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IXPE first look at the newly discovered Black Hole Binary MAXI J1744-294

Lorenzo Marra (INAF - IAPS)
Romana Mikusincova, Fiamma Capitanio, Shifra Mandel, Maxime Parra,
on behalf of a larger collaboration

11th Microquasar Workshop
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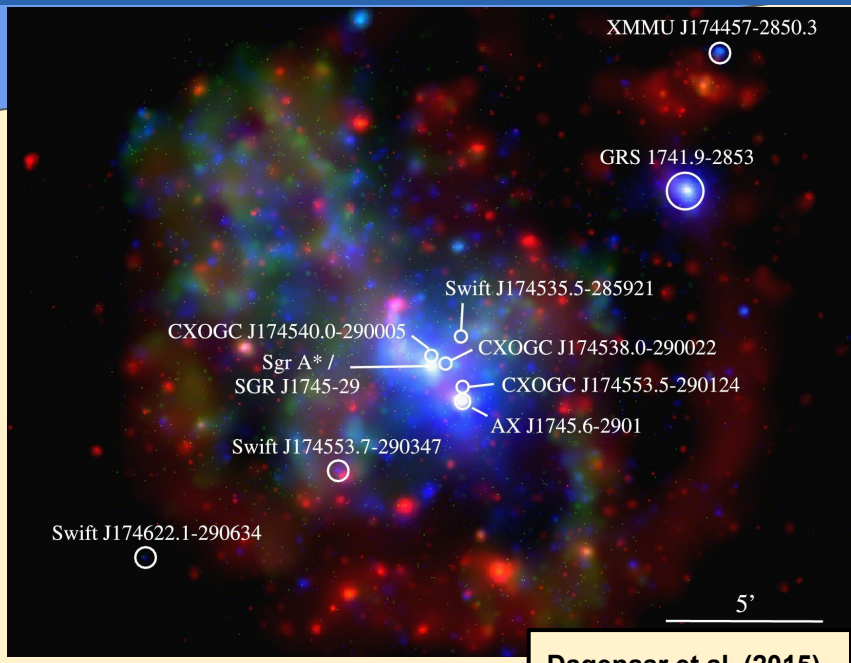
Galactic Center Region

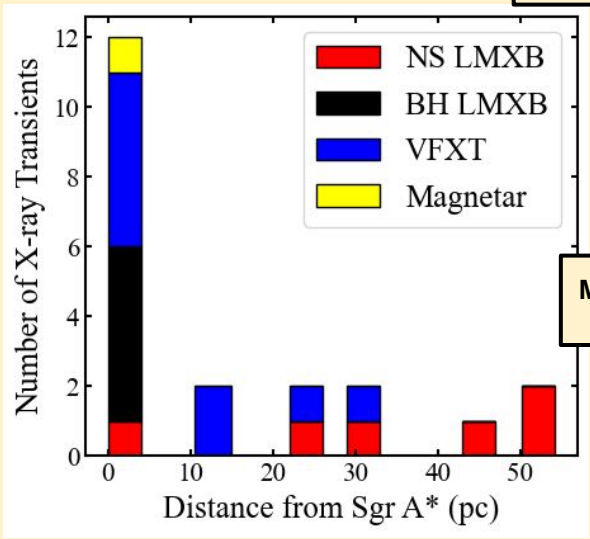
Population and monitoring

- **The central region of our Galaxy hosts a large population of Low Mass X-ray binaries.**
- **Swift/XRT daily monitoring since 2006**, allowing for the detection of several X-ray transients:
  - 6 NS - LMXRBs
  - 5 BH - LMXRBs
- Important for our understanding of **binary formation/evolution in a SMBH gravitational well.**

- Two new BH-LMXRBs in 2016
  - **No new X-ray transients observed in the GC for 8 years**.



Dagenaar et al. (2015)



Mori et al. (2021)

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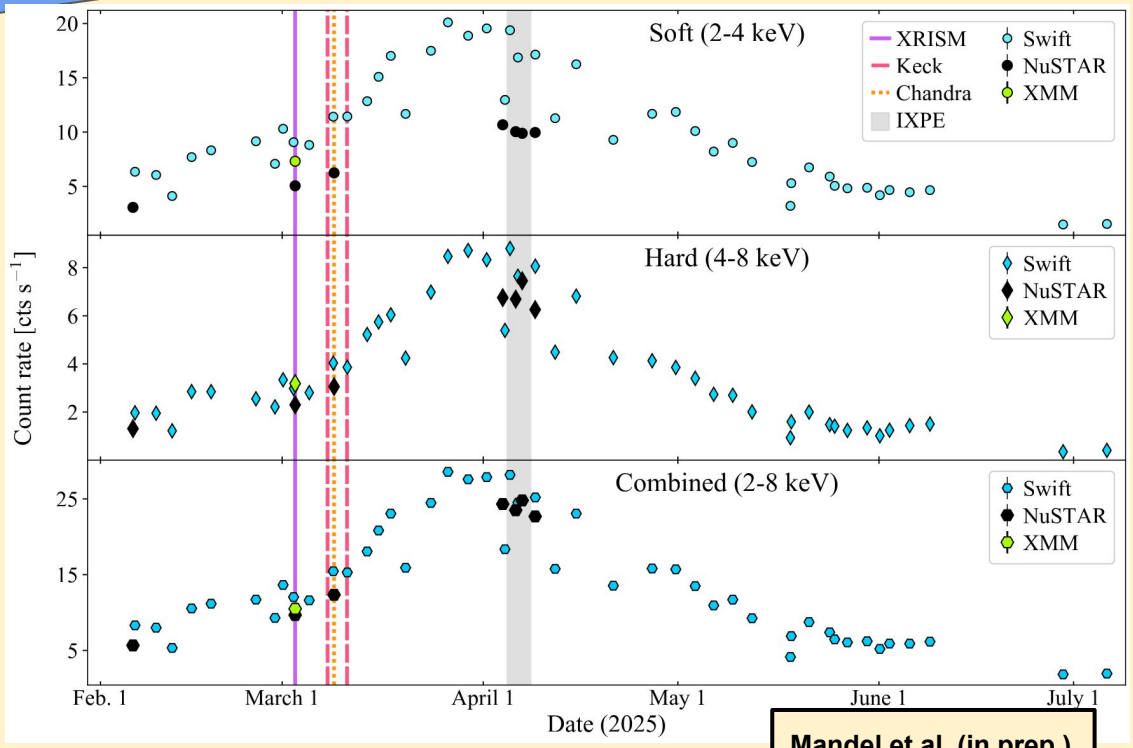
MAXI J1744-294

A new BH is discovered in the GC

- **On January 2, 2025 the MAXI all-sky X-ray observatory detected a bright X-ray outburst in the Galactic center.**



Mandel et al. (in prep.)

- **A large multi-instrument campaign (lead by Shifra Mandel) was initiated to study the BH candidate.**
- **Too IXPE observation of the source April 5-9 2025**
- First binary system observed by IXPE in the GC region **(but see Marin et al 2023)**

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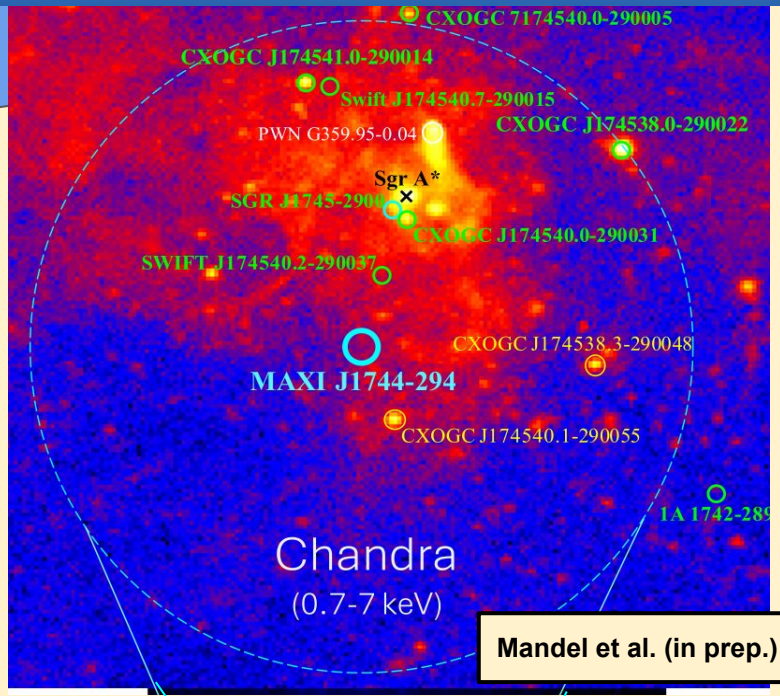
MAXI J1744-294 : IXPE observation

Background contamination & Polarization

- Exposure time **150 ks**
- **Estimate Background Contamination**
  - Flux 2-8 keV: **1.7 x 10^-9 erg/cm2/s**
  - **estimate the contamination from:**
    - **GC diffuse emission**
    - AX J1745.6–2901

- **No significant polarization signal detected**
  - Several tests for the source and bkg region
  - **PD < 1.3% in the 2-8 kev band**



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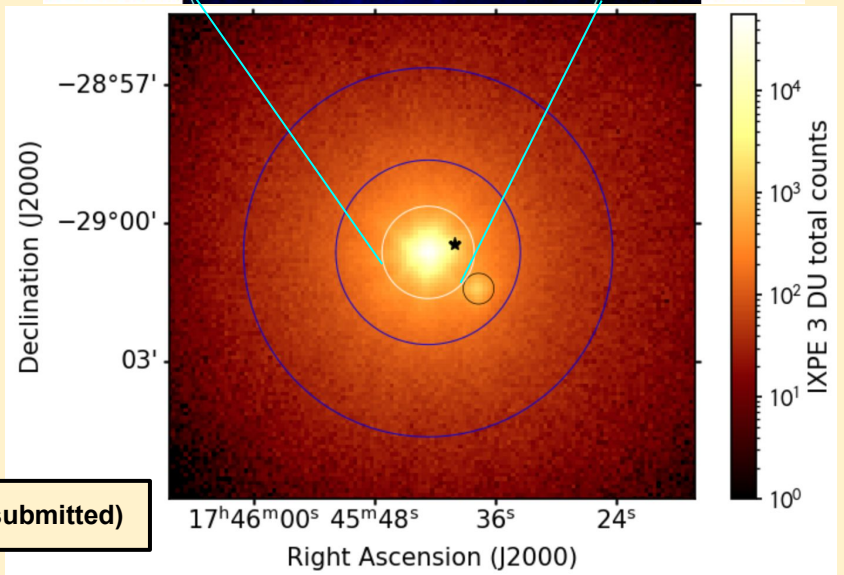

Marra et al. (submitted)

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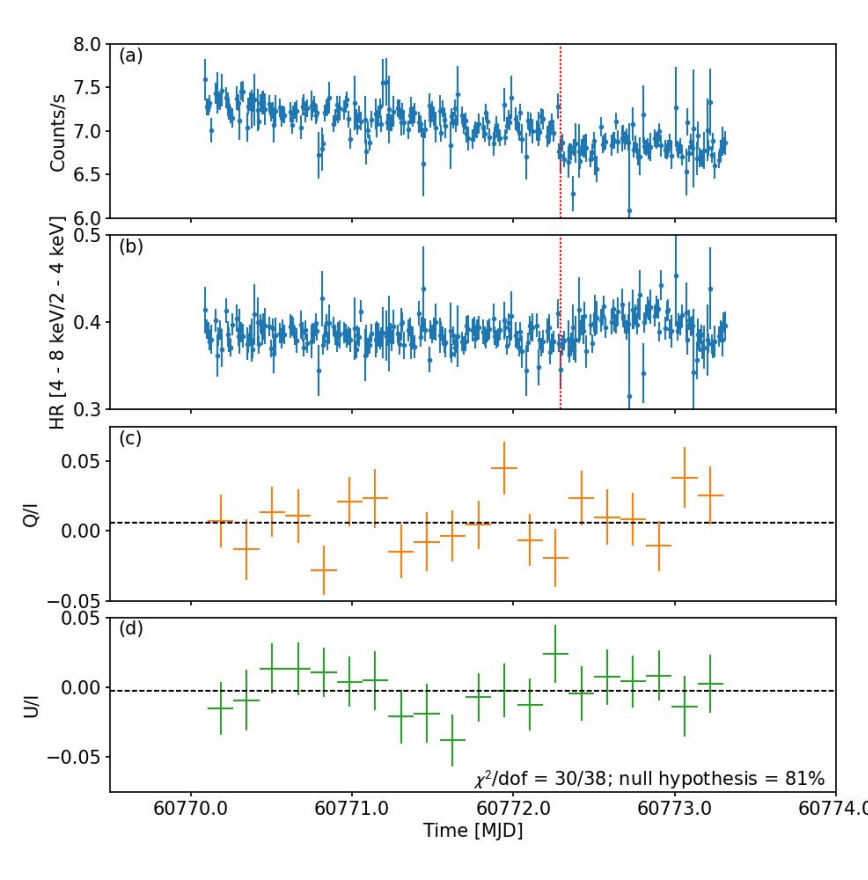
- **No significant polarization signal detected**
  - Several tests for the source and bkg region
  - **PD < 1.3% in the 2-8 kev band**
  - **No time-dependent polarization detected**



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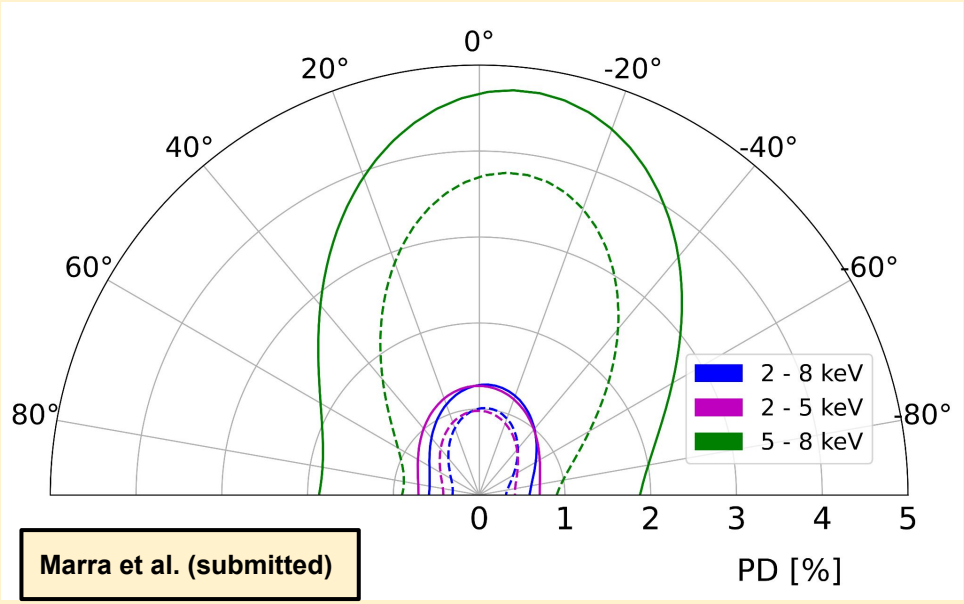
MAXI J1744-294 : IXPE observation

Background contamination & Polarization

- Exposure time **150 ks**
- **Estimate Background Contamination**
  - Flux 2-8 keV: **1.7 x 10^-9 erg/cm2/s**
  - **estimate the contamination from the nearby NS_LMXRB AXJ J1745**



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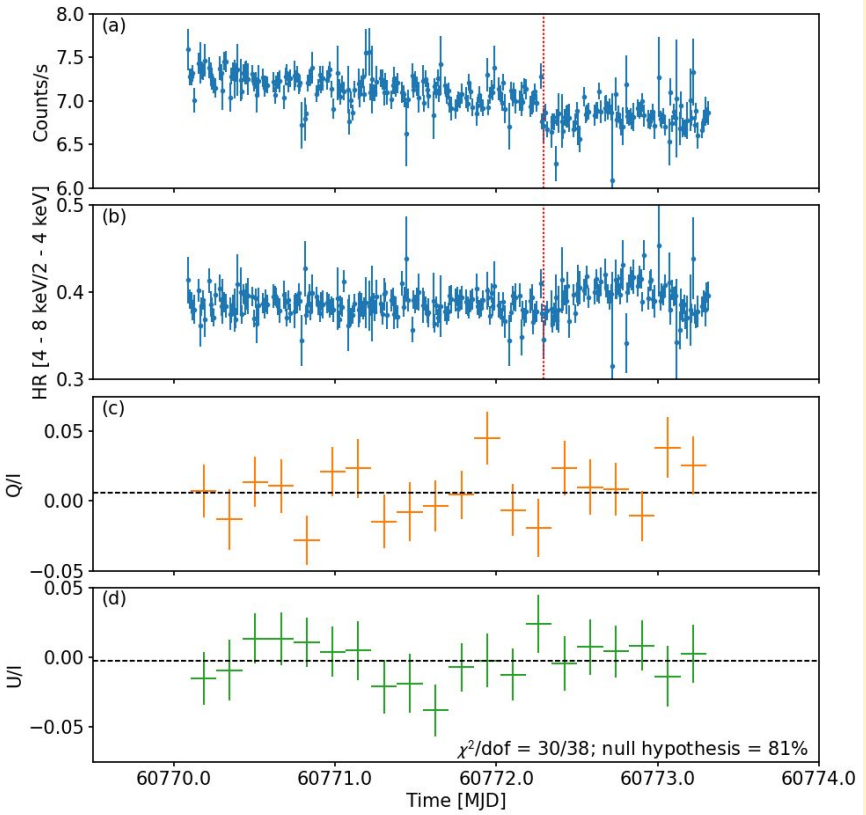
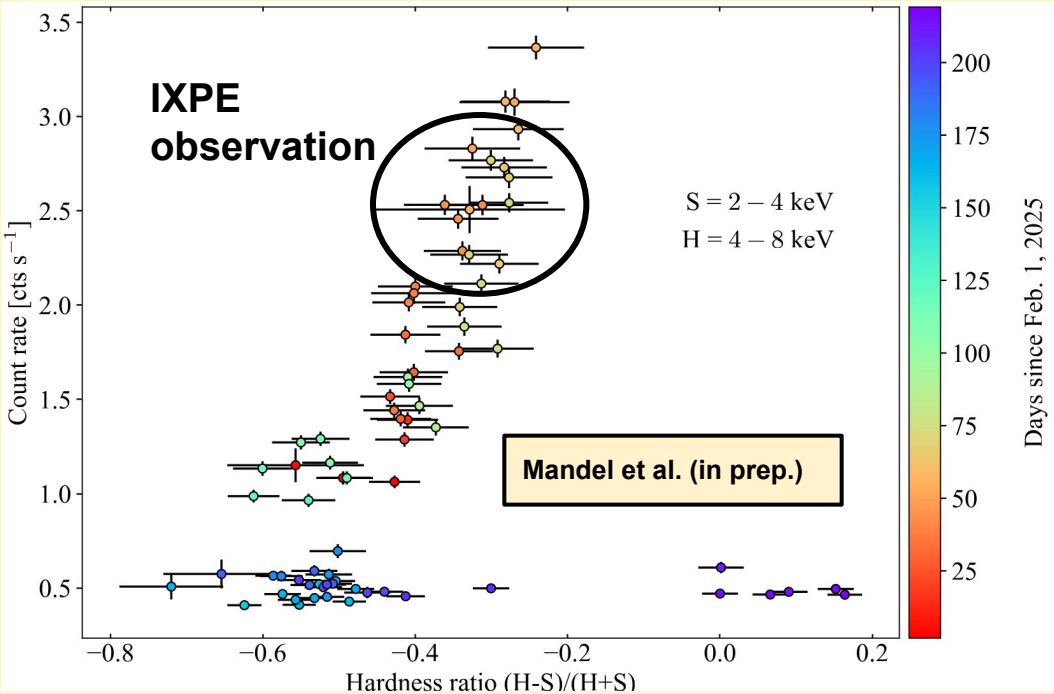


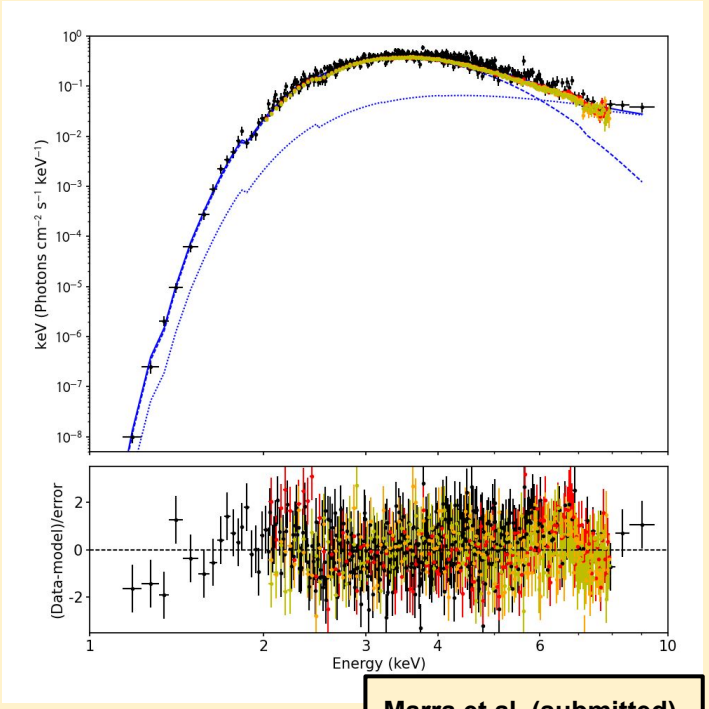
- **No significant polarization signal detected**
  - No detection in different energy ranges
  - **PD < 1.3% in the 2-8 and 2-5 kev bands**

MAXI J1744-294 : IXPE observation

Spectral state

- Source reported in soft state since February 2025 (Heinke et al 2025, Mandel et al 2025):
  - **IXPE+Swift/XRT** Spectral fit (diskbb+powerlaw);
  - Timing properties: **no variability in NICER**, RMS ≅3%.





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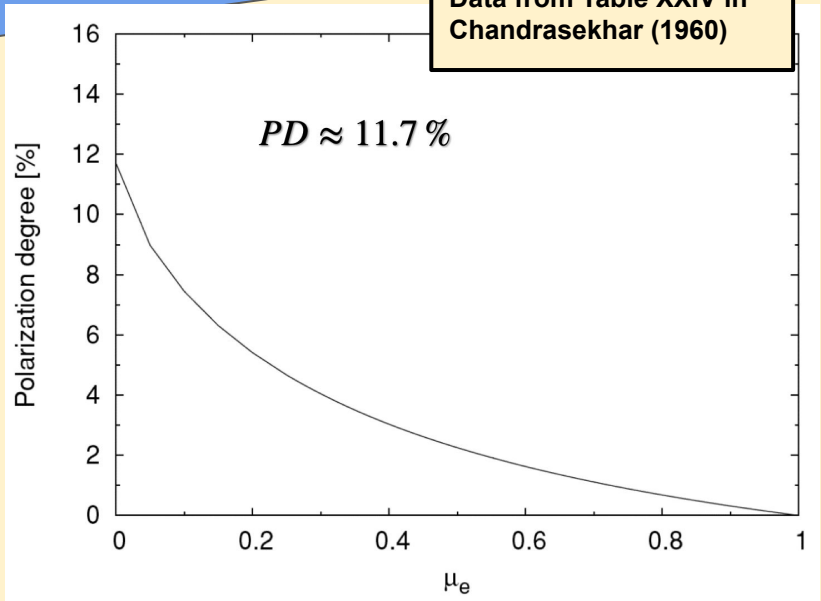
Polarization in accreting BHs in soft state

Theoretical expectations

- Polarization of the accretion disk emission:
  - **Chandrasekhar 1960 - Sobolev 1963 computations**



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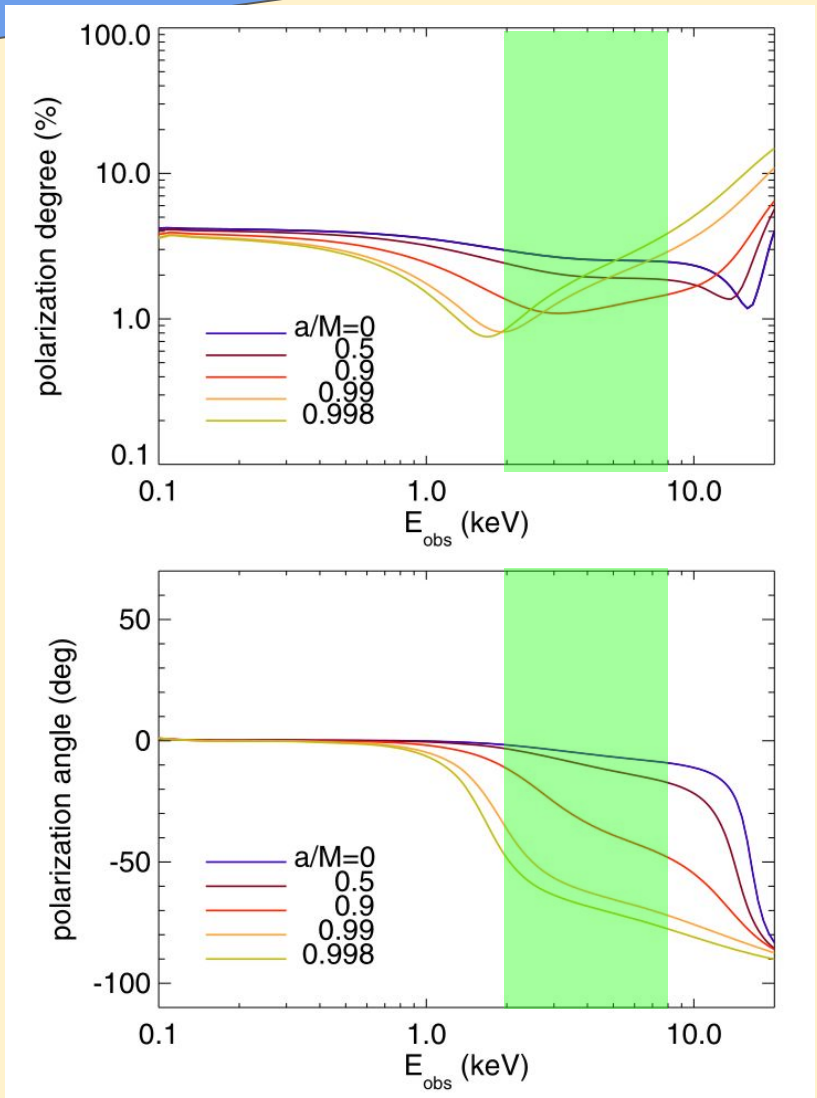

Schnittman & Krolik (2009)

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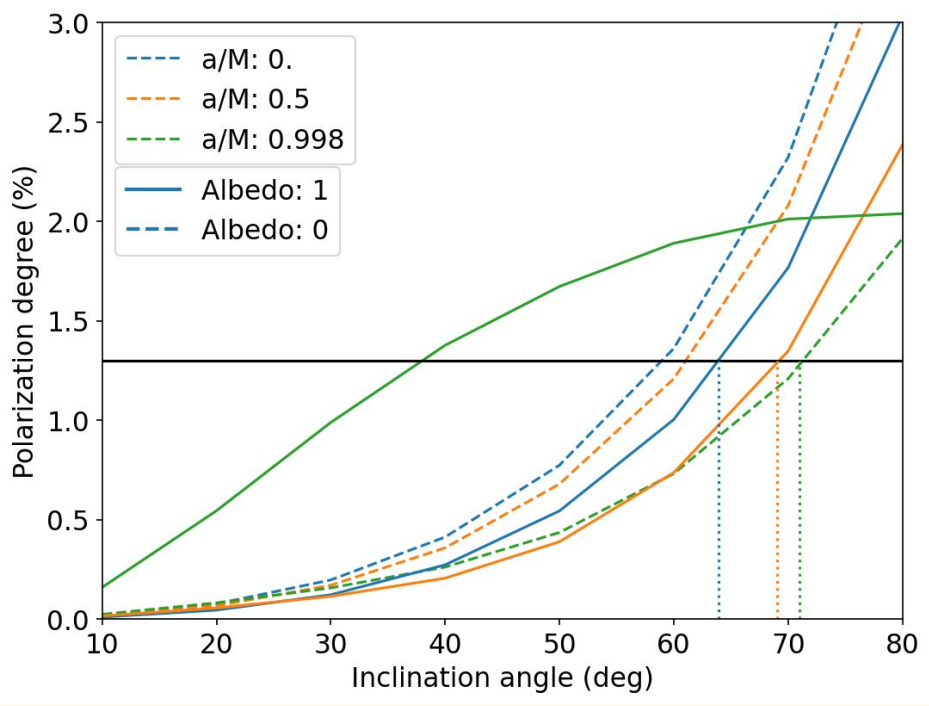
- **Low polarization values expected**
  - **A 38° - 71° inclination upper limit estimated from the theoretical model KYNBBRR (Taverna et al. 2020)**

Marra et al. (submitted)



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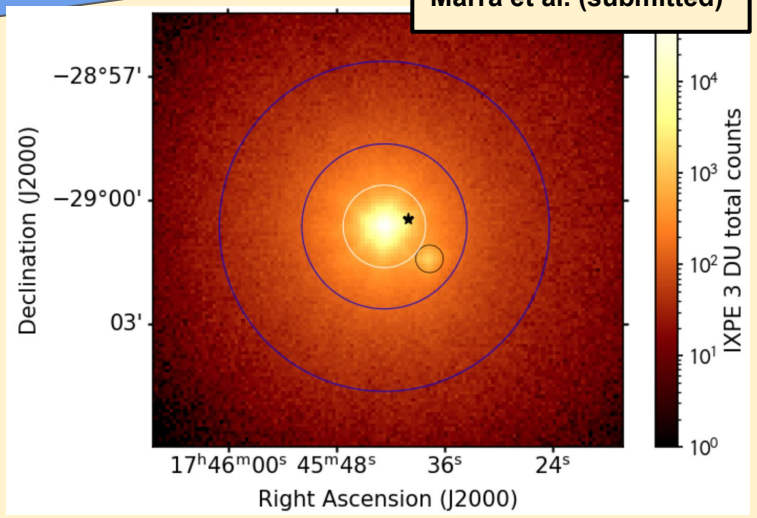
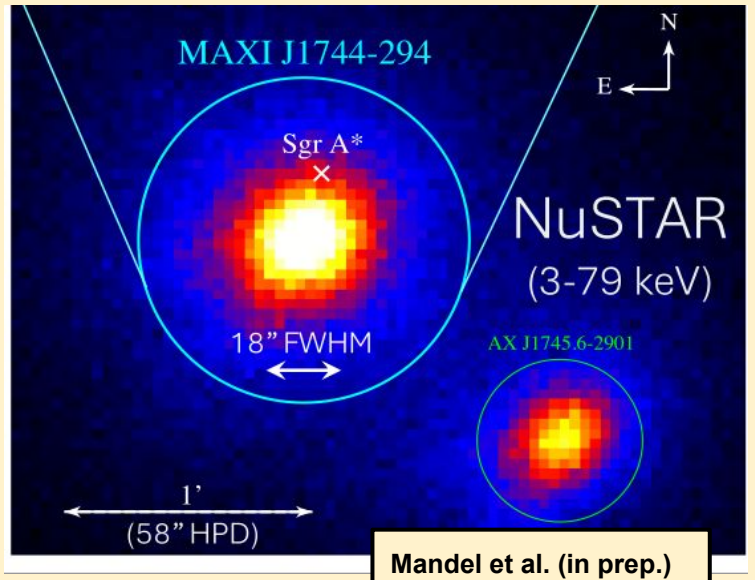
Wait, but there is more!

Serendipitous observation of AX J1745.6–2901

- **AX J1745.6–2901** (1.3’ from MAXI J1744-294) was **serendipitously observed during our IXPE pointing**
  - **Transient NS-LMXRBs** located 1.5’ away from Sgr A*
  - In Outburst roughly **⅓ of the time**, alternates between hard and soft states
  - **Wind signatures observed in soft state** (Ponti et al. 2015, Nielsen & Dagenaar 2023) disappearing in hard state (Ponti et al. 2018)
  - Indication of a **nearly edge-on disk geometry (i ≋70°-80°)**

Marra et al. (submitted)

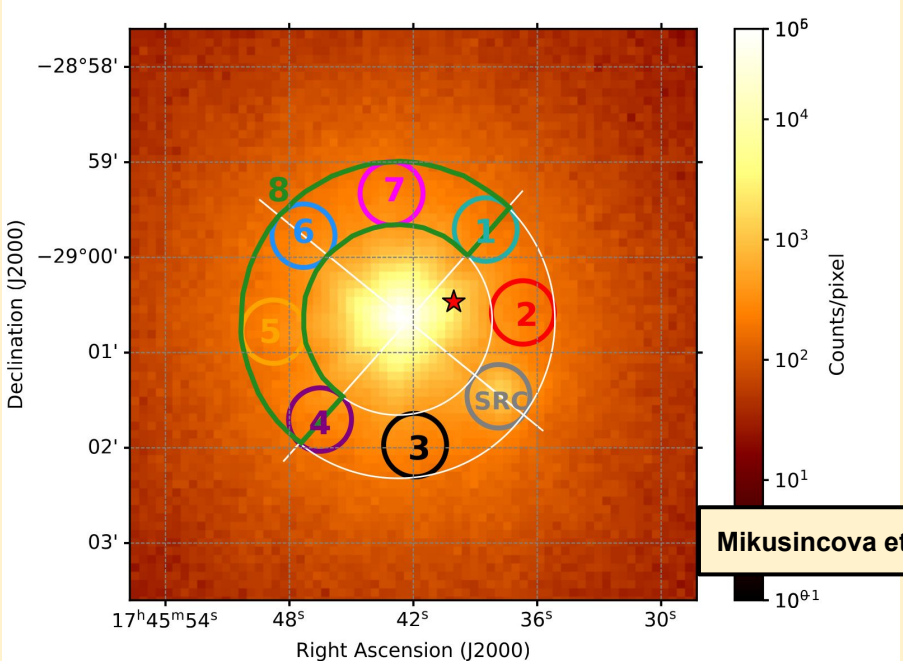




Mandel et al. (in prep.)

AX J1745.6–2901
Background contamination

- **Detailed background-subtraction analysis to estimate the source polarization**
  - PD slightly larger than MDP with no background subtracted
  - Likely **diluted from MAXI J1744 unpolarized emission**
  - **Region 6:** Same distance from MAXI J1744-294, symmetrical
  - **Very large energy-integrated PD in the 2-8 keV band**



Mikusincova et al. (in prep.)

Subtracted BKG	PD [%]	PA [deg]
none	8.9 ± 2.9	121 ± 9
1	11.5 ± 3.9	125 ± 10
2	7.0 ± 4.1	unconstrained (∼ 120)
3	10.3 ± 4.1	unconstrained (∼ 127)
4	11.5 ± 4.0	120 ± 10.0
5	11.2 ± 3.9	123 ± 10.0
6	14.7 ± 4.0	122 ± 7.8
7	9.4 ± 4.0	unconstrained (∼ 124)
8	11.1 ± 3.7	121 ± 10

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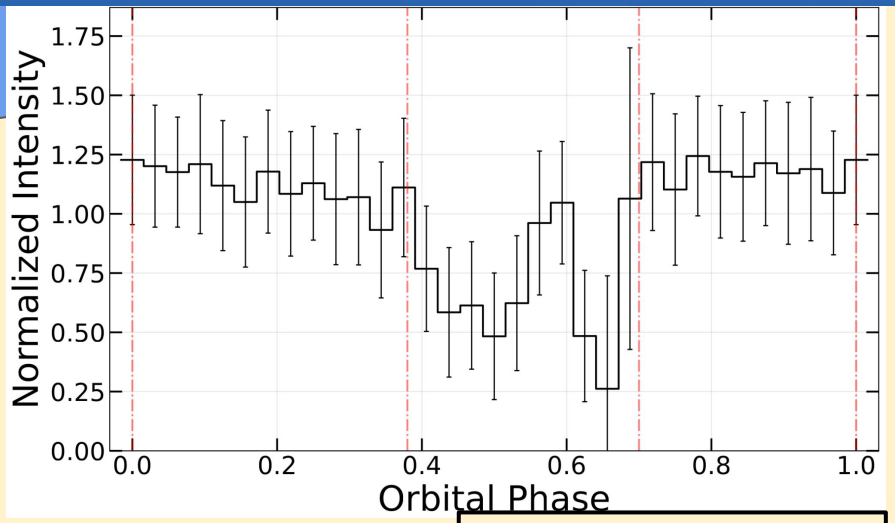
AX J1745.6–2901

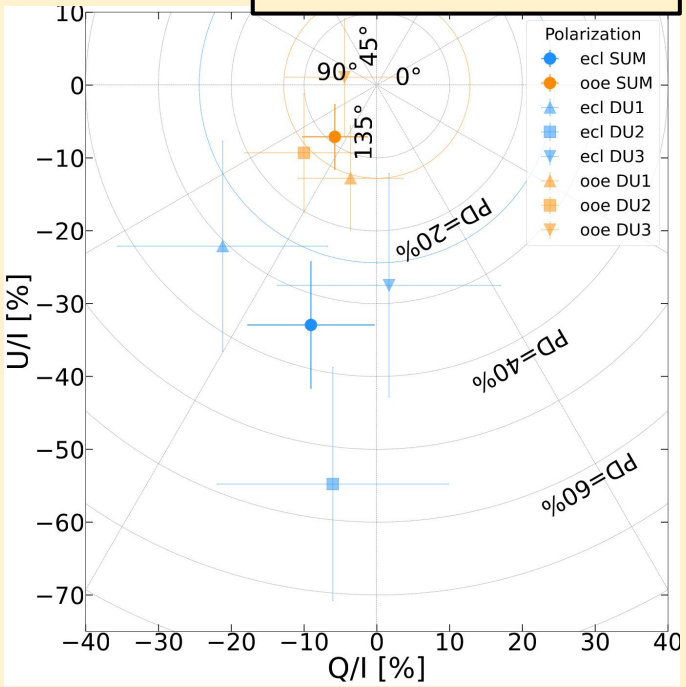
Phase dependent analysis



- **Periodic eclipses every 8.35 hours** together with complex dipping behavior.
- Phase-folding the IXPE data using the orbital period from Ponti et al. 2018 **reveals a dip+eclipse in the intensity orbital variation**.

- **Dip+eclipse phase:**
  - **PD = (34.2 +/- 8.7) %**
  - **PA consistent with the phase average value**
- **No polarization detection** (PD < MDP) in other phases.
- Possible explanation:
  - **Absorption of the unpolarized emission during the eclipse**
  - **Observed photons are reflected from a structure in the polar region (wind?)**

Mikusincova et al. (in prep.)



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Conclusions

- The Galactic Center region hosts a large and interesting population of LMXRBs
- **IXPE observed for the first time two X-ray transients located nearby SGR A***
  - **MAXI J1744-294**:
    - a newly discovered BH candidate
    - **No polarization signal detected (PD < 1,3%)**
    - In agreement with previous IXPE observations of stellar mass BHs in soft state observed with low/intermediate inclination
  - **AX J1745-2901:**
    - a NS-LMXRB characterized by winds detection
    - Detailed estimate of the GC diffuse emission and the MAXI J1744-294 contamination
    - **Large energy-integrated PD detected (as large as PD ≅15%)**
    - Phase dependent analysis revealed a larger PD during the dip+eclipse phase (PD≅30%) and no detection during the no-dip phase.
    - **Cygnus X-3-like situation? (see Romana Mikusincova's talk!)**

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