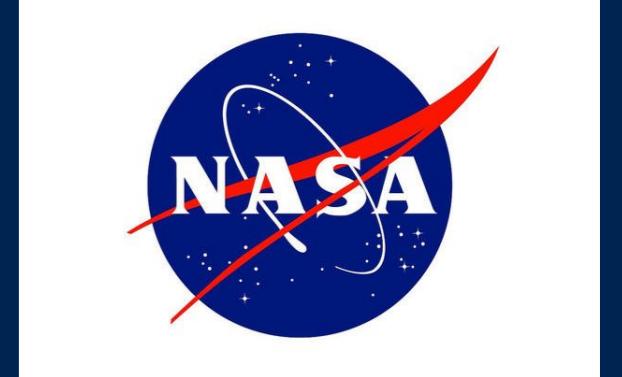
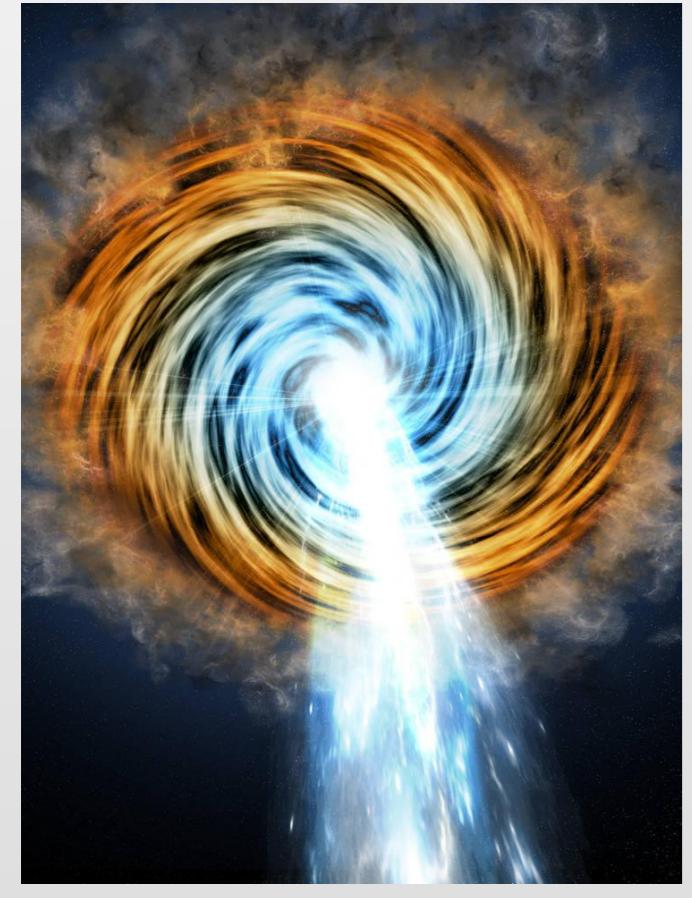


Blazars under the lens of X-ray polarimetry: perspectives for the IXPE mission

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Blazars: a natural target for X-ray polarimetry



- **High Synchrotron Peak (HSP) class:** the X-ray emission is direct **synchrotron** from the electrons in the jet. Synchrotron radiation is polarised up to $\sim 70\%$ in a ideal uniform magnetic field [1]. Polarisation properties sensitive to inhomogeneities in the magnetic field and in the particle distribution, turbulence [2], or shocks phenomena in the jet [3].

- **Low Synchrotron Peak (LSP) class:** Inverse Compton dominates the X-ray emission. Currently debated whether synchrotron photons of the jet (SSC) or external ambient photons (EC) feed the IC emission in leptonic jet. **X-ray polarisation expected only in the SSC scenario:** SSC retains half of the polarisation of synchrotron seed photon and preserves the same polarisation angle [4]. Other possible source of highly-polarised (up to 80%) X-rays: **Bulk Compton** [5] acceleration of a shell of cold electrons in the jet; direct synchrotron from relativistic protons in extreme **hadronic jet** [6].

IXPE: Imaging X-ray Polarimeter Explorer

- **NASA SMEX mission in partnership with ASI**
- First mission after OSO-8 (1975) to carry an **X-ray polarimeter** on board.
- Planned for launch in **spring 2021**.
- **Imaging capability** with an angular resolution of $25''$.
- Focal plan instrumentation: three **Gas Pixel Detectors**, (GPD) sensitive to the polarisation in the 2-8 keV band.

Target Selection

- **Minimum Detectable Polarization (MDP):** the minimum degree of polarisation that a polarimeter with a modulation factor M can measure at a confidence level of 99%. Depends on the source count-rate (S), the background count-rate (B) and on the integration time (t)

$$MDP = \frac{4.29}{M} \sqrt{\frac{S+B}{S^2 t}}$$

- **Examples of good targets for IXPE:** a X-ray bright HSP (Mrk 421); a bright LSP showing a average high degree of polarisation in the optical (3C 279)

Source	X-ray flux range (a)	Optical polarisation range (b)	MDP range (c)
Mrk 421	(1-8) 10^{-10} erg/s/cm ²	1%-10%	100 ks: 1.5%-4%
3C 279	(5-7) 10^{-12} erg/s/cm ²	2%-30%	500 ks: 7%-8%

(a): Flux range in the 2-10 keV band in a quiescent state (b): From: <https://www.bu.edu/blazars/VLBAproject.html> (c): Computed for the given exposure time.

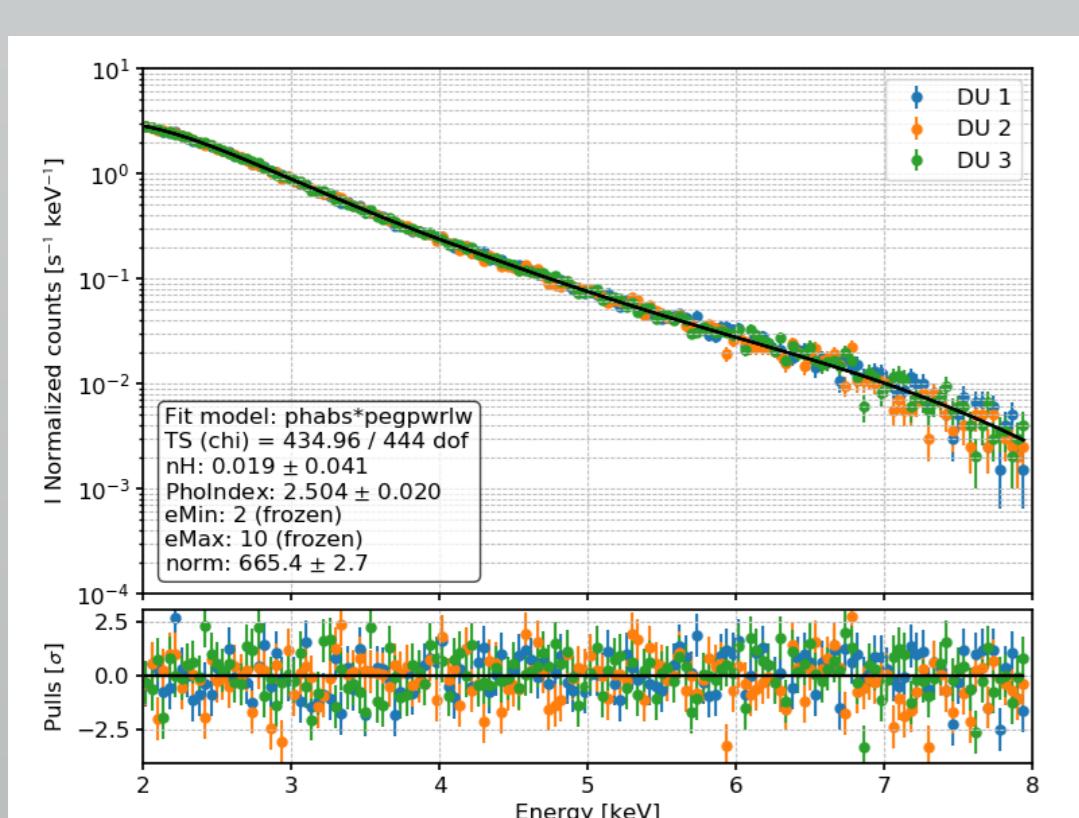
We present simulations of successful IXPE observations of prototypcal blazars

IXPE & HSP: Mrk 421

- Synchrotron spectrum: $\Gamma=2.5$
- Flux (2-10 keV) $\sim 6E-10$ erg/s/cm²
- Simple hypothesis: X-ray photons from the same region as the optical photons and have the same polarisation properties: $\theta=5^\circ$; $\Pi=5\%$ [7]

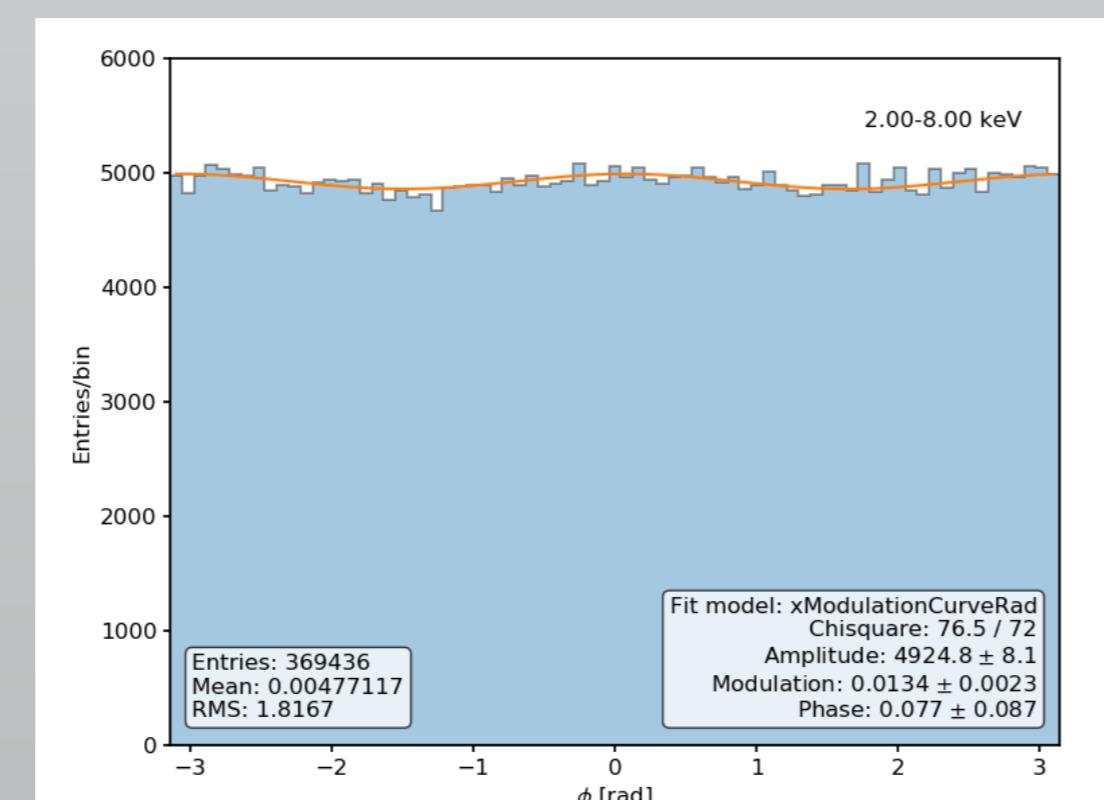
Results for 100 ks:

Spectrum:



- $\Gamma=2.50 +/- 0.2$;
- Flux = $(6.65 +/- 0.03) E-10$ erg/s/cm²

Modulation



- $\theta=8^\circ +/- 3^\circ$;
- $\Pi=5 +/- 1\%$

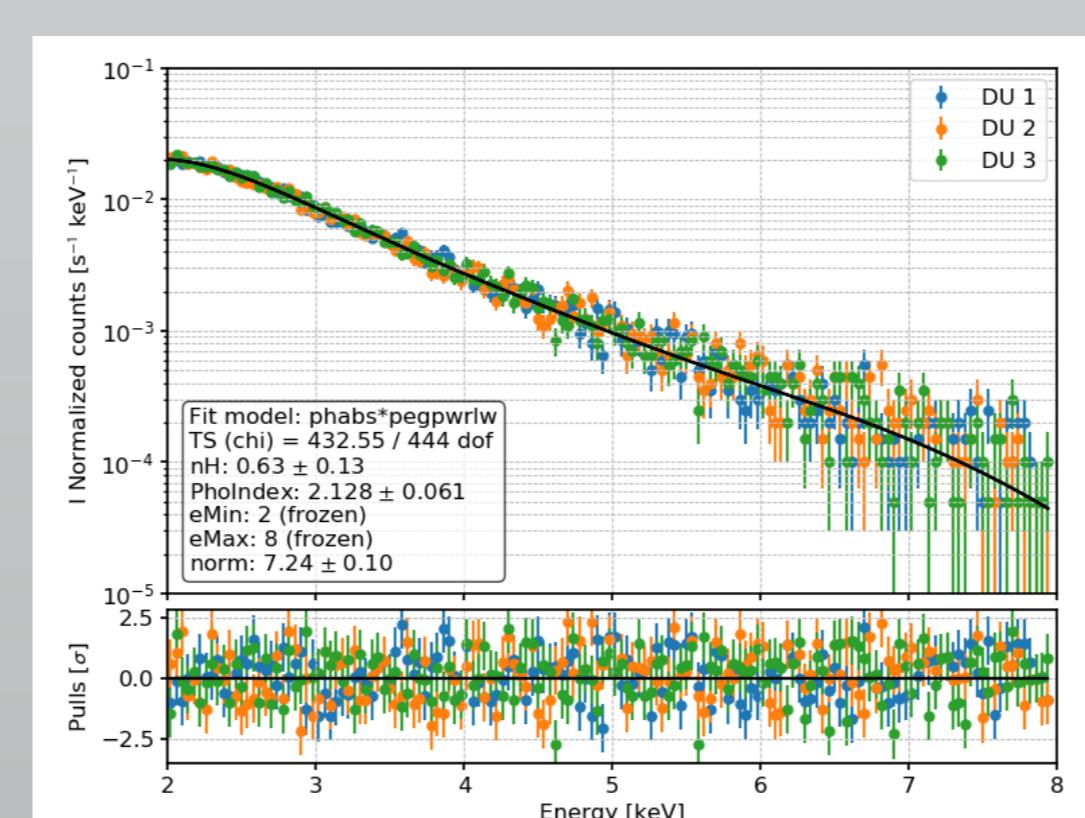
**IXPE can confirm
the prediction of
a one zone jet model**

IXPE & LSP: 3C 279

- SSC dominated spectrum: $\Gamma=1.8$
- Flux (2-10 keV) $\sim 7E-12$ erg/s/cm²
- Simple hypothesis: leptonic jet where SSC retains half of the optical polarisation: $\theta=45^\circ$; $\Pi=10\%$

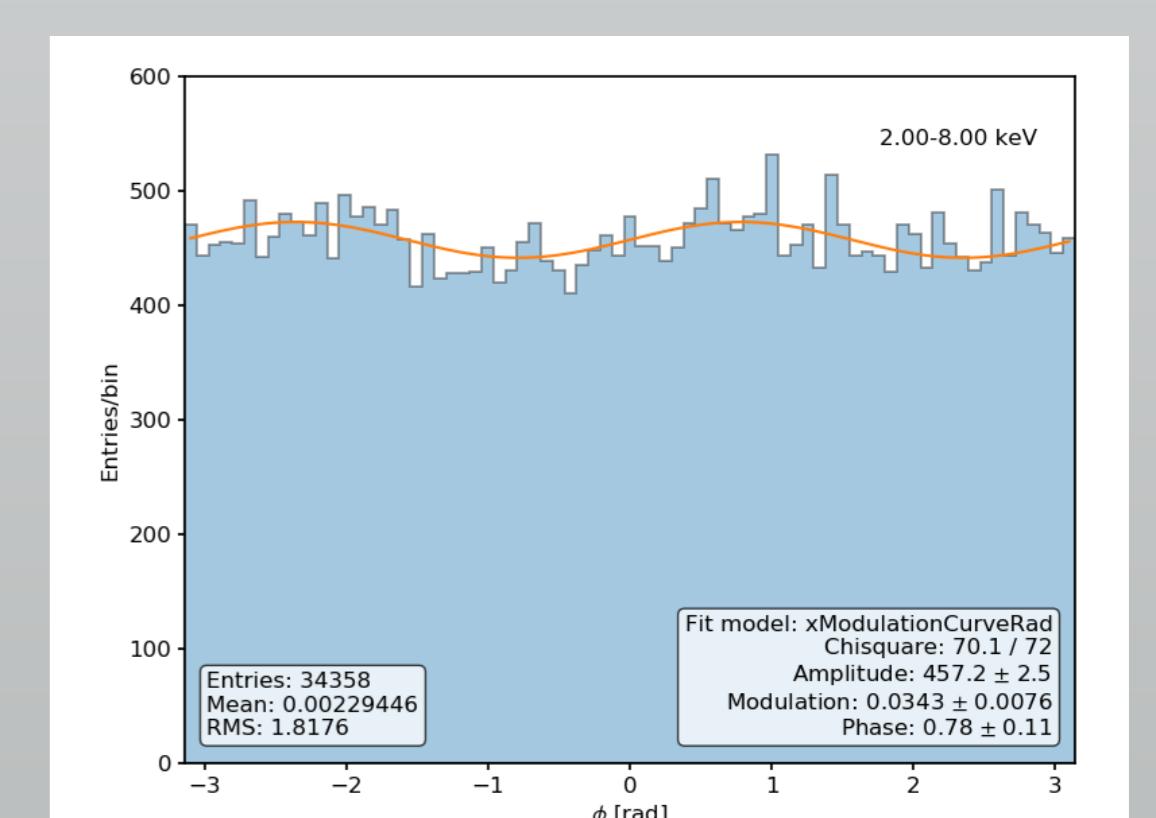
Results for 500 ks:

Spectrum:



- $\Gamma=2.1 +/- 0.1$
- Flux = $(7.2 +/- 0.1) E-12$ erg/s/cm²

Modulation



- $\theta=45^\circ +/- 6^\circ$
- $\Pi=9 +/- 2\%$

**IXPE can confirm
the prediction of
a simple leptonic SSC**