Polarisation signatures of the JED-SAD model
Application to Swift J1727.7-1613

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X-ray binary in Outburst

Spectral/timing:

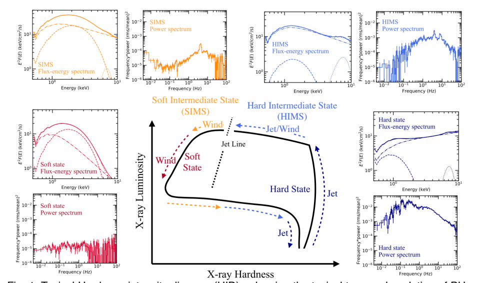


Fig. 1: Typical Hardness-intensity diagram (HID), showing the typical temporal evolution of BH-LMXBs through the different spectral states (hard state, HIMS, SIMS, and soft state). The regions where X-ray jets and/or winds are present are also indicated. From Wang et al. (2022).

Usual interpretation:

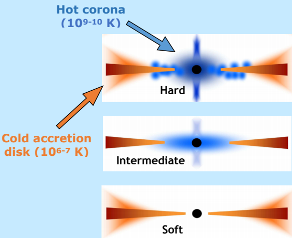
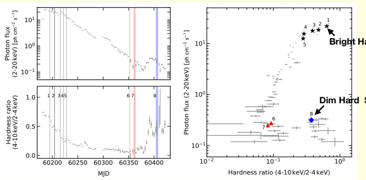


Fig. 2: The usual conventional framework (Esin et al. 1997, Done et al. 2007)

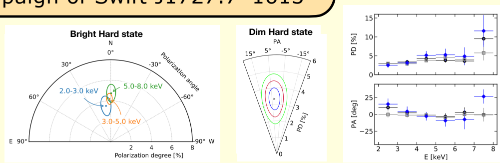
The main questions:

- ★ What produces spectral state transitions?
- ★ What triggers the Q-shaped cycle in the HID?
- ★ What produces/kills jets and winds and how is it related to spectral transition?
- ★ How hard states at high luminosities L > 0.1 L_{Edd} can exist?

X-ray Spectro-polarimetric campaign of Swift J1727.7−1613



Evolution of the MAXI flux and hardness ratio of Swift J1727.8−1613 during its 2023 outburst. The **initial five (1-5) observations** in the hard and intermediate states by IXPE (Veledina et al. 2023; Ingram et al. 2024) are indicated with **black stars,** the two (6-7) observations in the **soft state** (Svoboda et al. 2024) in **red triangles** and the **dim hard state** (8) with a **blue diamond** symbol.



Left: **bright hard state** contour plots (90% confidence level) of the PD and PA in three energy bands.

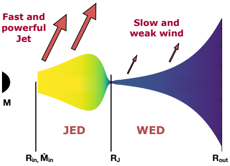
Middle: Dim hard state averaged PD and PA in the 2–8 keV band at 68.3% (blue), 95.5% (red), and 99.7% (green) confidence levels (Podgorný et al. 2024).

Right: PD and PA as a function of energy for the **Dim Hard State (blue diamonds)**. and for the Bright Hard State observations 3 and 4

The JED-SAD paradigm

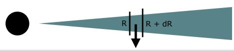
Assumptions:

I. **Physical accretion-ejection MHD** solution
II. Accretion flow threaded by a **large scale** B_z
III.A strongly magnetised inner region ($R<R_J$) where a jet is produced: **the Jet Emitting Disk (JED)**
IV. An low-magnetisation outer region ($R>R_J$) where an MHD wind forms: the **Wind Emitting Disk (WED)**
V. The WED emission is similar to a **Standard Accretion Disk (SAD)**



Spectral signature:

I. Resolution of the thermal equilibrium at each radius R



analytical calculations

(1) Vertical equilibrium
(2) Ions thermal equilibrium: (1-δ) $q_{acc} = q^{i}_{adv} + q_{ie}$
(3) Electrons thermal equilibrium: δ $q_{acc} = q^{e}_{adv} - q_{ie} + q_{rad}$
δ = 0.5 (Yuan & Narayan 2014)

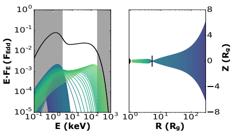
Radiative cooling as a **bridge formula** between:
- Thick: Blackbody radiation,
- Thin: Synchrotron, Bremsstrahlung and Compton processes as well as inverse-Compton illumination between two different flows using **BELM** (Belmont+08,09).

T_e, τ, ε = h/r : thermal structure at any given radius!
Marcel et al. (2018b)

II. Spectral building

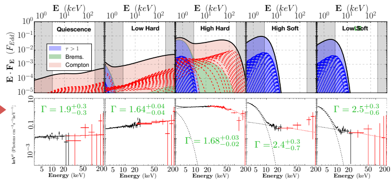
Once the thermal equilibrium is solved for each radius, the thermal structure is used to build each sub-spectrum self-consistently, and then the total spectrum from the addition of the sub-spectra.

Broad band spectra: The DYPLO code



III. Spectral analysis

- Theoretical and Xspec faked spectra for each of the 5 canonical spectral states of GX339-4 (Marcel et al. 2018b)
- The JED-SAD model has been applied with success to different microquasars and AGN (e.g., Marcel et al. 2020; Ursini et al. 2020; Marino et al. 2021)



Combining DYPLO and MONK

A spectro-polarimetric model

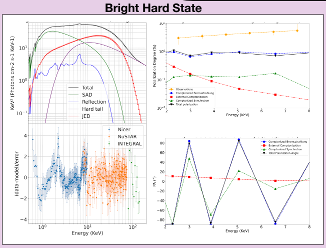
MONK is a Monte-Carlo radiative transfer code (Zhang et al. 2019, 2023) which includes:

- ➡ general relativistic effects
- ➡ emission processes (synchrotron, bremsstrahlung, compton),
- ➡ time-dependent and/or axially-asymmetric geometries
- ➡ polarized radiative transport in magnetised plasma
- ➡ reflection process

DYPLO: Spectral fit ➡ Radial distribution of B, n, T, ... ➡ **MONK**: Polarisation signatures

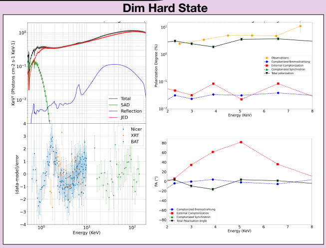
Application to Swift 1727-1613

Bright Hard State



- Dominated by Bremsstrahlung and self-compton Bremsstrahlung
- Required a Comptonised accretion disk emission and a high energy hard tail
- **Do not reproduce the observed PD and PA**

Dim Hard State



- Dominated by Synchrotron and self-compton Synchrotron
- Do nor require a Comptonised accretion disk emission nor a high energy hard tail
- **Reproduce roughly the observed PD and PA**