

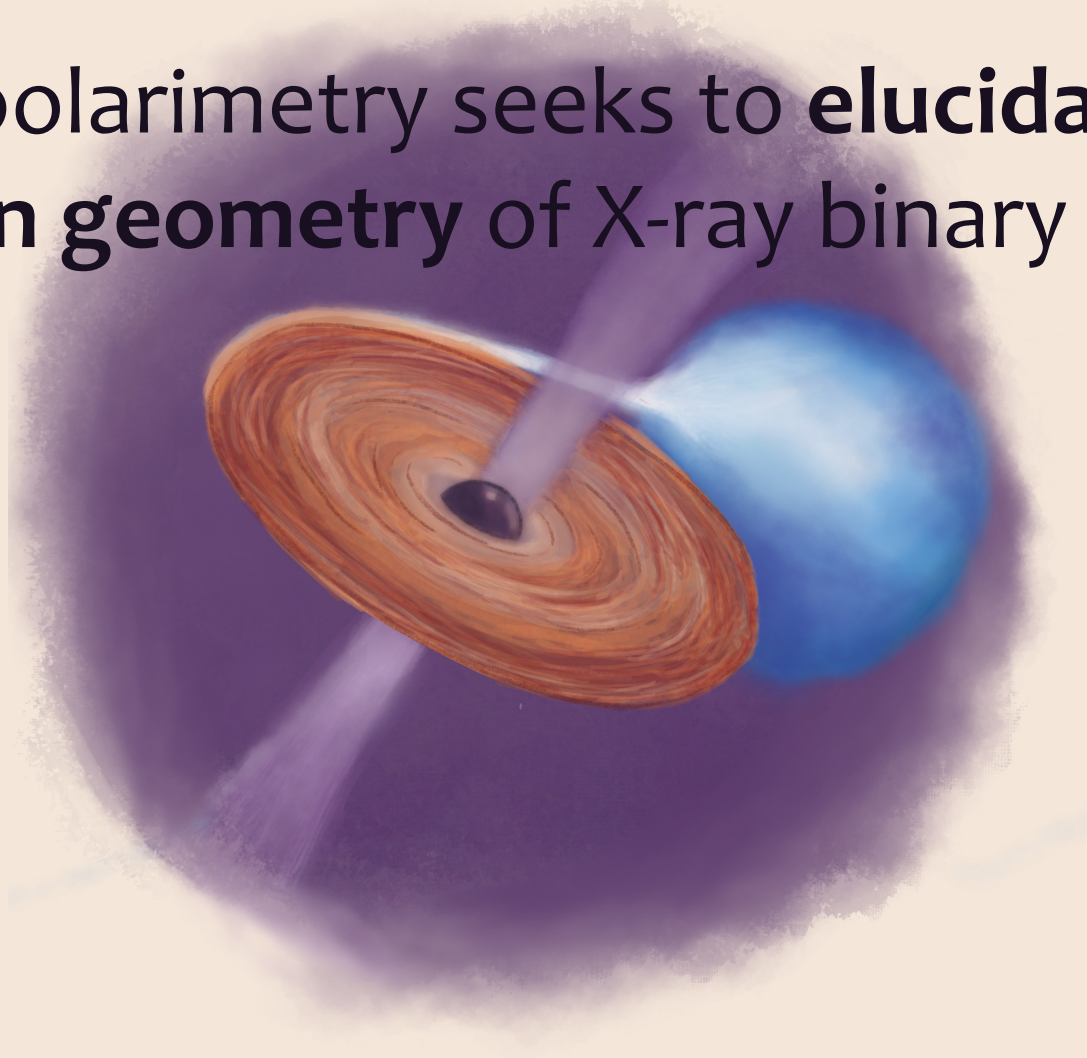
# **Black Holes in a New Light:** X-ray Polarimetry of Stellar-Mass Black Holes

**Swati Ravi**

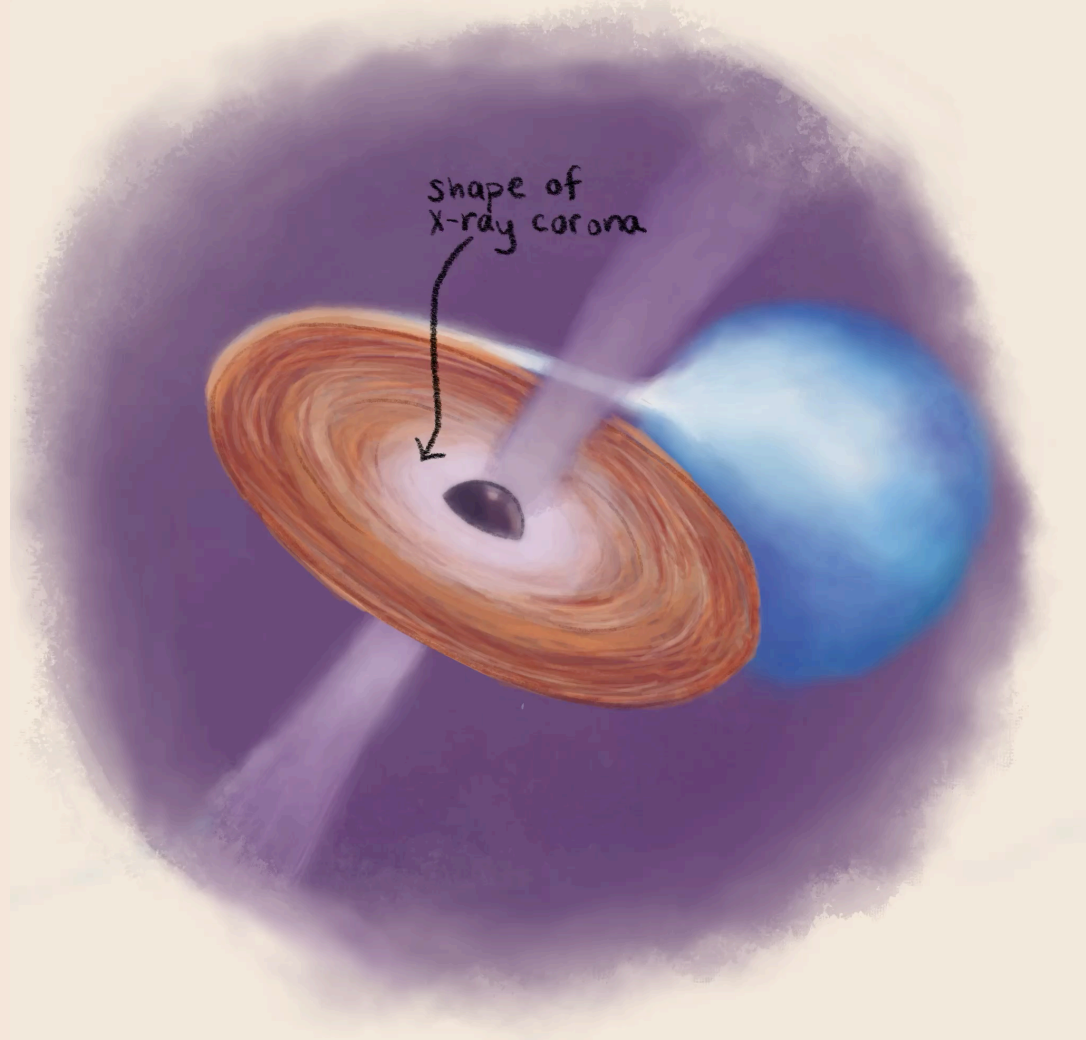
May 21, 2026 | Friends of IXPE Forum



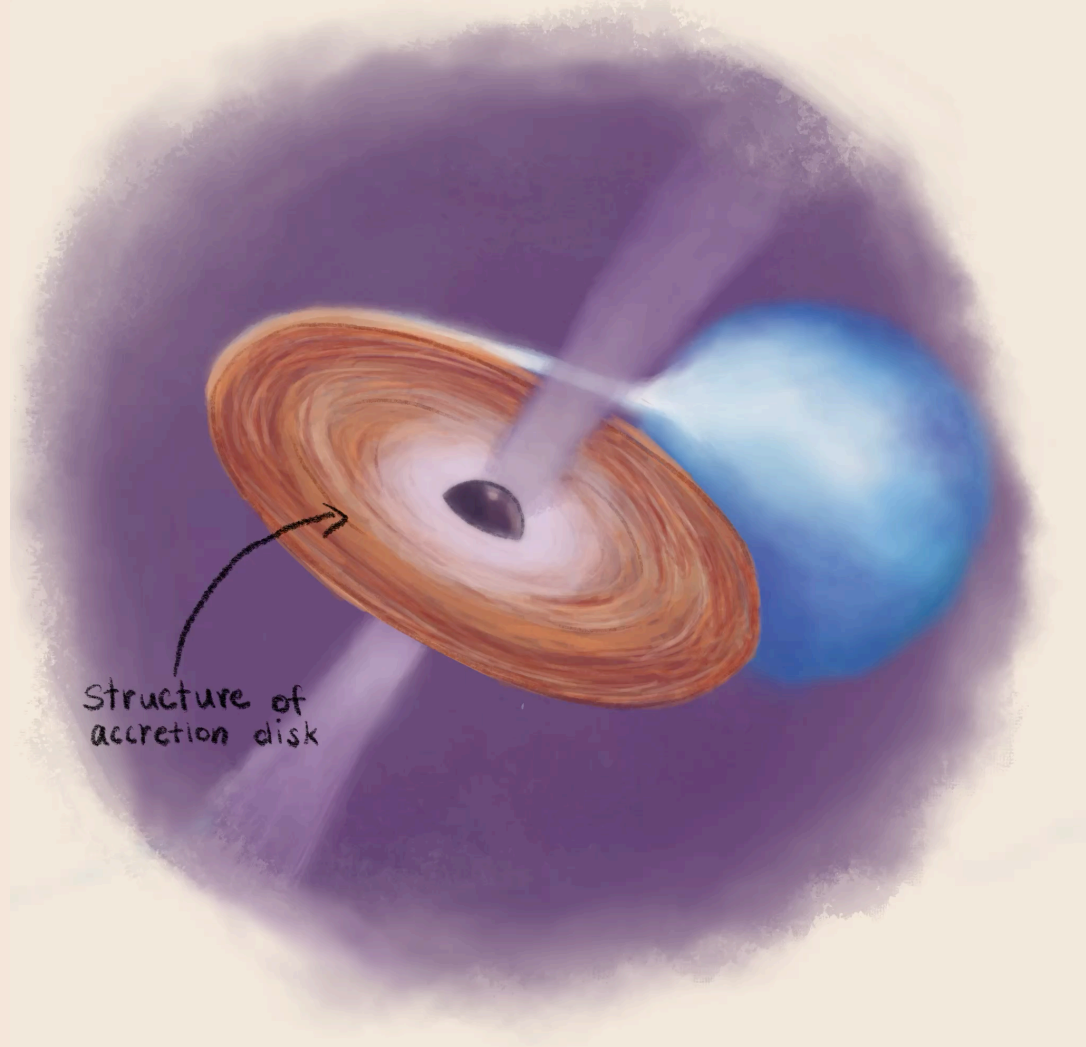
X-ray polarimetry seeks to **elucidate the accretion geometry** of X-ray binary systems





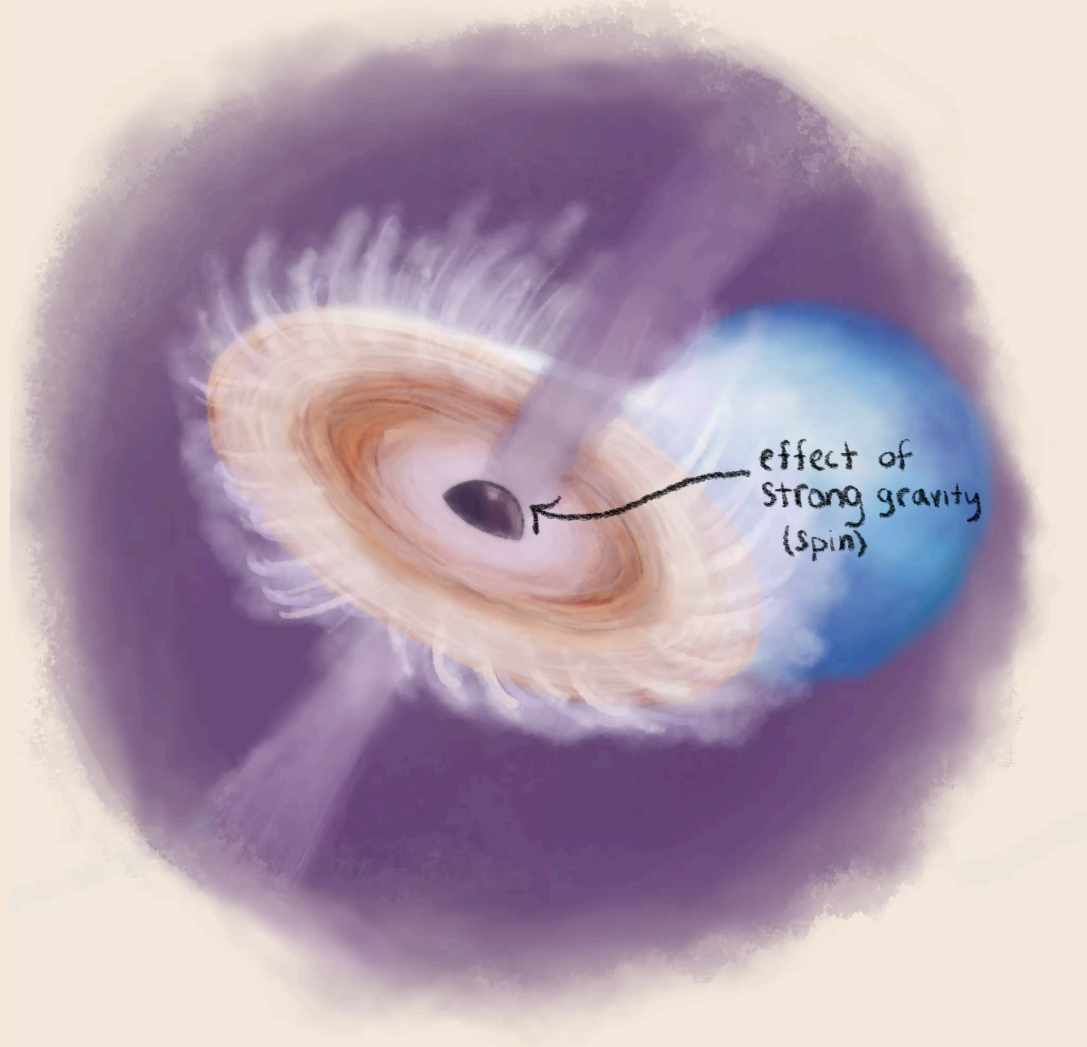


shape of  
x-ray corona

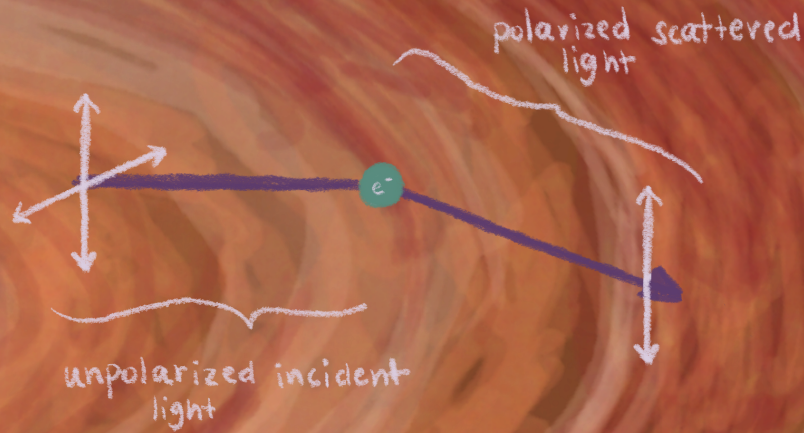




nature of outflows/  
winds

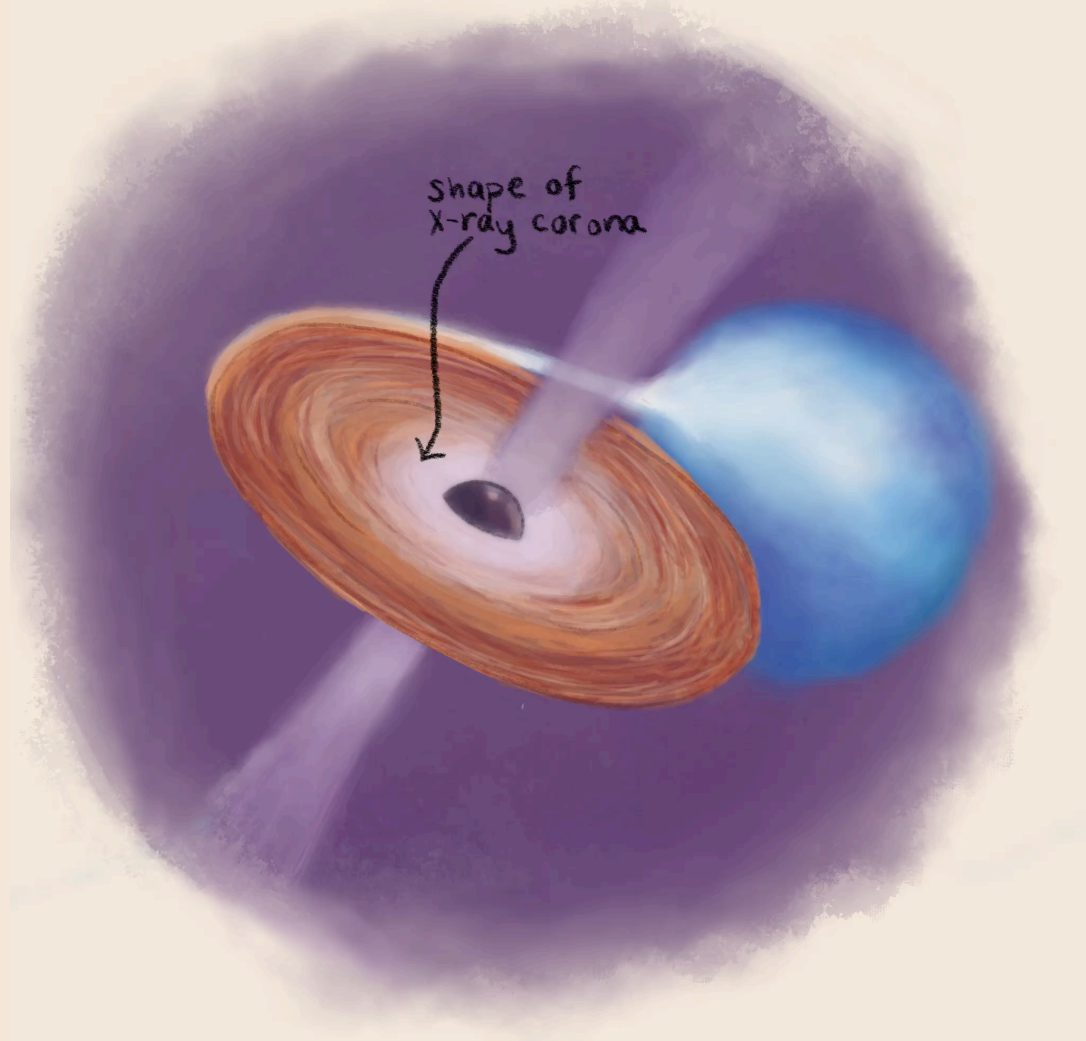


# Polarization is perpendicular to the plane of scattering

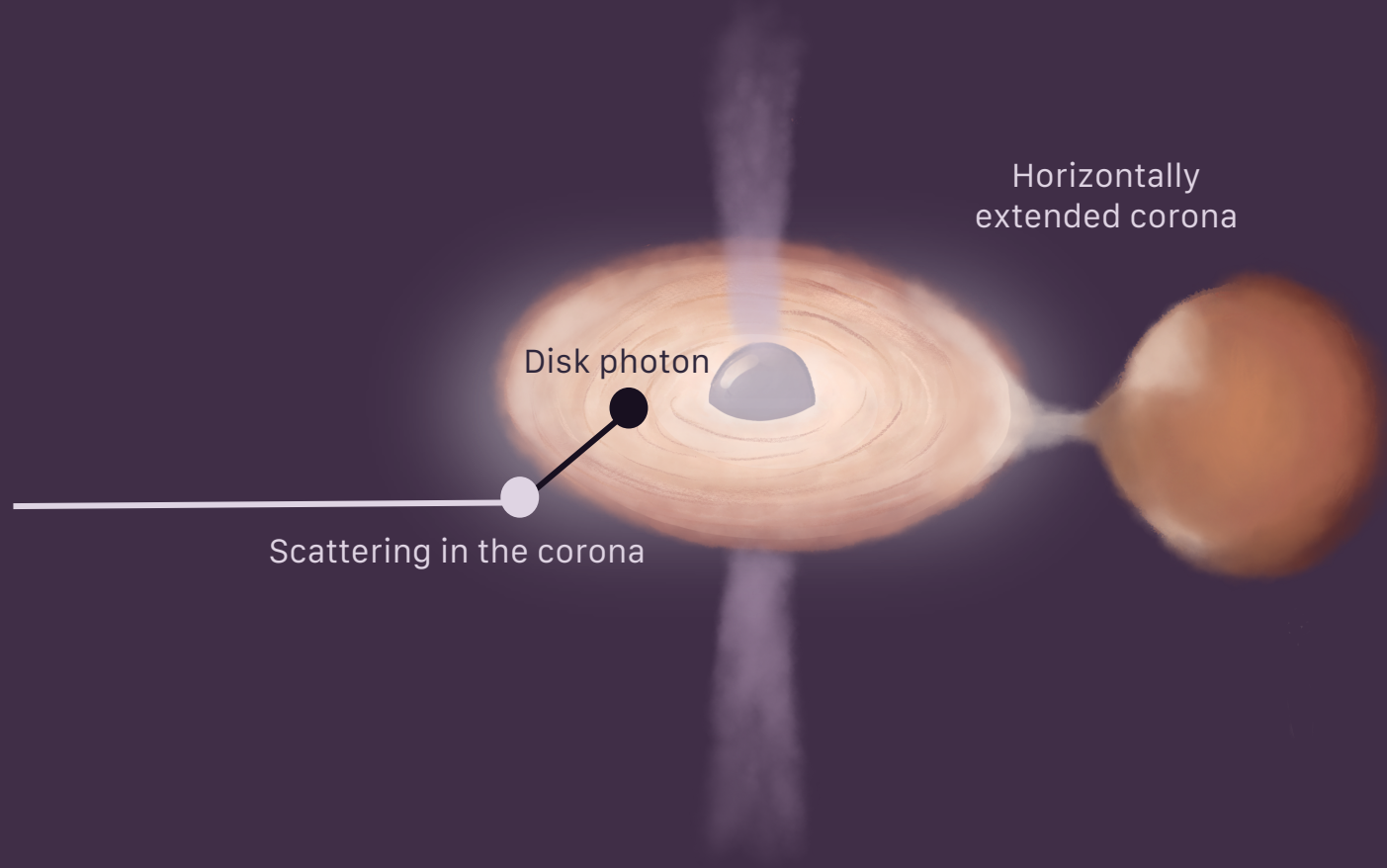


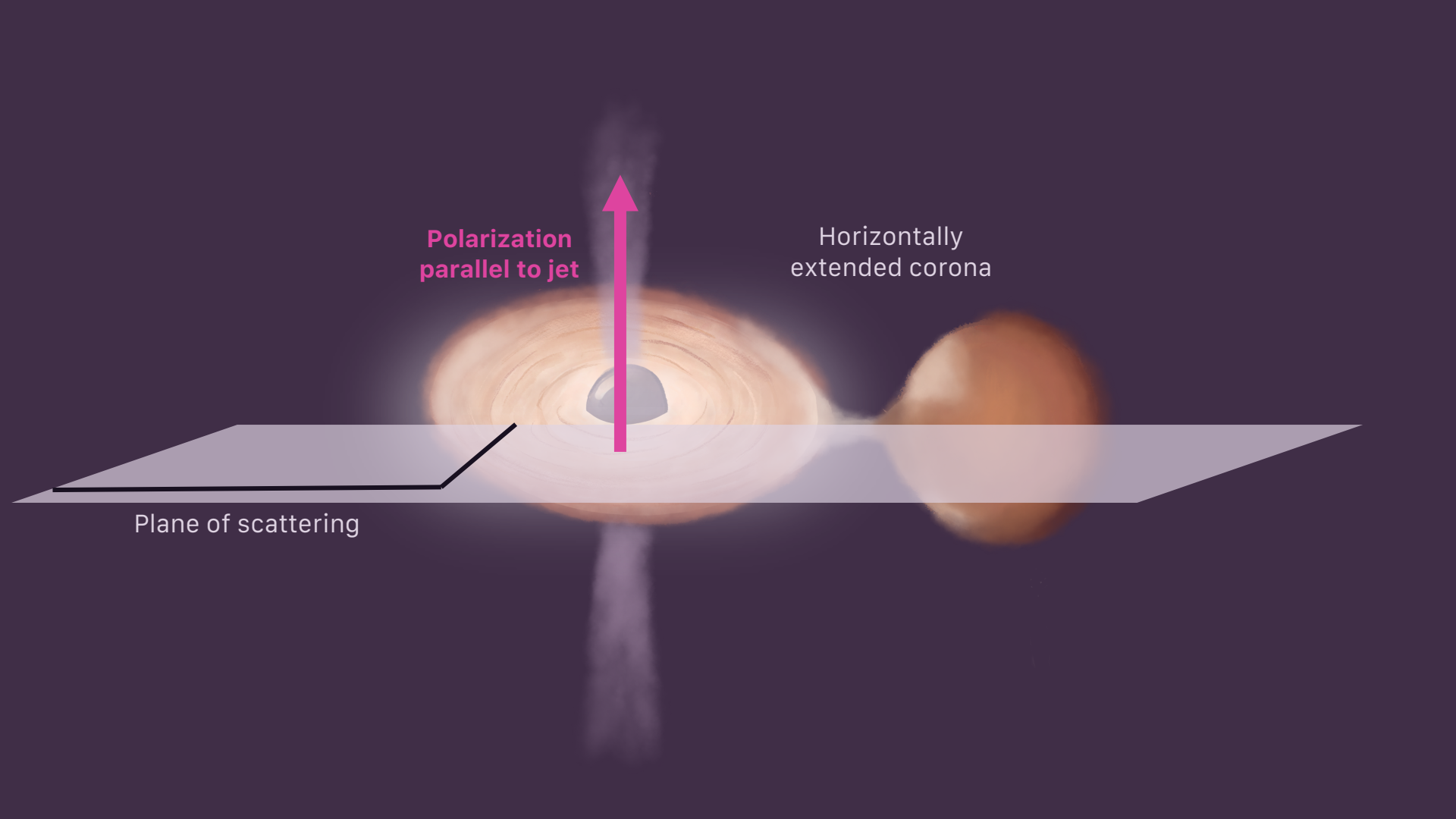
Thomson scattering → Disk  
Compton scattering → Corona





shape of  
x-ray corona



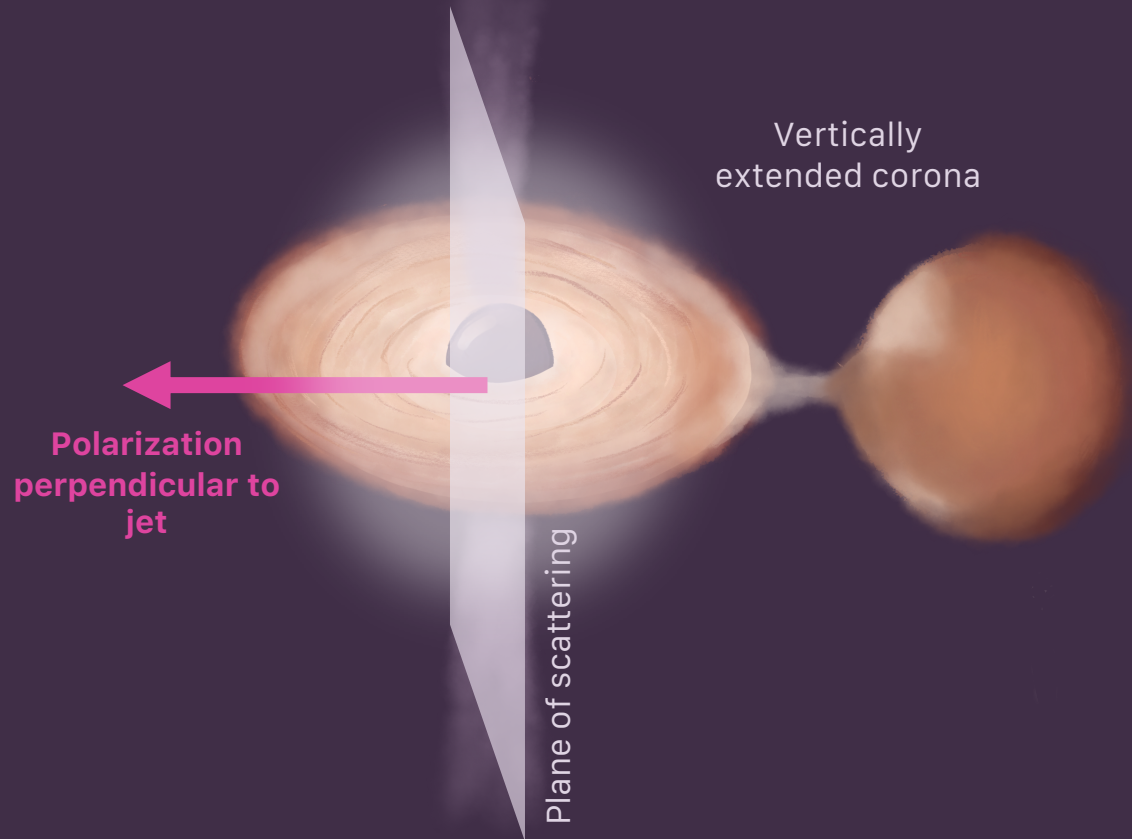


The diagram illustrates the interaction of a jet with a liquid surface. A horizontal plane, labeled 'Plane of scattering', is shown. A jet, represented by a vertical pink arrow, impacts the surface. The impact creates a 'Horizontally extended corona', depicted as a series of concentric orange and yellow rings. A label 'Polarization parallel to jet' points to the vertical jet. The background is a dark purple gradient.

**Polarization  
parallel to jet**

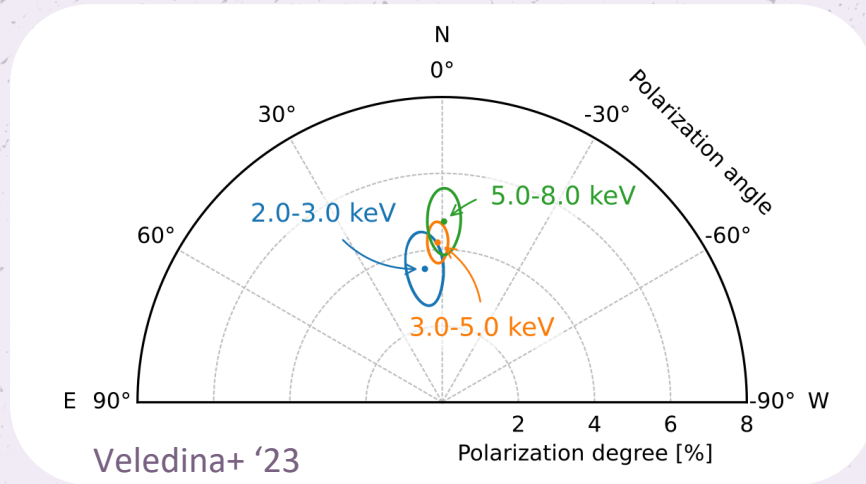
Horizontally  
extended corona

Plane of scattering



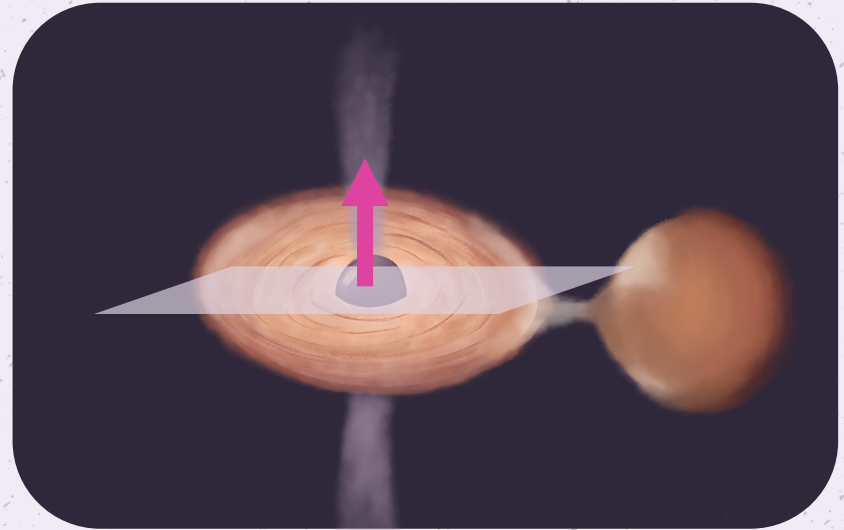
# IXPE Hard State Observations of BHXBs

## Swift J1727.8–1613



**P.D.  $4.1\% \pm 0.2\%$**

**P.A.  $2.2^\circ \pm 1.3^\circ$  (parallel to radio jet)**



**Horizontally Extended Corona**



# IXPE BHXB Coronal Geometry Constraints

## **Swift J1727.8–1613** (Veledina+ '23)

- ~4% PD
- PA parallel to radio jet

## **Cyg X-1** (Krawczynski+ '22)

- ~4% PD
- PA parallel to radio jet

## **GX 339-4** (Mastroserio+ '25)

- 1.3% PD
- PA parallel to radio jet

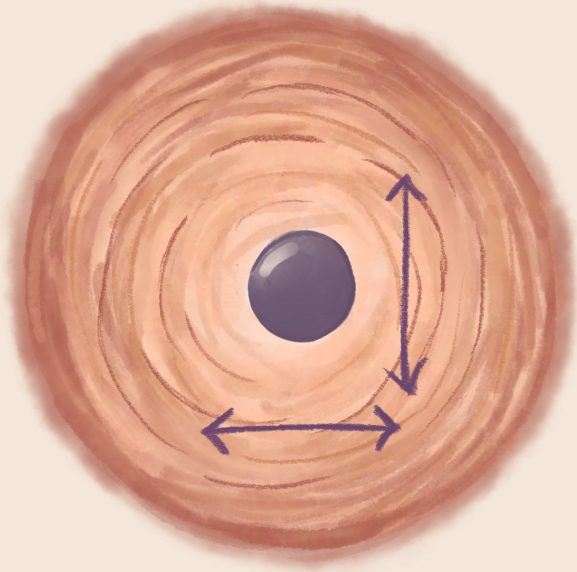
## **IGR J17091** (Ewing+ '25)

- ~9% PD
- Jet direction inferable

How can we reconcile  
discrepancy in inferred geometry  
between polarimetry and  
spectroscopic + timing results?

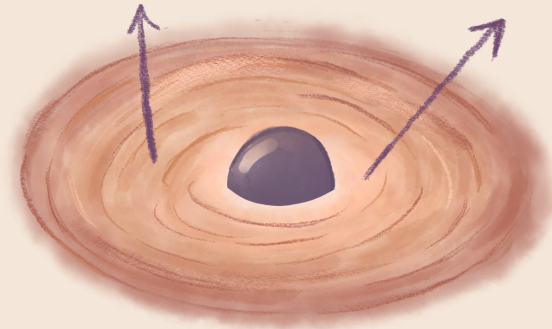
# PD Traces Inclination

**Net depolarization** due to symmetry  
and  $90^\circ$  rotated components



Low inclination

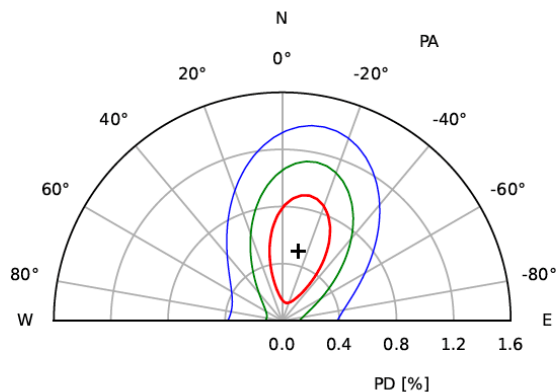
Fewer cancelation effects due to observed  
asymmetry; Thomson scattering **preferentially**  
**polarizes** parallel or perpendicular to the disk



High inclination

# IXPE Soft State Observations of BHXBs

## Swift J1727.8–1613



Svoboda+ '23

**P.D. <1.2%**

**P.A.  $-13^\circ \pm 28^\circ$**

**GX 339-4** (Mastroserio+ '25)

- <1.2% PD

**LMC X-1** (Podgorný+ '23)

- <1% PD

**LMC X-3** (Svoboda+ '24)

- ~ 3% PD

**4U 1957+115** (Marra+ '24)

- ~2% PD

**MAXI J1744-294** (Marra+ '26)

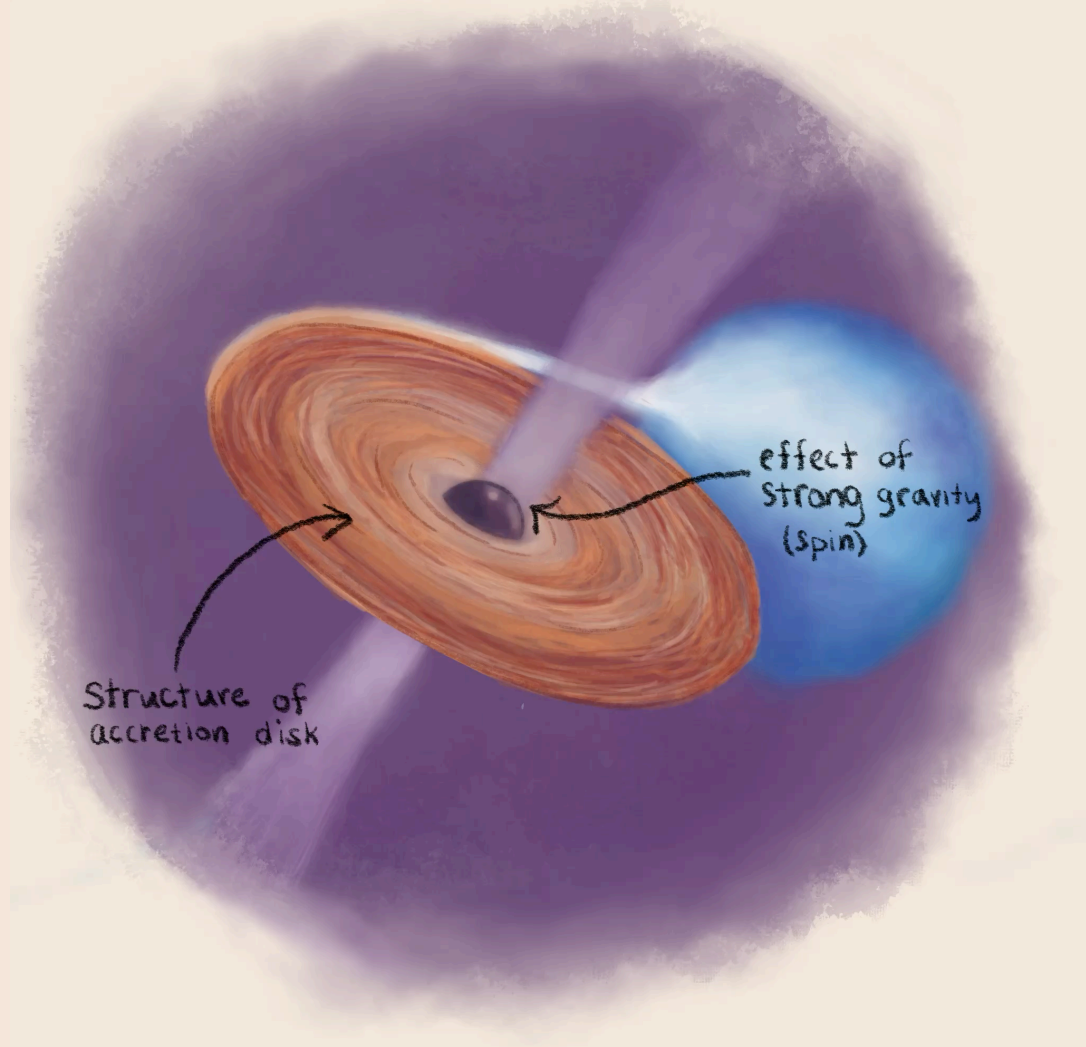
- <1.3% PD

**GRS 1739–278** (Zhao+ '26)

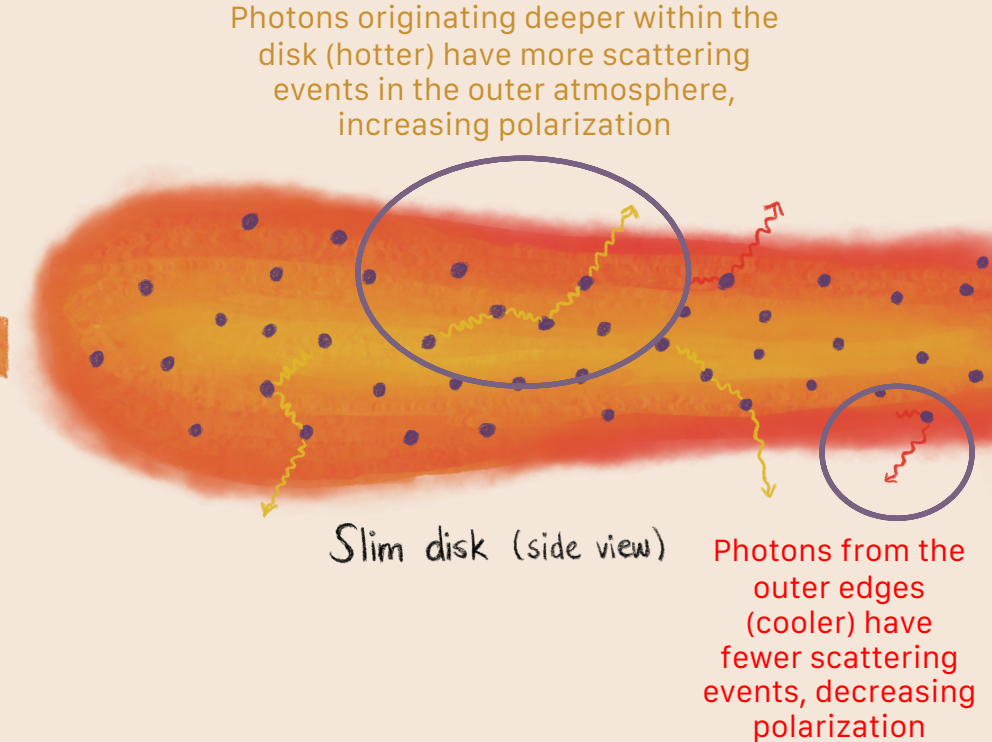
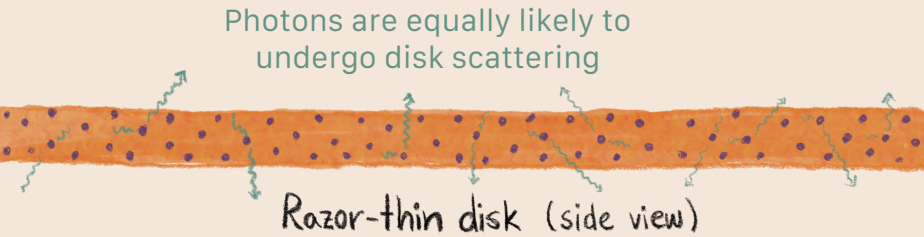
- ~2% PD

**4U 1630-47** (Ratheesh+ '24)

- ~6% PD

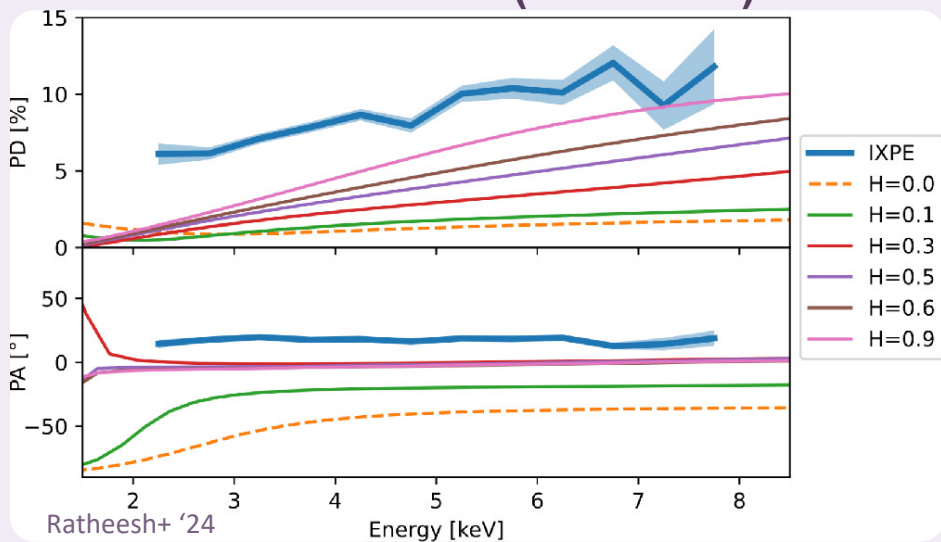


# PD(E) as a probe of vertical disk structure

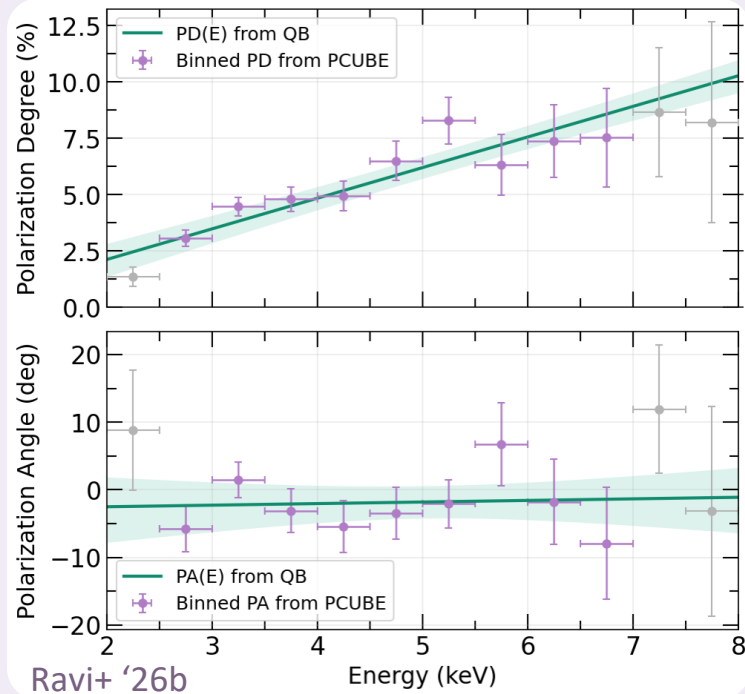


# PD(E) as a probe of vertical disk structure

## 4U 1630-47 (soft state)

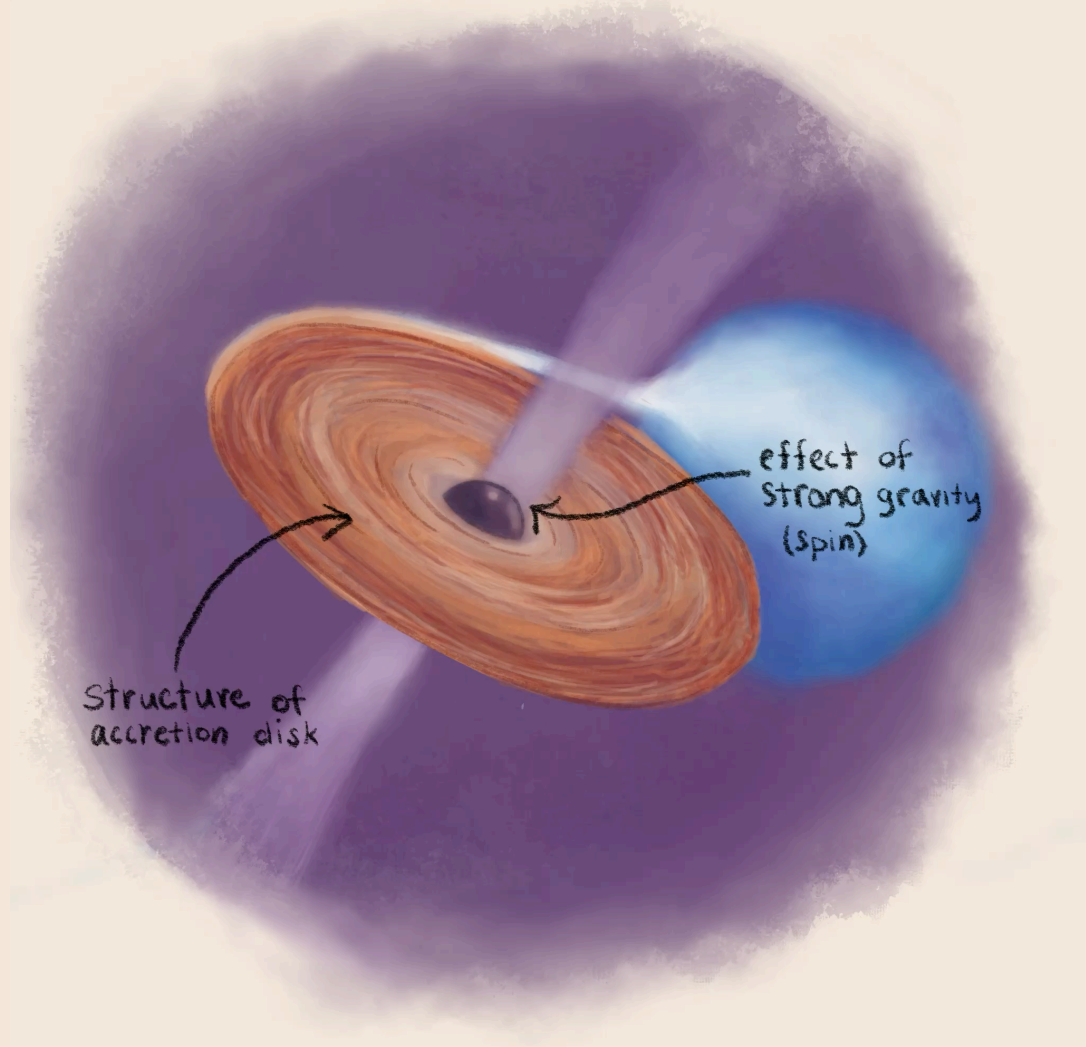


## GS 1354-64 (intermediate state)

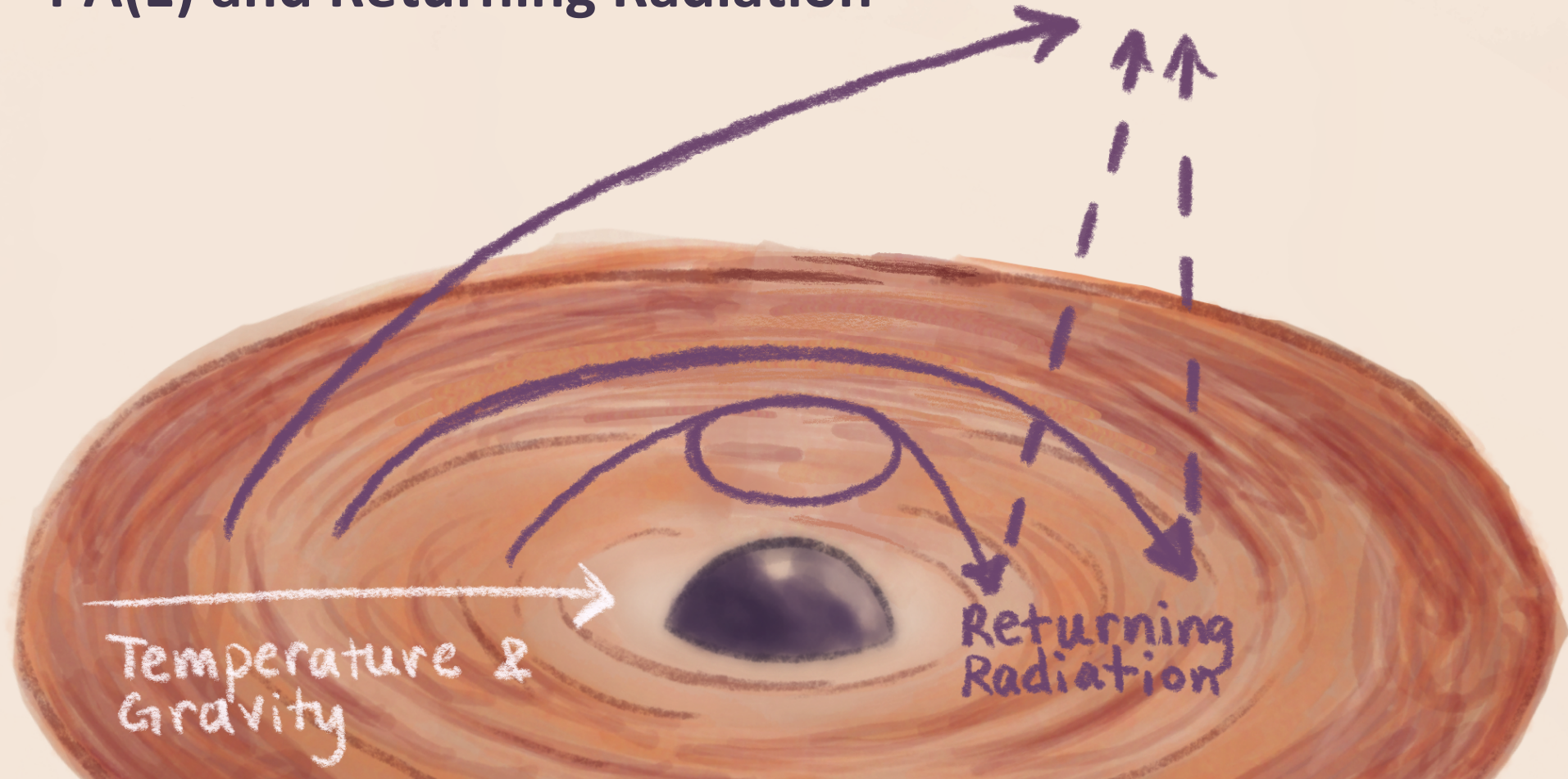


What is the nature of the ubiquitous energy dependence of the PD across states?

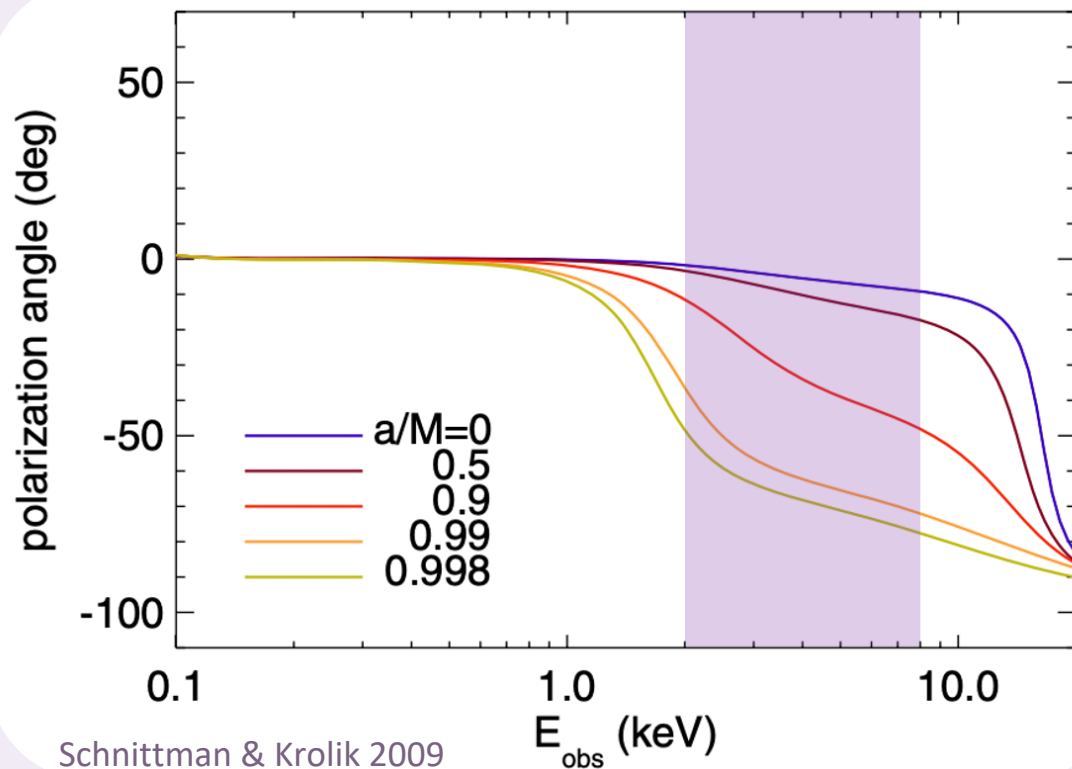




# PA(E) and Returning Radiation

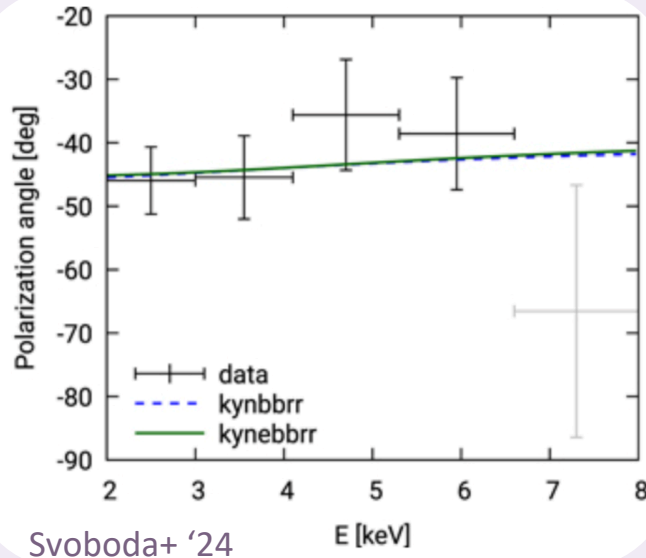


# PA(E) and Returning Radiation

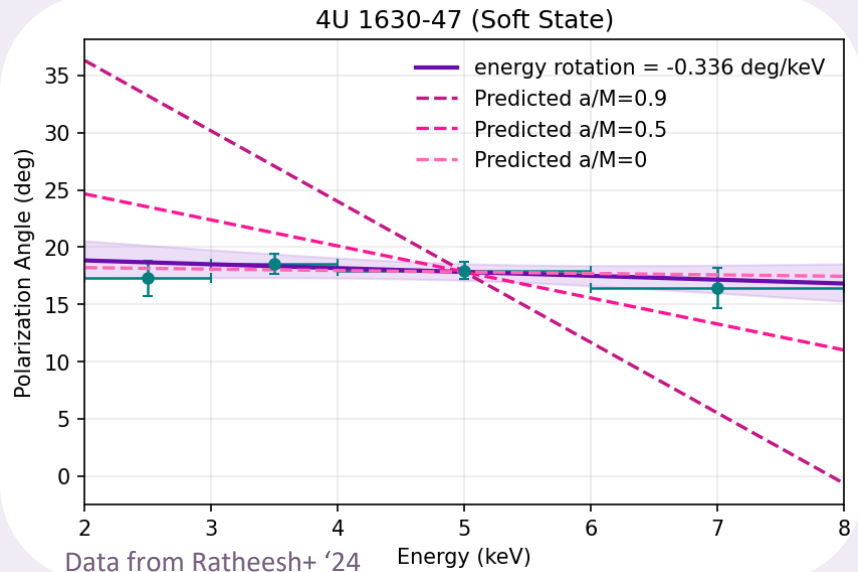


# PA(E) and Returning Radiation

LMC X-3 ( $a \sim 0.2$ )



4U 1630-47 ( $a > 0.8$ )



Where is the predicted PA swing due to returning radiation?

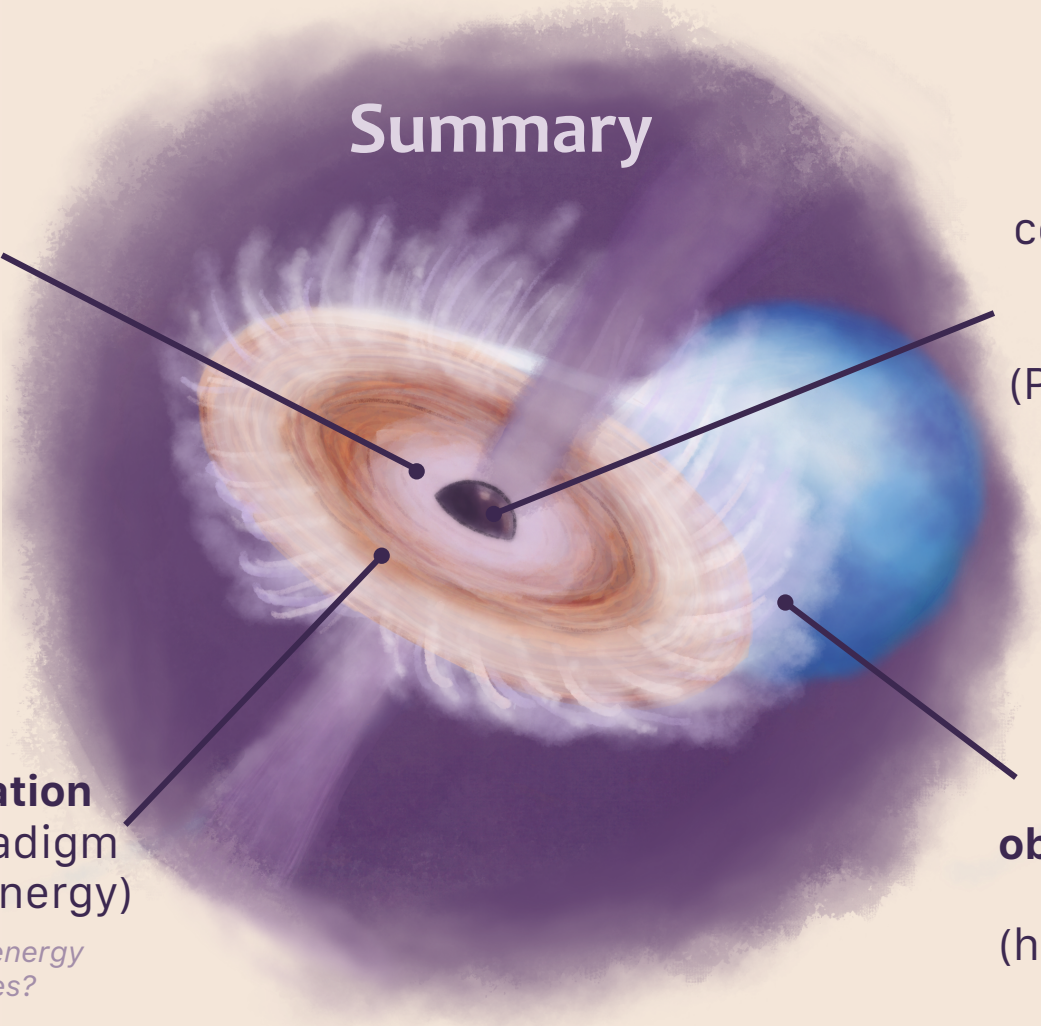


nature of outflows/  
winds

Tomaru+ 24  
Nitindala+ 25



# Summary



Multi-source  
consensus on  
**horizontally  
extended corona**  
(PA // to jet)

*How to square this with  
spectroscopy and timing  
results?*

Predicted, but not  
conclusively observed  
**returning radiation  
signature of GR**  
(PA swing with energy)

*Where is the PA swing?*

Evidence of **deviation  
from thin disk** paradigm  
(PD increase with energy)

*Why is the PD trend with energy  
ubiquitous across states?*

Potential  
**enhancement of  
observed polarization**  
due to winds  
(high PD, constant PA)

*Could winds also net  
depolarize a signal?*