SIMULATION OF THE OBSERVATION OF SGR B2 WITH IXPE

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Introduction

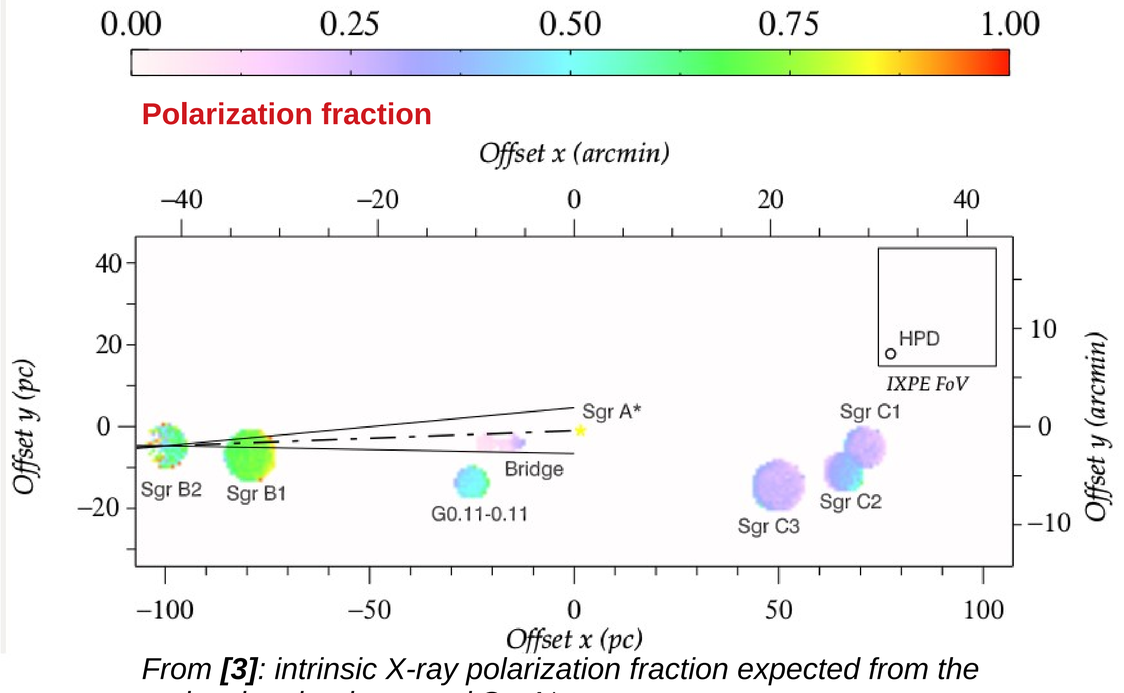
The combination of imaging and polarimetric capabilities over a **~8 arcmin** Field of View will allow the Imaging X-ray Polarimetry Explorer (**IXPE**) to investigate the polarization properties of complex fields and extended sources by means of position- and energy-dependent polarization maps that will clarify the emission processes and the role of the magnetic field structure on the acceleration process in the X-ray emitting region **[6]**.

The **SgrB2** Molecular Cloud near the Galactic center is one of the most representative targets, being faint, extended and in a crowded field.
The interest in the observation of the molecular Clouds in the Galactic center lies in the opportunity to determine if their observed hard X-ray reflection spectrum is an “echo” from a past outburst of SgrA*.

If this theory is true we expect the clouds to be strongly polarized (depending to their relative position to SgrA*), with a polarization angle perpendicular to the direction of the external source **[2]**.

We expect he intrinsic polarization degree to be diluted by the presence of a hot plasma “bubble” in which the clouds are embedded.
This factor, together with the effect of the instrumental and diffuse background must be addressed.

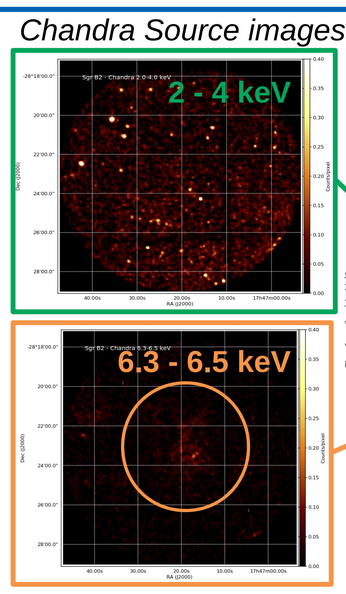
Here a simulation of a long (**3 Ms**) IXPE observation is presented: “ixpeobssim” **[5]**, a Python based Monte Carlo code that allows to use Chandra observations in order to preserve the full correlation between the source morphology and the spectrum, is employed.



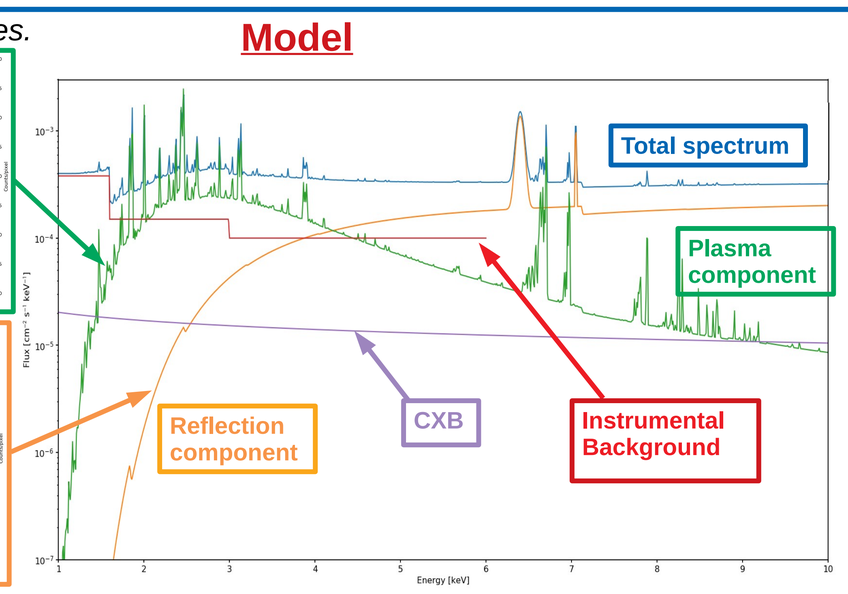
*From **[3]**: intrinsic X-ray polarization fraction expected from the molecular clouds around SgrA**

- **Plasma Component:** simulated as an extended source attached to a Chandra image in the **2 - 4 keV** band. The spectrum of the plasma is modeled with two APEC at **2.2 keV** and **6.5 keV**.
- **Reflection component:** simulated as an extended source attached to a Chandra image centered in energy on the Iron line at **6.4 keV**. The spectrum is modeled as a power law + gaussian lines.
- **Cosmic X-ray background: (CXB):** Model from **[3]**.
- **Instrumental Background:** estimated from the Neon filled detector described in **[1]** that better approximates the Gas Pixel Detector.

Chandra Source images.



Model

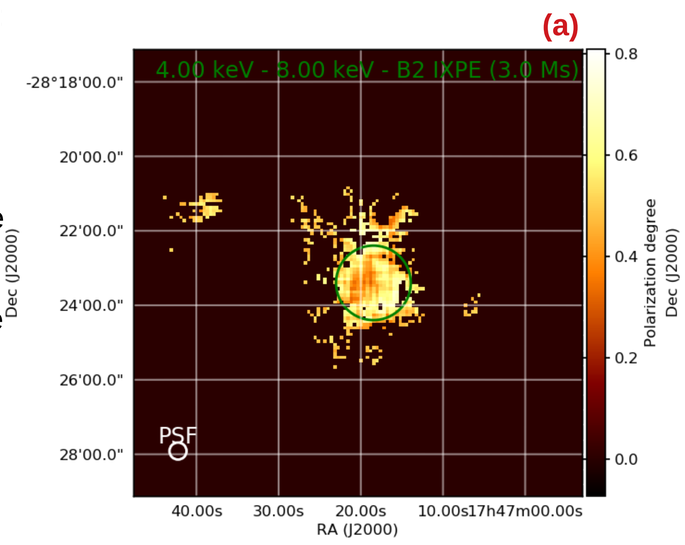


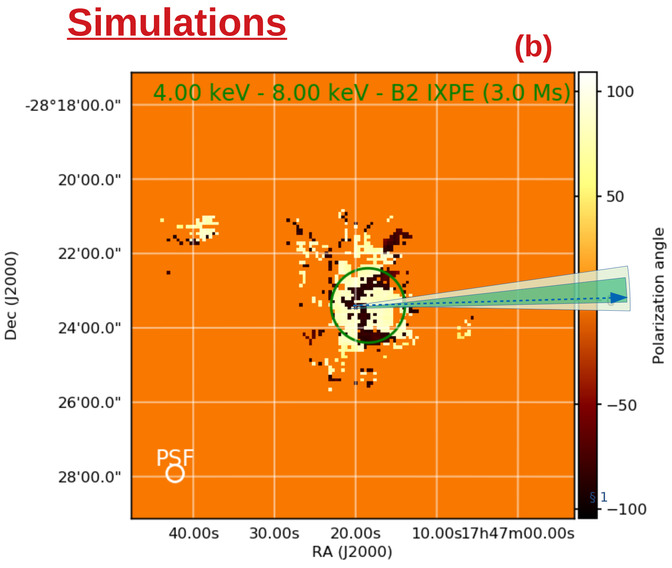
*Spectral and polarimetric Model table: polarization degree and angle values from **[3]***

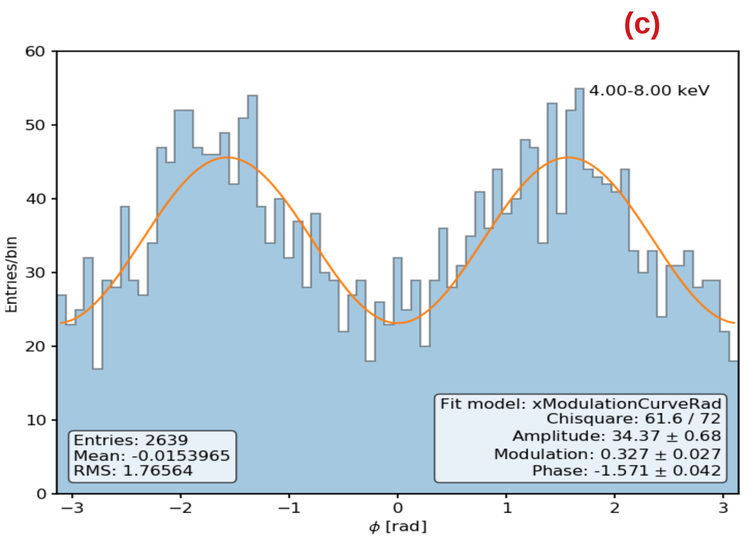
Component	Model	Polarization Degree [%]	Polarization Angle [°]
Reflection	Power law + Gauss	65.0	88.3
Plasma	APEC	0	0
CXB	Moretti et al. 2008 **[4]**		
Instrumental Background	Bunner 1978 **[1]**		

Simulations

- **3 Ms** long IXPE observation:
- **(a) Polarization Degree map** for the **4 – 8 keV** energy band.
- **(b) Polarization Angle map** for the **4 – 8 keV** energy band. In shades of green the **1σ** and **2σ** uncertainty on the direction of the external illuminating source. The blue arrow points toward SgrA*.
- **(c) Modulation Curve** extracted from the green circle region in **(a)** and **(b)** centered on SgrB2.





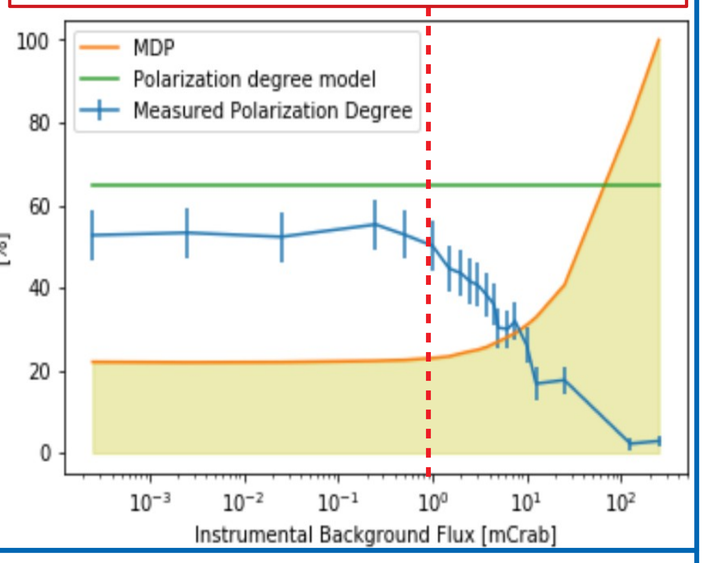


Results

- Polarization degree and angle consistent with the ones expected from **[3]**.
- The plasma “bubble” in which the reflection-nebulae such as SgrB2 is embedded reduces the polarization signal by **20%.**
- We find that **the observation is source dominated**: by increasing the flux of the instrumental background, the polarization signal deteriorates for an instrumental background flux **> 1 mCrab (2.0e-11 ergs/cm²/s)**, i.e. four times higher than the baseline value.
- A few Ms mapping the molecular clouds are sufficient to investigate the past activity of Sgr A*.
- Since SgrB2 is dimming, by the time IXPE launches other molecular clouds for which these results still stands, such as **SgrC** or **“the Bridge”**, may be selected for observation instead.

Observation Time [Ms]	Energy range [keV]	MDP [%]	Polarization Degree [%]	Polarization Angle [°]
3	4 - 8	16.81	52.2 +/- 4.8	84.9 +/- 2.4
Expected from [3]			57.4 +/- 4.4	83.3 +/- 3.4

“Acceptable” instrumental background threshold.



Contacts and References

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(1) Bunner, A. N., Soft X-ray results from the Wisconsin experiment on OSO-8. The Astrophysical Journal 220, 261 (1978).
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(3) Marin, F., Muleri, F., Soffitta, P., Karas, V. & Kunneriath, D. Reflection nebulae in the Galactic center: soft X-ray imaging polarimetry. Astronomy & Astrophysics 576, A19 (2015).
(4) Moretti, A., A new measurement of the Cosmic X-ray background. in AIP Conference Proceedings 1126, 223–226 (2009).
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(6) Weisskopf, M. C. et al., The Imaging X-ray Polarimetry Explorer (IXPE) . Proceedings of the SPIE, Volume 9905, id. 990517 10 pp. (2016).