiorgio Casella

The X-ray binary emission models

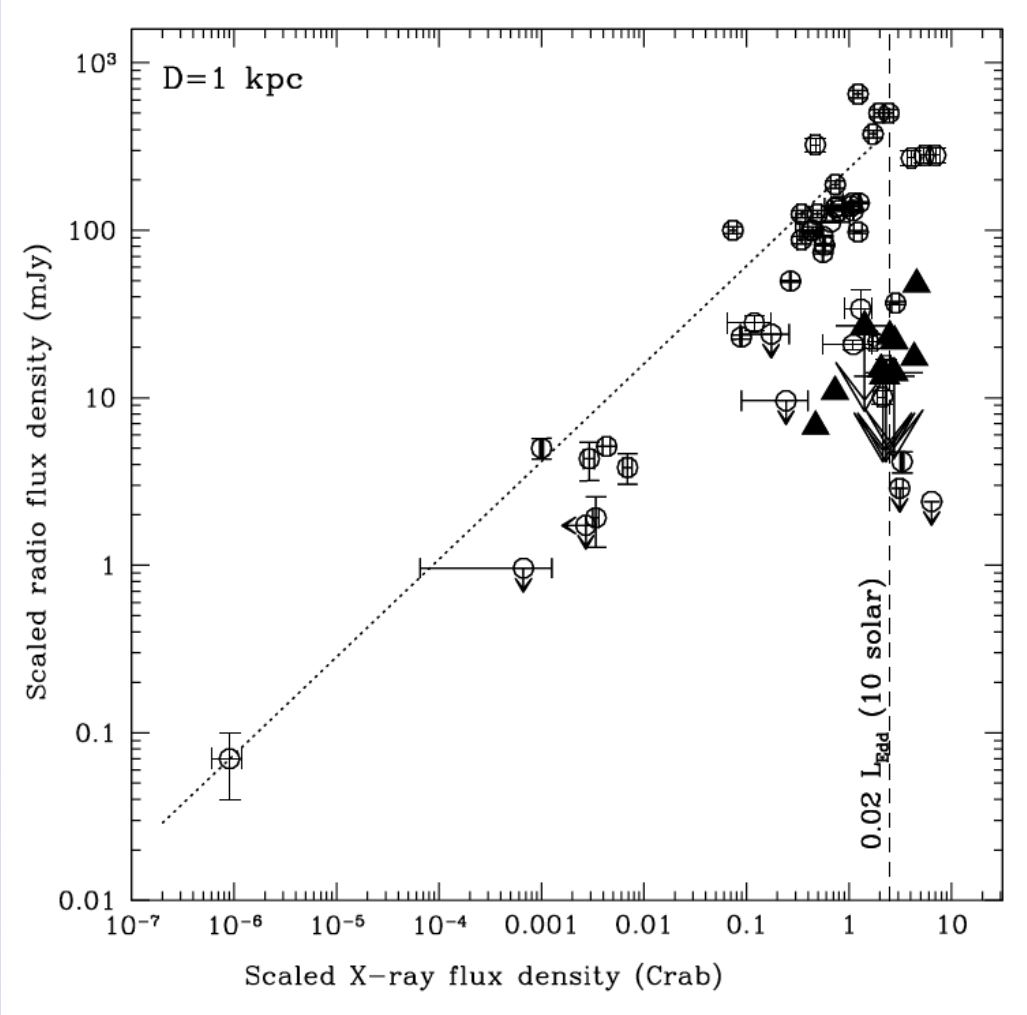
Thermal emission (soft X-rays)

Synchrotron emission (radio)



Non-thermal emission (hard X-rays)

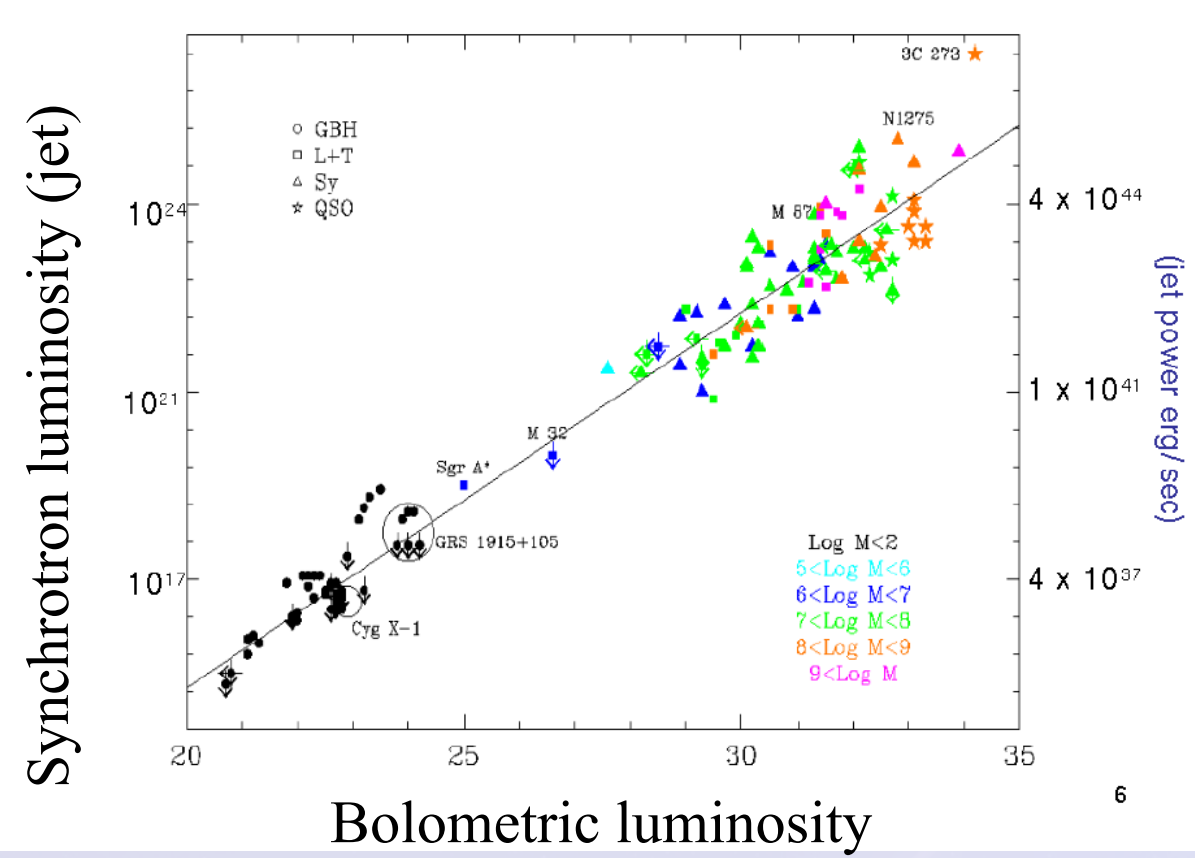
Universal correlation of BH XRBs in the low state



$$L_{\rm radio} \propto L_{\rm X-ray}^{0.71\pm0.1}$$

Corbel et al. (2003)
&
Gallo et al. (2003)

Fundamental plane of black holes



$$L_{\rm radio} \propto L_{\rm X-ray}^{0.6} M^{0.8}$$

Merloni et al. (2003)
&
Falcke et al. (2004)

Spin: Power Generation

- Blandford and Znajek 1977: energy released from the accretion disk/black-hole system from BH spin: power in the jet is

$$P = 10^{35}\left(\frac{J}{J_{\max}}\right)^2\left(\frac{M}{M_{sun}}\right)^2\left(\frac{B}{10^8}\right)^2$$

(In ergs/sec, J is spin of BH, B in gauss)

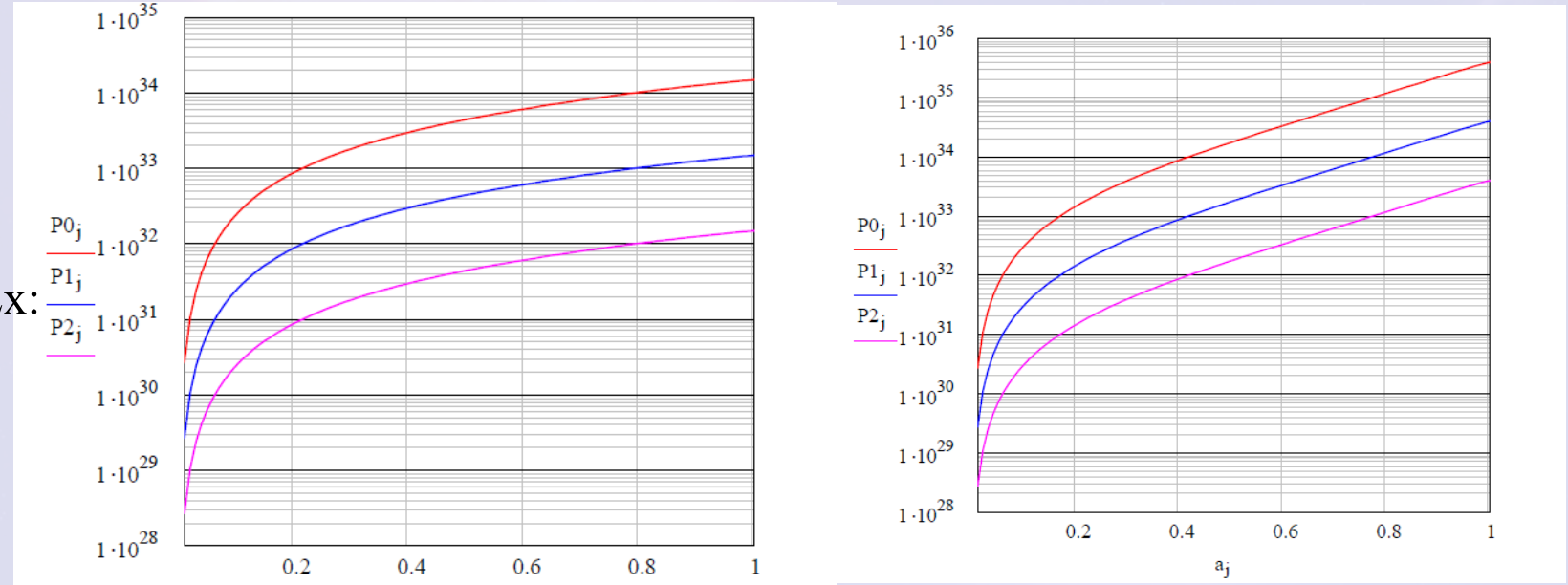
What's the value of B?

Typical jet luminosities suggest B~ 10^8 gauss or more

- Ralph Spencer

Spin: Power Generation

Lx:

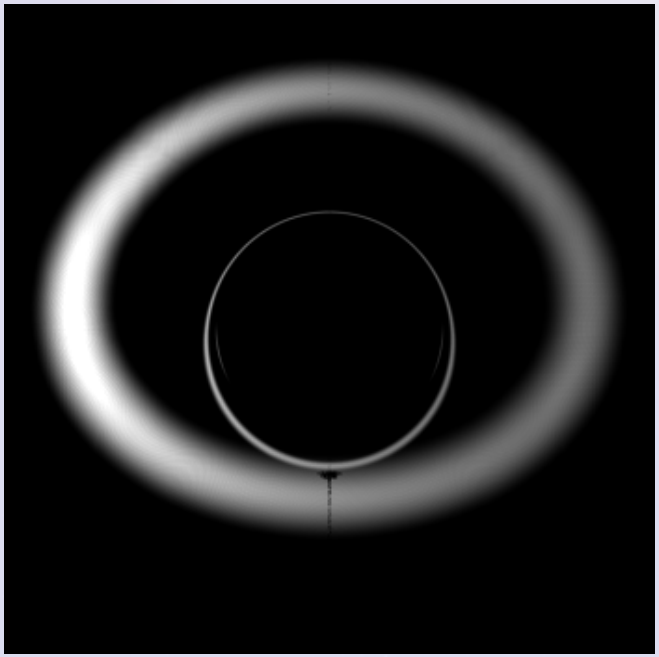


Spin Parameter

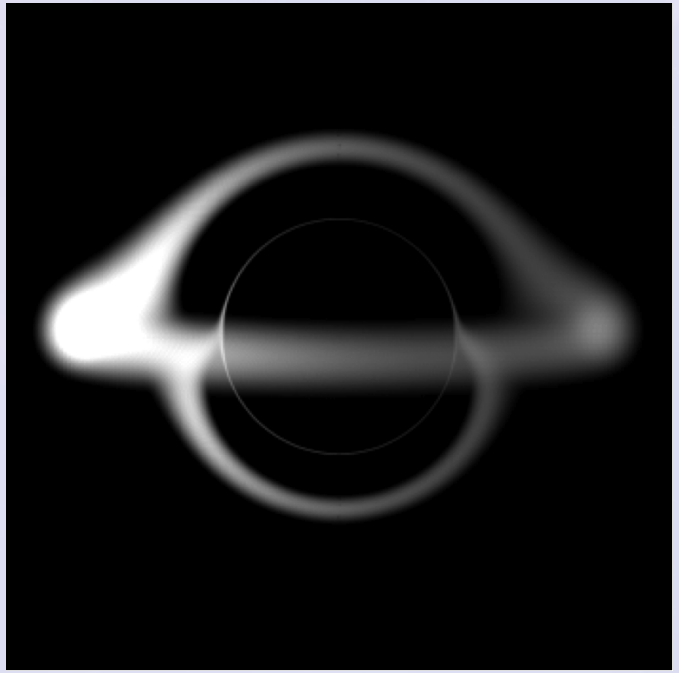
- Ralph Spencer

X-ray emission shows QPO(s)

Light bending and relativistic beaming can modulate the X-ray emission from an oscillating torus.



A torus viewed from 45 degrees latitude (Bursa)



A torus viewed from 5 degrees latitude (Bursa)

- Ulf Torkelsson

Questions

What is the relationship between the different bands (i.e. IR to X)?

How does the spin of a black hole effect the emission?

How does the BH effect the QPO?

How does the stellar wind of high-mass stars effect the jet?