

X-ray spectro-polarimetric models for XRBs and AGN

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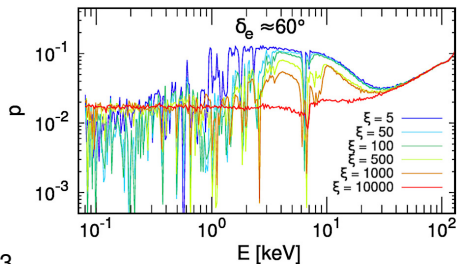
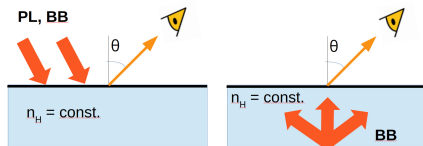
Michal Bursa, René Goosmann, Vladimír Karas, Frédéric Marin,
Lorenzo Marra, Giorgio Matt, Romana Mikušincová, Matěj Ptáček,
Agata Róžańska, Roberto Taverna, Wenda Zhang , ...

The 11th Microquasar Workshop

A Microquasar Odyssey: unveiling the Complexities

15th – 19th September 2025, Cefalù, Sicily, Italy

Radiative transfer in the slab — reflection and transmission



Power-law illumination:

- Podgorný et al. (2022) *MNRAS*, 510, 4723
- https://github.com/jpodgorny/stokes_tables
- dependent on scattering geometry (defined by 3 angles), power-law index, ionisation and incident polarisation
- available as table models for XSPEC in OGIP FITS files

Black-body illumination:

- Podgorný et al. (2025) *A&A*, submitted (arXiv: 2507.23687)

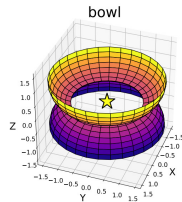
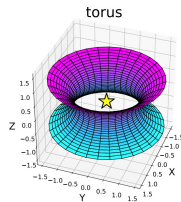
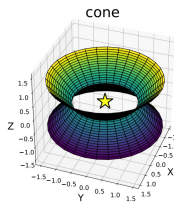
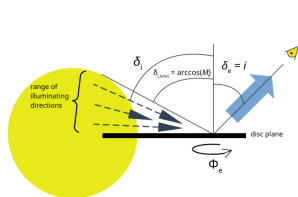
Black-body transmission:

- Taverna et al. (2021) *MNRAS*, 501, 3393
- Ratheesh et al. (2024) *ApJ*, 964, 77
- Marra et al. (2025) *A&A*, submitted (arXiv: 2507.23379)

Example figure:

Energy dependent polarisation degree dependence on disc ionisation, ξ , for emission angle of 60° for an isotropic unpolarised illumination by a power-law radiation with photon index $\Gamma = 2$ for a constant density slab with density of $n_H = 10^{15} \text{ cm}^{-3}$.

Non-relativistic distant reflection

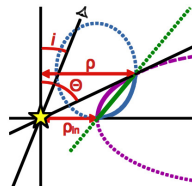


Reflection from a distant disc or torus:

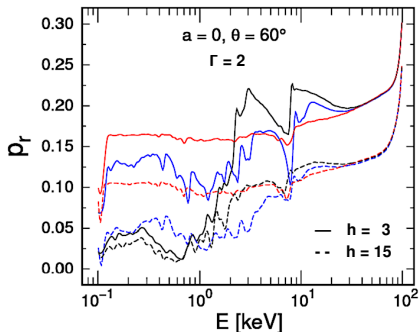
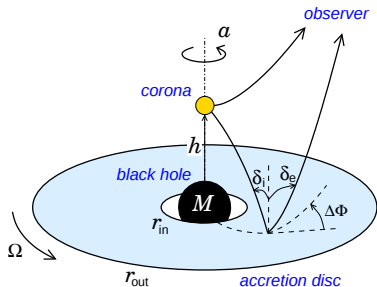
- Podgorný et al. (2024) *MNRAS*, 530, 2608
- Disc: https://github.com/jpodgorny/xsstokes_disc
- Torus: https://github.com/jpodgorny/xsstokes_torus
- reflection tables are integrated over scattering geometry for a given shape of the distant reflector

Distant reflector — various shapes (cone, torus, bowl)

- Podgorný (2025) *A&A*, submitted (arXiv: 2506.01798)
- includes ionization dependence



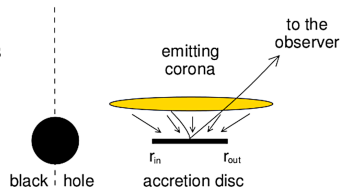
Relativistic reflection from accretion disc illuminated by corona



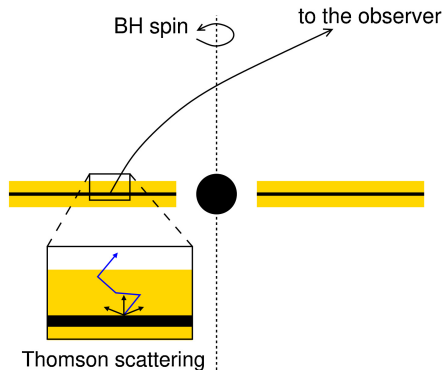
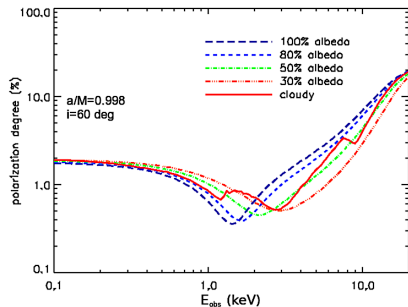
Example figure: Energy dependent polarisation degree for disc reflection for low (black), medium (blue) and high (red) disc ionisations and unpolarised illumination

KYNSTOKES:

- Podgorný et al. (2023) *MNRAS*, 524, 3853
- <https://projects.asu.cas.cz/dovciak/kynstokes>
- lamp-post corona and extended corona just above the disc are included
- illumination by black-body is being worked on to be used for neutron stars



Thermal radiation from accretion disc



KYNBB:

- Dovčiak et al. (2008) *MNRAS*, 391, 32
- <https://projects.asu.cas.cz/stronggravity/kyn#kynbb>
- different radiative transfer models for scattering being implemented

KYNBBRR (including Returning Radiation):

- Taverna et al. (2020) *MNRAS*, 391, 32
- Mikušincová et al. (2023) *MNRAS*, 519, 6138
- disc reflection due to self-irradiation is included parametrized by albedo
- work in progress: use of BB reflection tables for reflection of self-irradiation

Availability of the models

All public models are available also via HEASARC web page

More models for XSPEC:

- <https://heasarc.gsfc.nasa.gov/docs/software/xspec/moremodels.html>