The X-ray Imaging Polarimeter Explorer

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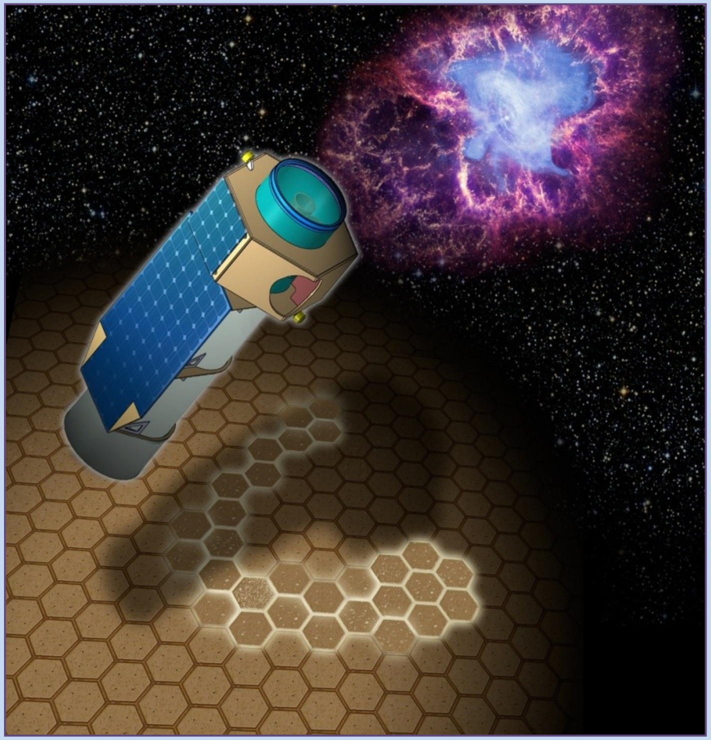
on behalf of the XIPE Study Science Team



www.isdc.unige.ch/xipe

Picking the right direction

Xipe

STRONGGRAVITY
EU FP7-SPACE research project 312789 2013 - 2017

SEVENTH FRAMEWORK PROGRAMME

Introduction

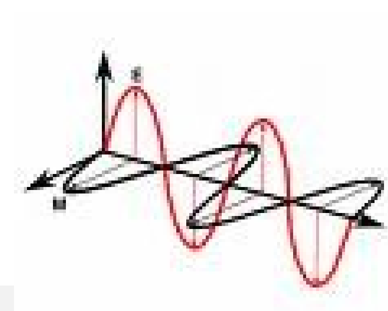
Information on celestial (extra-solar) sources are mostly provided by electromagnetic radiation.

They can be obtained by studying the spatial, spectral, timing and *polarization* properties of the observed radiation.

In particular, the polarization properties give us information on *geometry* (in a broad sense: geometry of the emitting matter but also of magnetic and gravitational fields, of space-time, etc.): the polarization degree depends on the level and type of symmetry of the system, the polarization angle indicates its orientation.

Our knowledge of the emission from a celestial source in a certain energy band is therefore incomplete without polarimetry.

However, polarimetric informations of astrophysical sources are basically missing in the X-ray band !



Why X-ray polarimetry?

Introduction

Polarimetry has proved very important in radio, IR and optical bands (eg. jet emission in blazars, Unification Model of AGN, ...).

In X-rays, where non-thermal emission processes and aspherical geometries are likely to be more common than at lower energies, polarimetry is expected to be vital to fully understand emitting sources.

However, only one measurement (P=19% for the Crab Nebula, indicating synchrotron emission) has been obtained so far, together with a tight upper limit to Sco X-1.

These measurements have been obtained in the 70s, for the two brightest sources in the X-ray sky.

The lack, for many decades, of significant technical improvements implied that no polarimeters were put on board of X-ray satellites.

Why X-ray polarimetry?

Why XIPE?

The situation has changed dramatically with the advent of polarimeters based on the photoelectric effect. Such detectors, on the focal plane of a X-ray telescope, may provide astrophysically interesting measurements for hundreds of sources (remember that polarimetry is a photon hungry technique…). The brightest specimens of all major classes of X-ray sources are now accessible!

Time is ripe for a X-ray polarimetric mission !

Indeed, a X-ray polarimeter was part of the focal plane suite of detectors of XEUS/IXO, but it did not survive the severe descooping towards Athena.

A X-ray polarimetric mission, GEMS, was approved by NASA as a SMEX but later cancelled for programmatic reasons.

And finally, XIPE has been selected for a phase A study in ESA M4 (together with Ariel, devoted to exoplanets, and Thor, a solar magnetosphere mission; final down-selection in Spring 2017).

XIPE will perform spectrally-, spatially- and time-resolved polarimetry of hundreds of celestial sources to provide a breakthrough in astrophysics and fundamental physics

Why X-ray polarimetry?

XIPE goals

Astrophysics

- **Acceleration phenomena**
  - Pulsar wind nebulae
  - SNRs
  - Jets
- **Emission in strong magnetic fields**
  - Magnetic cataclysmic variables
  - Accreting millisecond pulsars
  - Accreting X-ray pulsars
  - Magnetars
- **Scattering in aspherical situations**
  - X-ray binaries
  - Radio-quiet AGN
  - X-ray reflection nebulae

Fundamental Physics

- **Matter in Extreme Magnetic Fields:**
  - **QED effects**
- **Matter in Extreme Gravitational Fields: GR effects**
  - Galactic black hole system & AGNs
- **Quantum Gravity**
- **Search for axion-like particles**

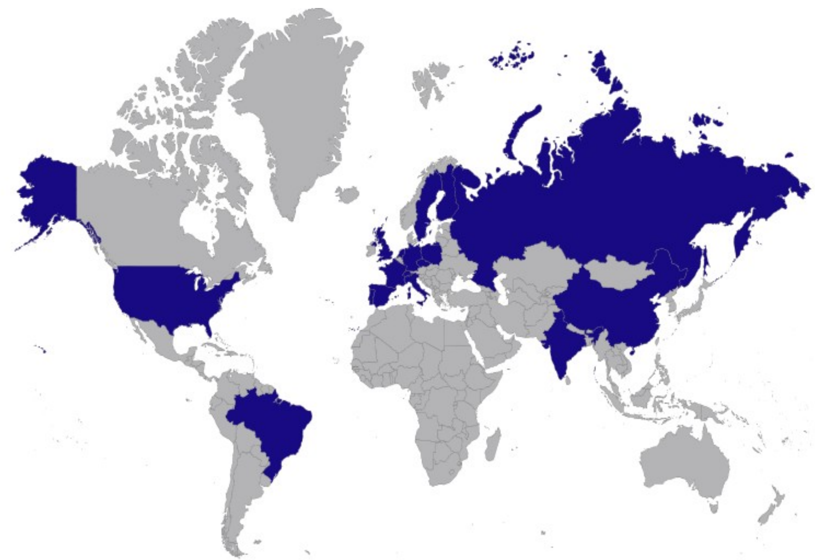
XIPE will observe **almost all classes of X-ray sources**

A large community involved (as for the proposal):

17 countries

146 scientists

68 institutes around the world



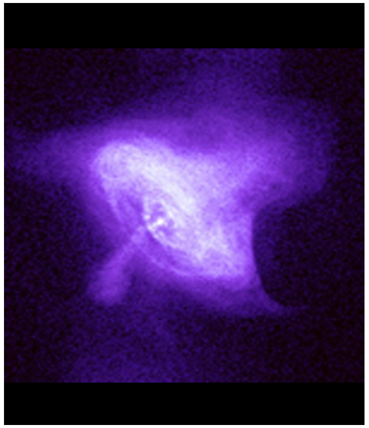
XIPE scientific goals

Astrophysics: Acceleration: PWN - The Crab Pulsar

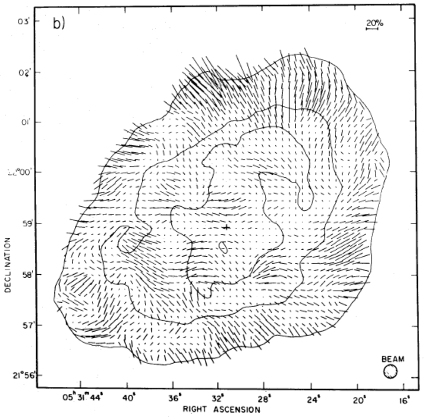
Radio (VLA)

Infrared (Keck)

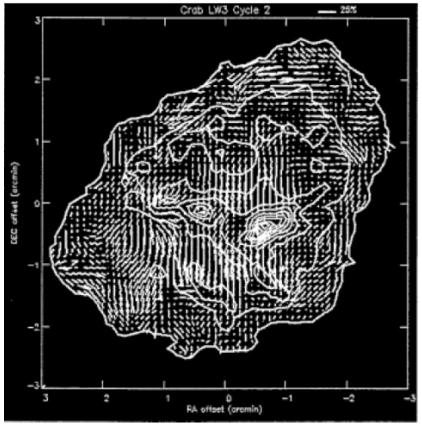
Optical (Palomar)



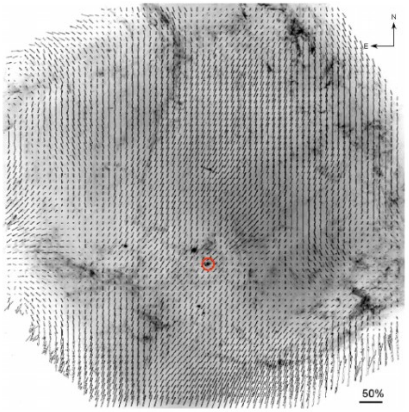
X-rays (Chandra)



Radio polarisation



IR polarisation



Optical polarisation

?

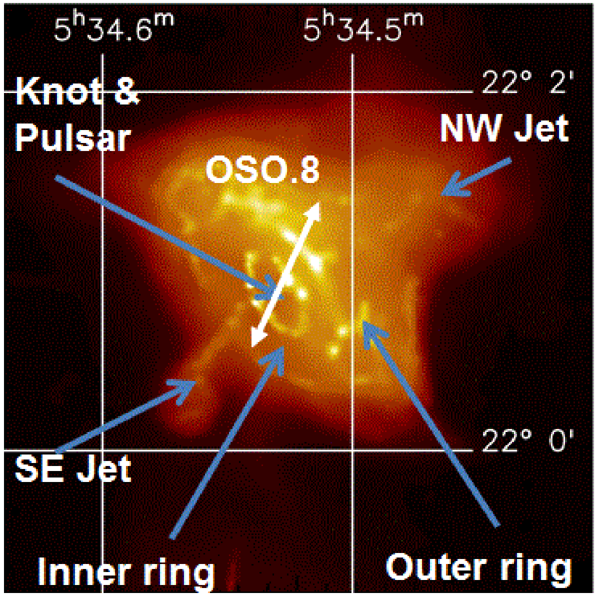
P=19% integrated over the entire nebula (Weisskopf et al. 1978)

X-ray polarisation

X-rays probe **freshly accelerated** electrons and their acceleration site.

XIPE scientific goals

Astrophysics: Acceleration: PWN



Region	σdegree (%)	σangle (deg)	MDP (%)
1	±0.60	±0.96	1.90
2	±0.41	±0.65	1.30
3	±0.68	±1.10	2.17
4	±0.86	±1.39	2.76
5	±0.61	±0.97	1.93
6	±0.46	±0.75	1.48
7	±0.44	±0.70	1.40
8	±0.44	±0.71	1.41
9	±0.46	±0.74	1.47
10	±0.60	±0.97	1.92
11	±0.52	±0.83	1.65
12	±0.53	±0.85	1.69
13	±0.59	±0.95	1.89

20 ks with XIPE

- The OSO-8 observation, integrated over the entire nebula, measured a position angle that is tilted with respect to the jets and torus axes.
- What is the role of the magnetic field (turbulent or not?) in accelerating particles and forming structures?
- XIPE imaging capabilities will allow us to measure the pulsar polarisation by separating it from the much brighter nebula emission.
- Other PWN, up to 5 or 6, are accessible for larger exposure times (e.g. Vela or the “Hand of God”).

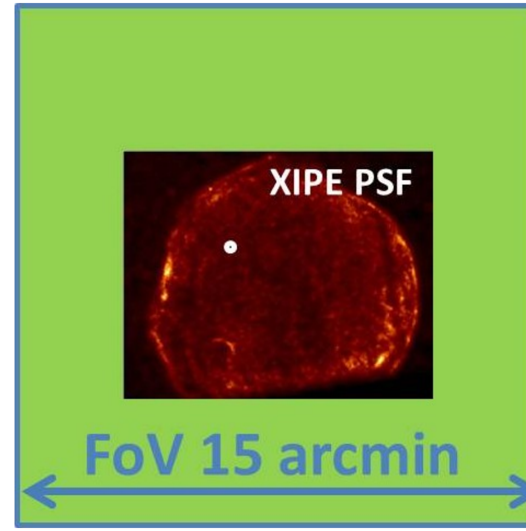
XIPE scientific goals

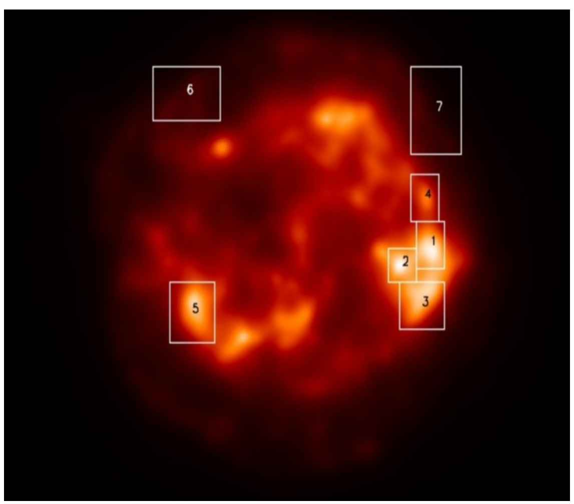
Astrophysics: Acceleration: SNR

Map of the magnetic field

Spectral imaging allows to separate the thermalised plasma from the regions where shocks accelerate particles.

What is the orientation of the magnetic field? How ordered is it? The spectrum cannot tell…





4-6 keV image of Cas A blurred with the PSF of XIPE

Region	MDP (%)	σdegree (%)	σangle (deg)
		if P=11%	
1	3.7	±1.2	±3.2
2	4.3	±1.3	±3.7
3	3.2	±1.0	±2.8
4	4.6	±1.4	±4.1
5	3.0	±0.9	±2.6
6	5.3	±1.7	±4.5
7	5.4	±1.7	±4.9

2 Ms observation with XIPE

XIPE scientific goals

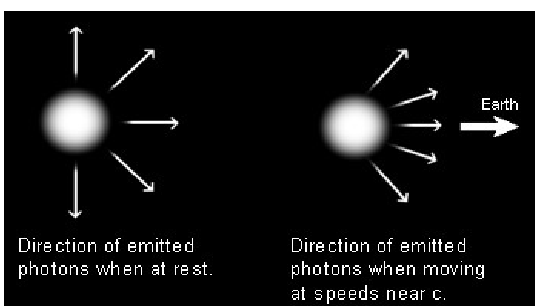
Astrophysics: Acceleration: Unresolved Jets in Blazars

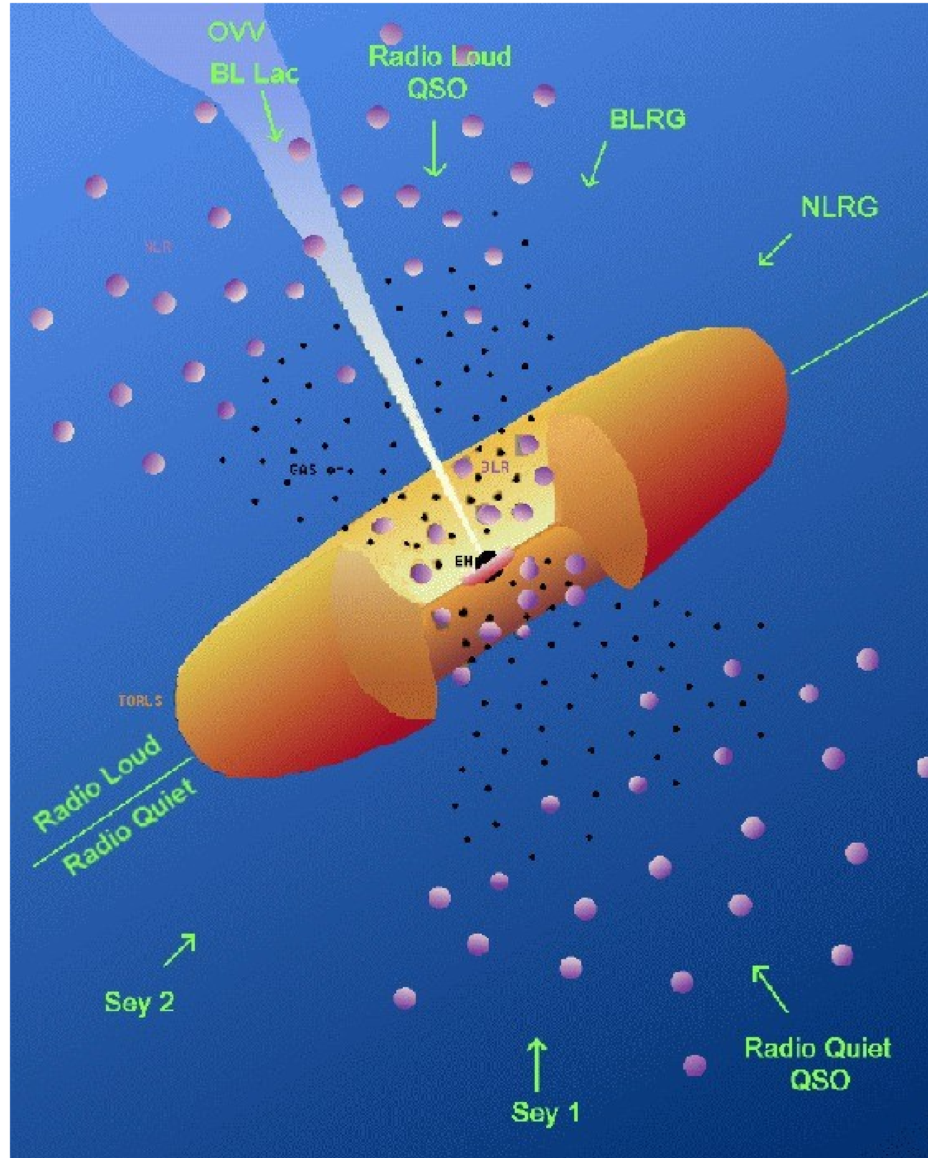
Schematic view of an AGN

➡

Blazars are those AGN which not only have a jet (like all radiogalaxies), but it is directed towards us.

Due to a Special Relativity effect (aberration), the jet emission dominates over other emission components





XIPE scientific goals

Astrophysics: Acceleration: Unresolved Jets in Blazars

Blazars are extreme accelerators in the Universe, but the emission mechanism is far from being understood.

In inverse Compton dominated Blazars, a XIPE observation can determine the origin of the seed photons:

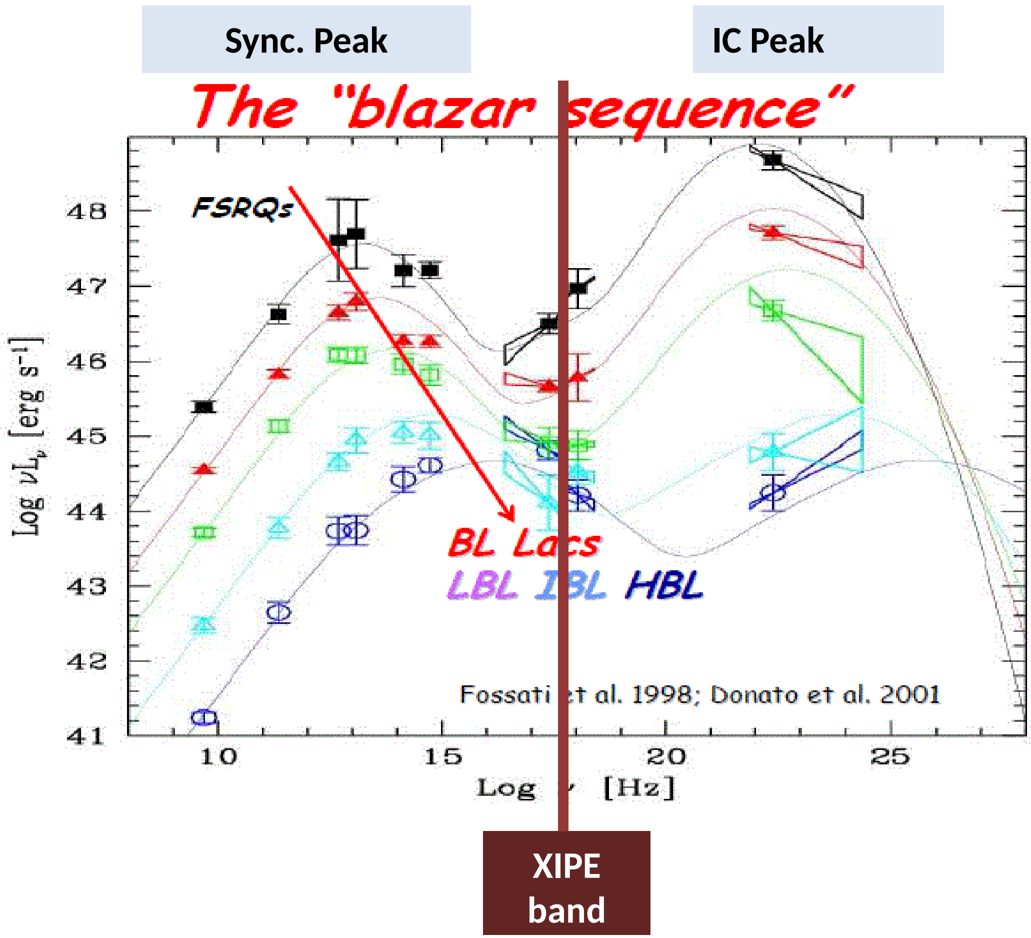
- Synchrotron-Self Compton (**SSC**) ?

The polarization angle is the same as for the synchrotron peak.

- External Compton (**EC**) ?

The polarization angle may be different.

The polarization degree determines the electron temperature in the jet.



Astrophysics: Acceleration: Unresolved Jets in Blazars

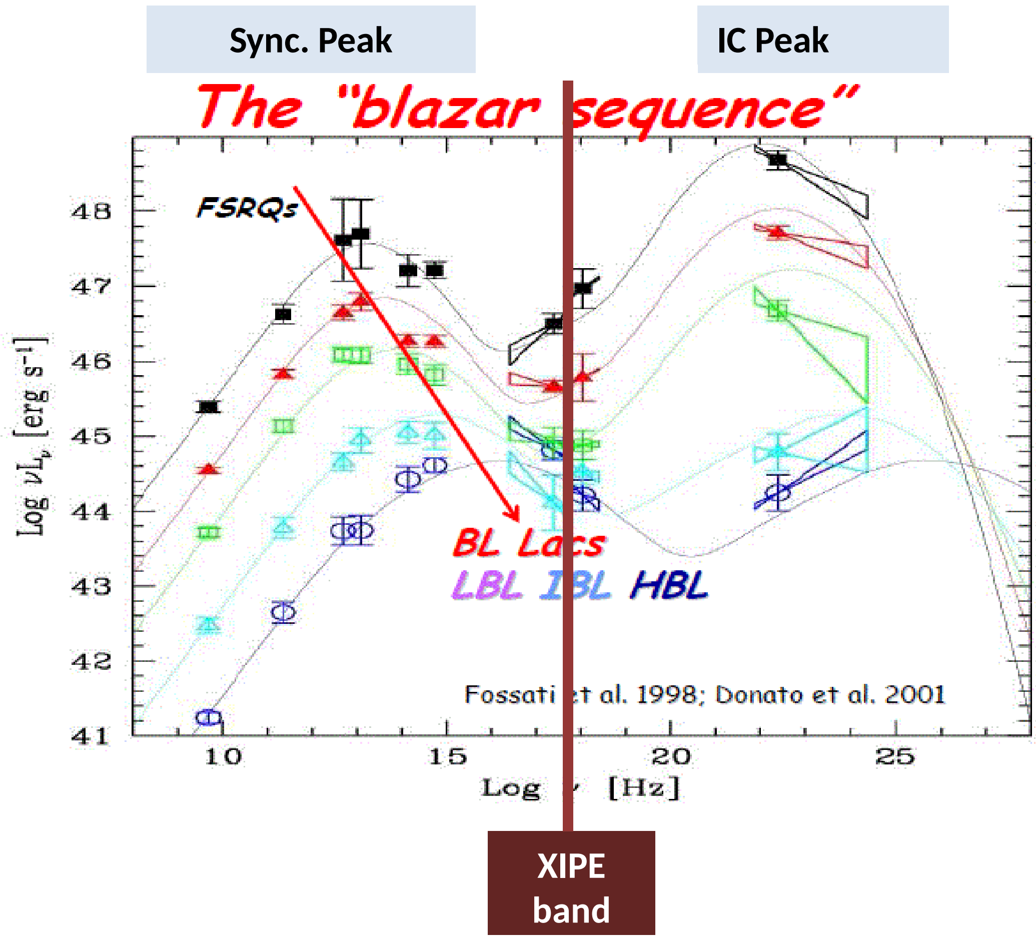
Blazars are extreme accelerators in the Universe, but the emission mechanism is far from being understood.

In synchrotron-dominated X-ray Blazars, multi-λ polarimetry probes the structure of the magnetic field along the jet.

Models predict a larger and more variable polarisation in X-rays than in the optical.

Coordinated multi-wavelength campaigns are crucial for blazars.

Such campaigns (including polarimetry) are routinely organised and it will be easy for XIPE to join them.

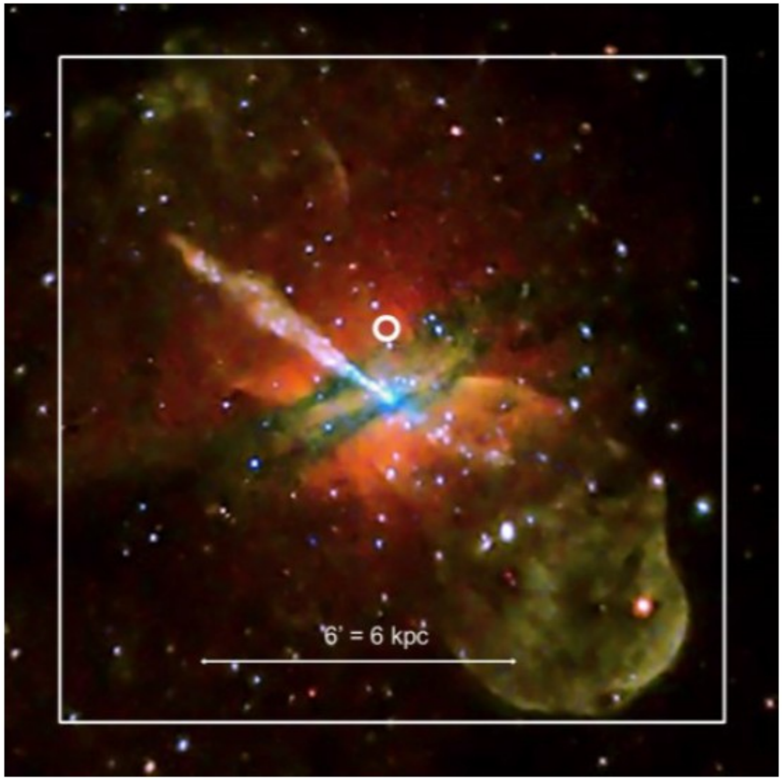


Astrophysics: Acceleration: Resolved Jets in Radiogalaxies

In nearby, non-blazar radiogalaxies, the jet may be resolved.

XIPE can map the X-ray polarisation and thus the magnetic field of resolved X-ray emitting jets.

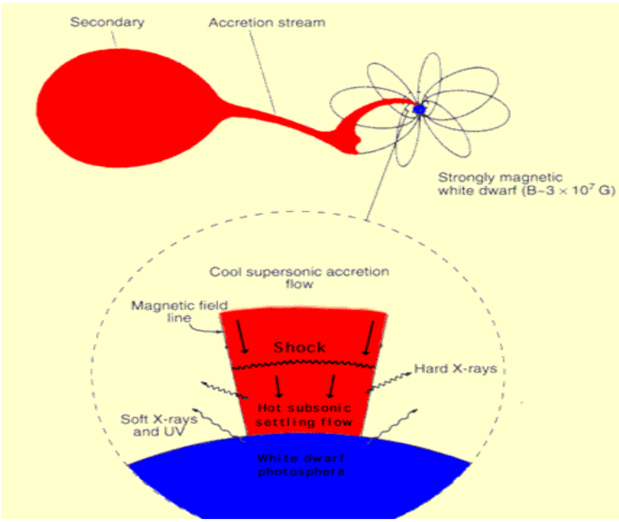
MDP for the jet of Centaurus A
is 5% in 1 Ms in 5 regions.



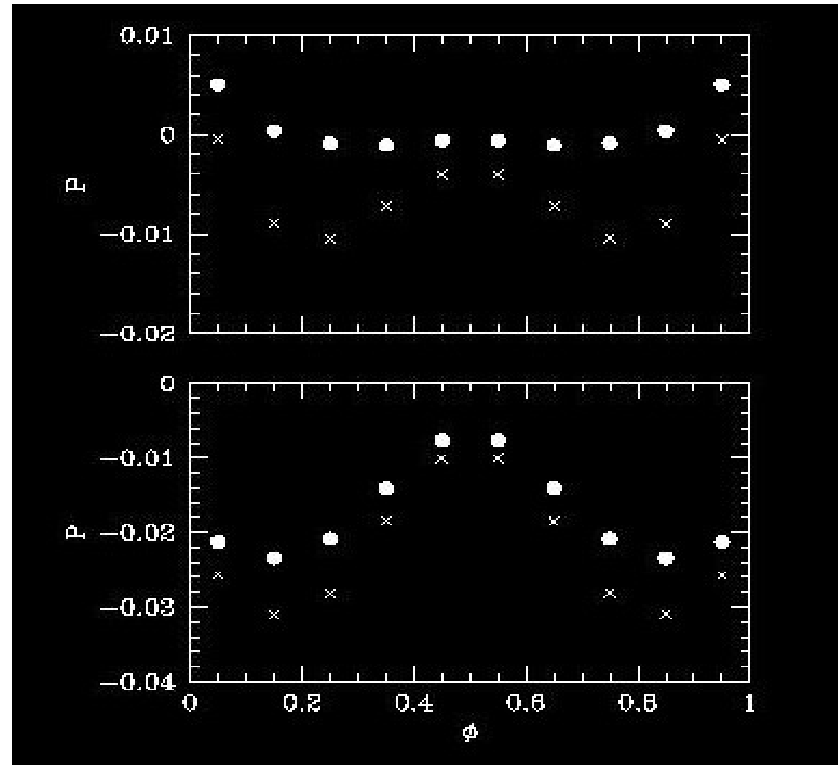
The extended (4') radio jet in Cen A.

XIPE scientific goals

Astrophysics: Strong Magnetic Fields: Cataclysmic variables



Accretion in Magnetic Cataclysmic Variables occurs in accretion column.
Main emission process is thermal bremsstrahlung, but scattering may be relevant. Polarization gives informations on the accretion mode (Matt 2004; McNamara et al, 2008)



Matt 2004

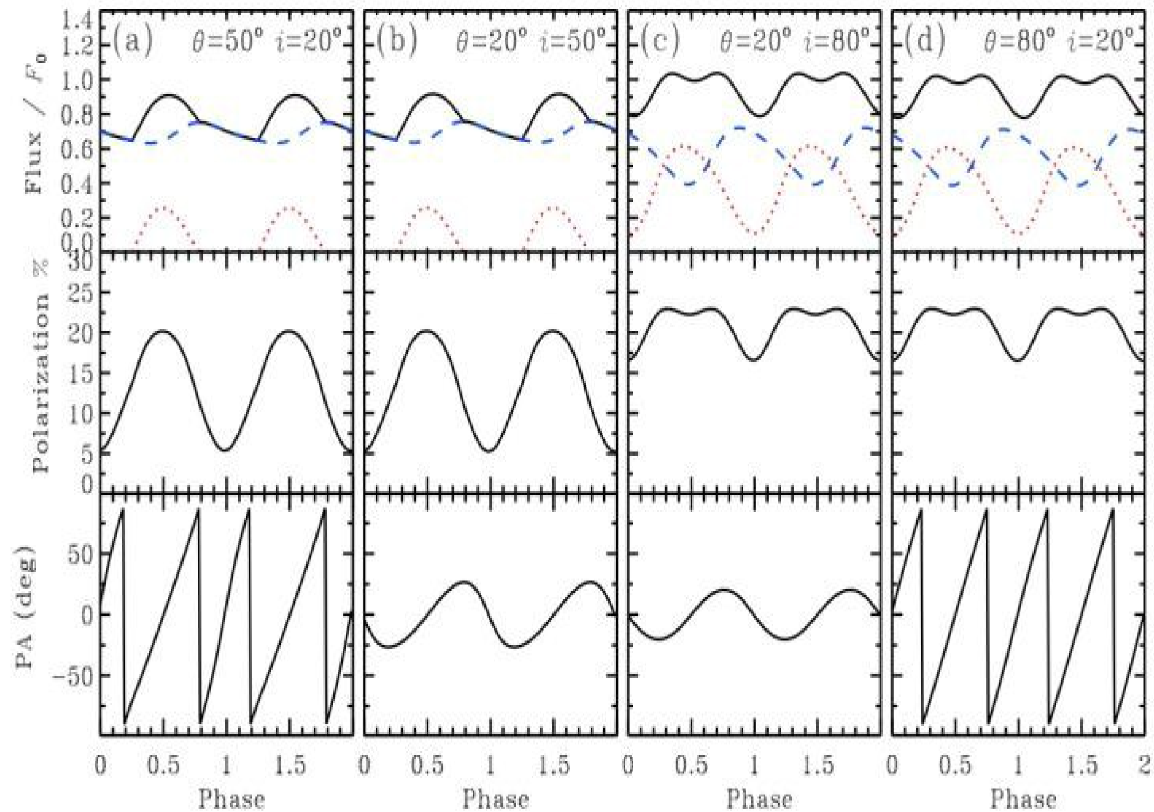
XIPE scientific goals

Astrophysics: Strong Magnetic Fields: Accreting Millisecond Pulsars

Emission due to scattering in hot spots

⇒

Phase-dependent linear polarization



Viironen & Poutanen 2004

XIPE scientific goals

Astrophysics: Strong Magnetic Fields: Accreting X-ray Pulsars

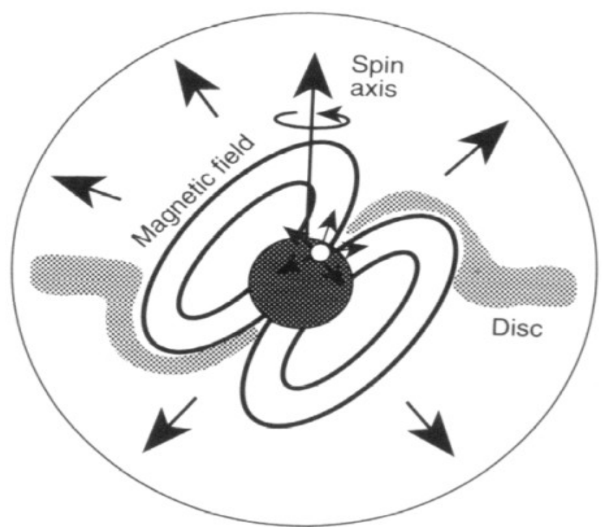
Opacity in highly magnetized plasma

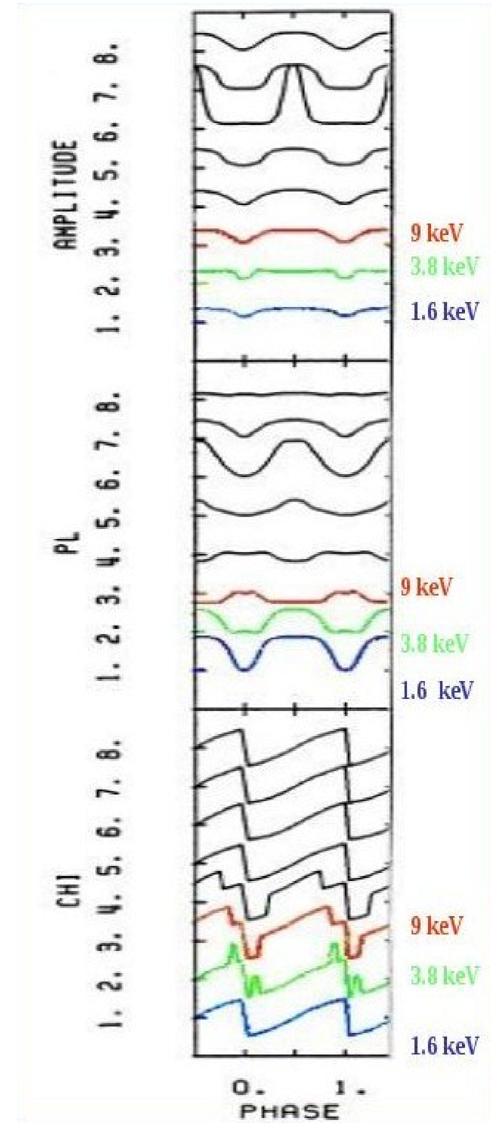
$$\Rightarrow \quad k_{\perp} \neq k_{\parallel}$$

Phase-dependent linear polarization

From the (phase-resolved) swing of the polarisation angle :

Orientation of the rotation axis and inclination of the magnetic field (required for many purposes, e.g. measure of mass/radius relation)

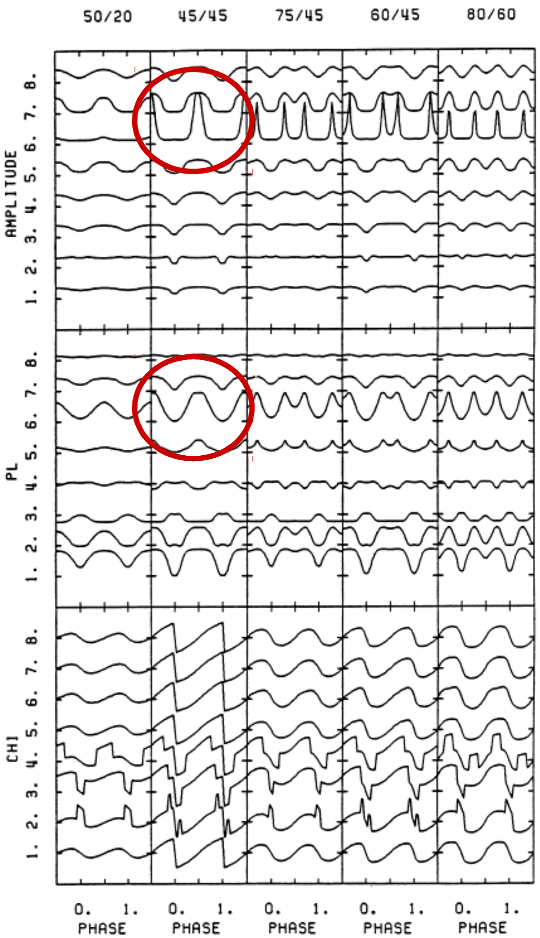




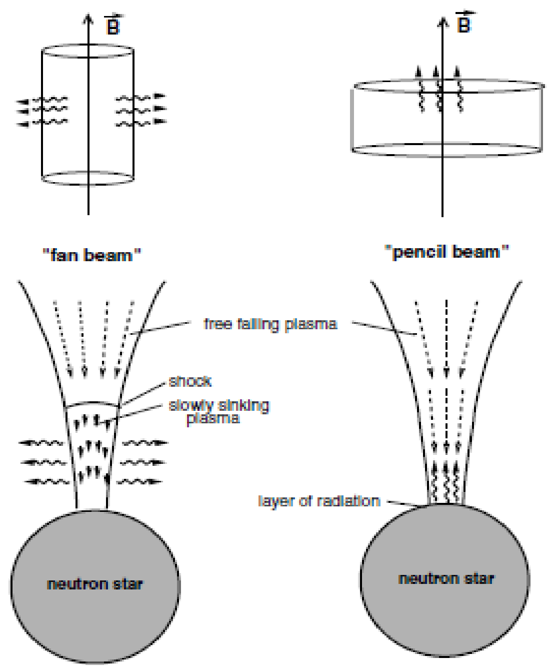
Meszaros et al. 1988

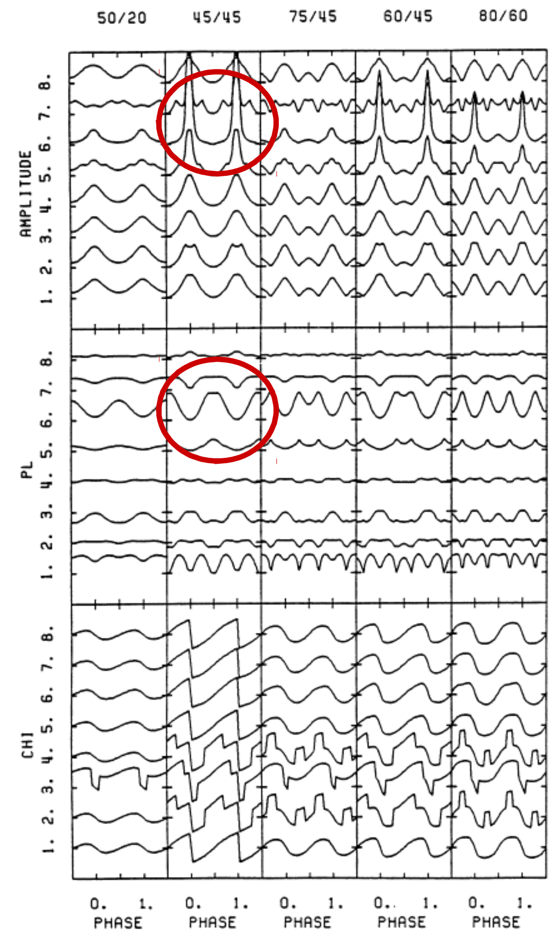
XIPE scientific goals

Astrophysics: Strong Magnetic Fields: Accreting X-ray Pulsars



“Fan” vs. “Pencil” beam





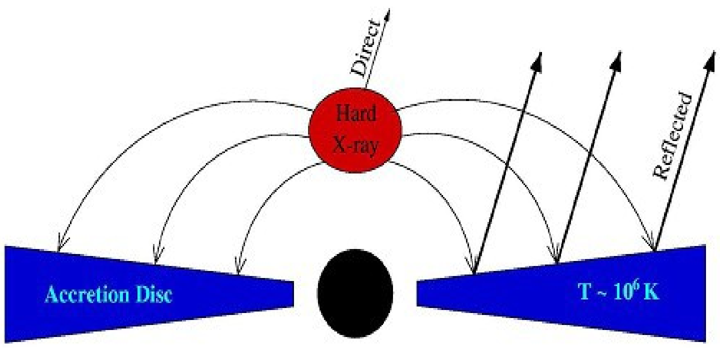
Meszaros et al. 1988

Astrophysics: Scattering: Coronae in X-ray binaries & AGN

The geometry of the hot corona, considered to be responsible for the (non-disc) X-ray emission in binaries and AGN, is largely unconstrained.

The geometry is related to the corona origin:

- Slab – high polarisation (up to more than 10%): disc instabilities?
- Sphere – very low polarisation: aborted jet?



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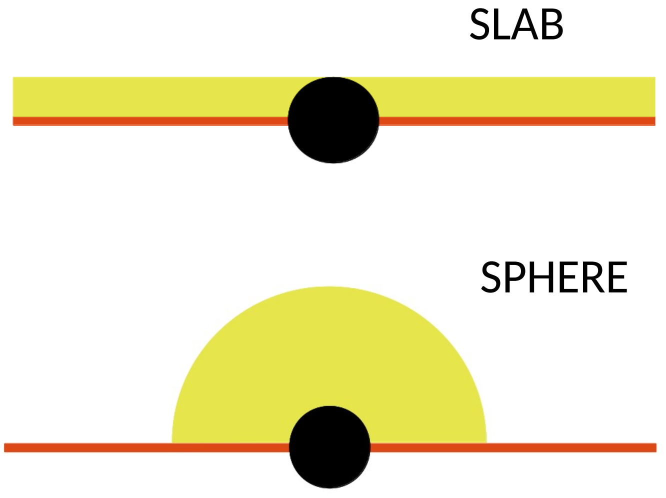


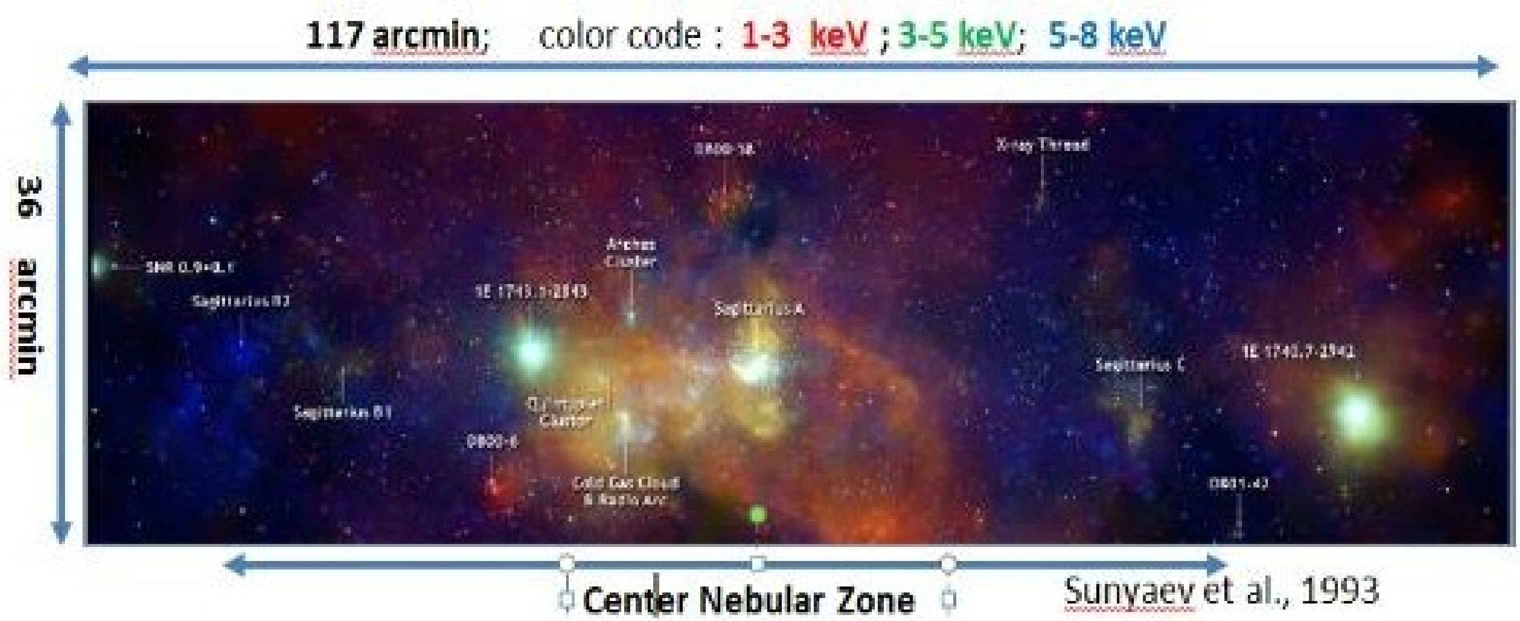
Marin & Tamborra 2014

XIPE scientific goals

Astrophysics: Scattering: X-ray reflection nebulae in the GC

Cold molecular clouds around Sgr A* (i.e. the supermassive black hole at the centre of our own Galaxy) show a neutral iron line and a Compton bump → Reflection from an external source!?!

No bright enough sources are in the surroundings. Are they reflecting X-rays from Sgr A*? so, was it one million times brighter a few hundreds years ago?
Polarimetry can tell!

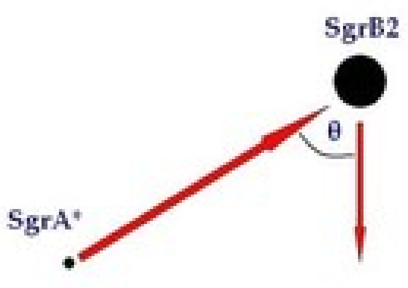


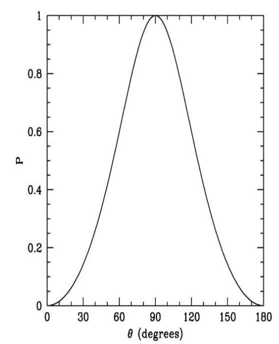
Astrophysics: Scattering: X-ray reflection nebulae in the GC

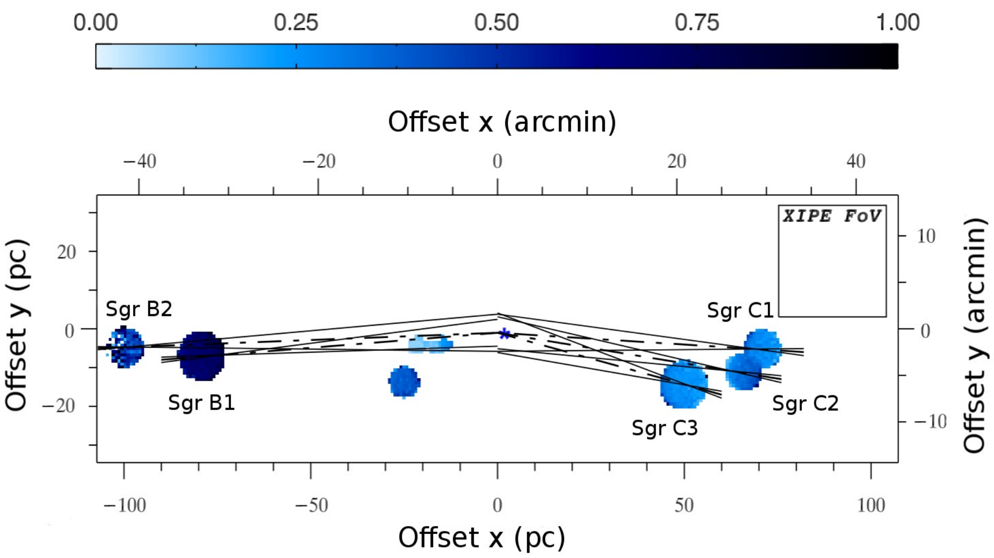
Polarization by scattering from Sgr B complex, Sgr C complex

- The angle of polarisation pinpoints the source of X-rays
- The degree of polarization measures the scattering angle and determines the true distance of the clouds from Sgr A*.

Marin et al. 2014







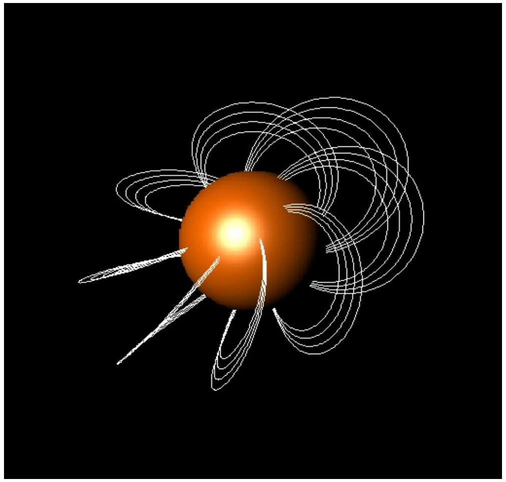
XIPE scientific goals

Fundamental Physics: Matter in extreme magnetic fields: QED effects

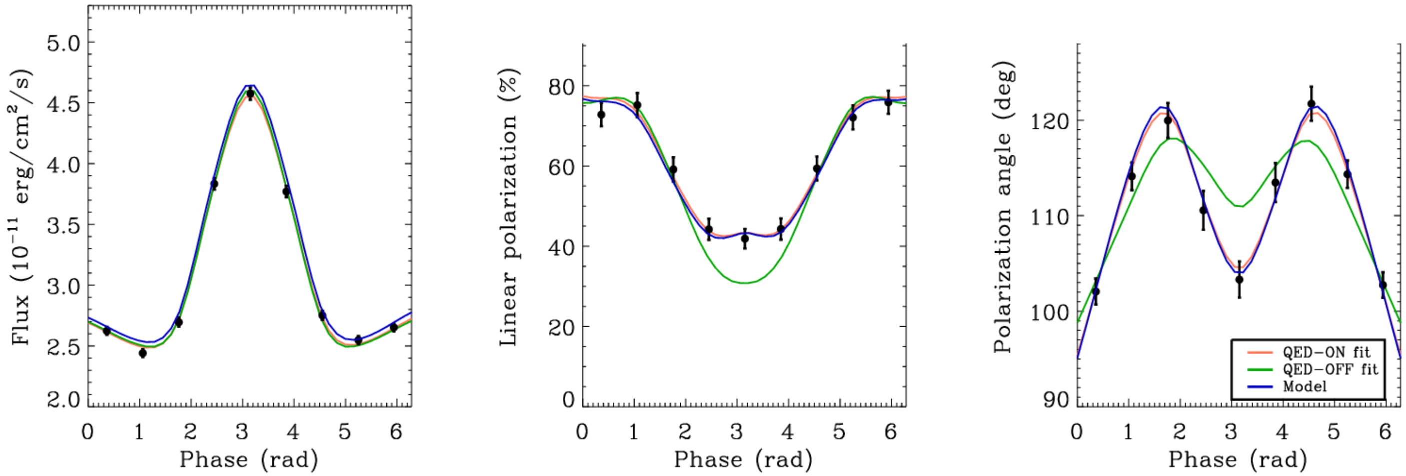
Magnetars are isolated neutron stars with likely a huge magnetic field (B up to 10^{15} Gauss).

It heats the star crust and explains why the X-ray luminosity largely exceeds the spin down energy loss.

QED foresees vacuum birefringence, an effect predicted 80 years ago (Eisenberg & Euler 1936), expected in such a strong magnetic field and never detected yet.



Light curve **Polarisation degree** **Polarisation angle**



Such an effect is **only** visible in the phase dependent polarization degree and angle.

XIPE scientific goals

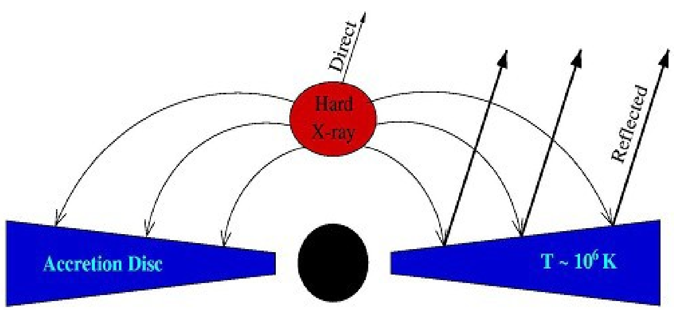
Fundamental Physics: Strong Gravitational Fields: GR effects in XRB

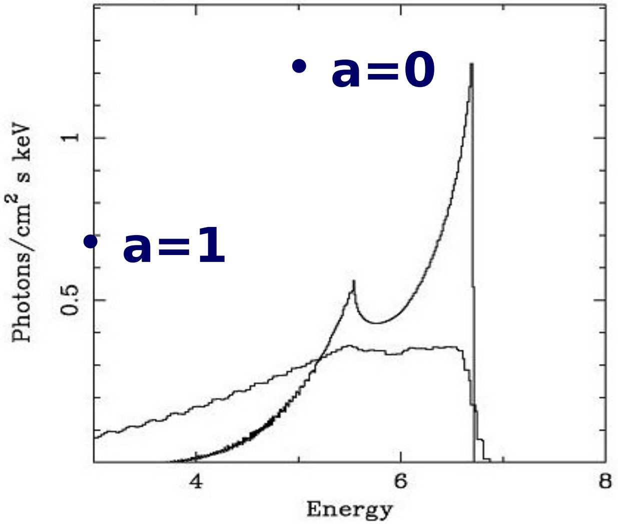
Black holes are fully characterized by their mass and angular momentum (spin, indicated with a) (+Q)

Knowledge of the spin tells us about the BH birth (in Galactic black holes) or the BH growth (in galaxies).

So far, three methods have been used to measure the BH spin in XRBs:

1. Relativistic reflection (still debated, requires accurate spectral decomposition);
2. Continuum fitting (requires knowledge of the BH mass, distance and inclination);
3. QPOs (all three QPOs required to completely determine the parameters, so far applied only to two sources).





XIPE scientific goals

Fundamental Physics: Strong Gravitational Fields: GR effects in XRB

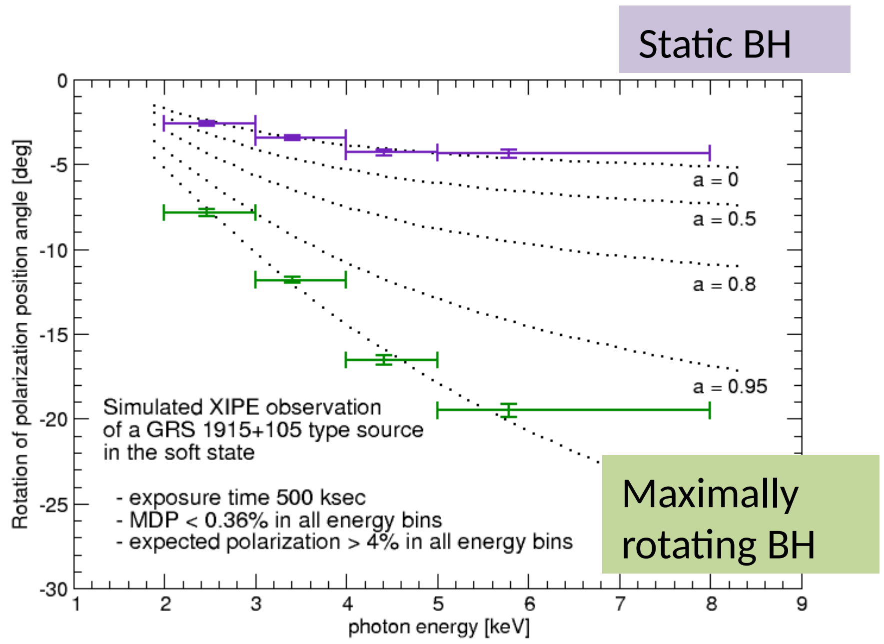
For a number of XRBs, the three methods do not agree!

Example: J1655-40:

QPO: a = J/Jmax = 0.290±0.003
Continuum: a = J/Jmax = 0.7±0.1
Iron line: a = J/Jmax > 0.95

Energy dependent rotation of the X-ray polarisation plane

- Two observables: polarisation degree & angle
- Two parameters: disc inclination & black hole spin



XIPE scientific goals

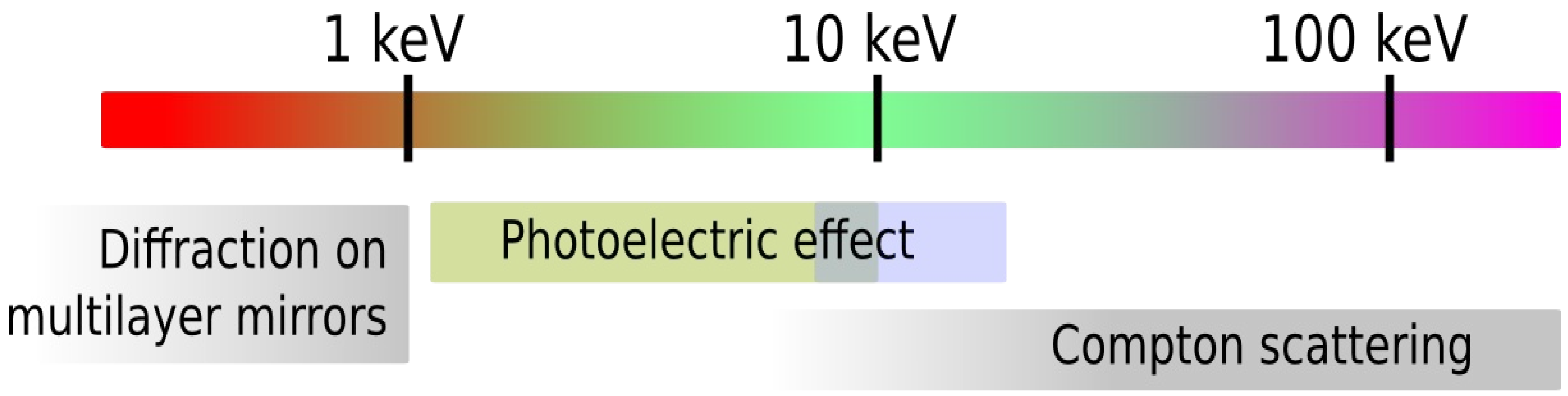
Fundamental Physics: Loop QG and search for Axion-like particles

Search for energy-dependent birefringence effects on distant polarized sources (e.g. Blazars) may put tighter constraint on
QG theories (e.g. Loop Quantum Gravity).

Variations of polarization angle and degree from sources in the background of large regions with significant magnetic field (eg clusters of galaxies) may indicate the presence of Axion-like particles, a candidate to be one of the dark matter main ingredients.

Very challenging measurements, but potentially very rewarding!!

The energy band



XIPE Science Requirements

The energy band

Scientific goal	Sources	< 1keV	1-10	> 10 keV
Acceleration phenomena	PWN	yes (but absorption)	yes	yes
	SNR	no	yes	yes
	Jet (Microquasars)	yes (but absorption)	yes	yes
	Jet (Blazars)	yes	yes	yes
Emission in strong magnetic fields	WD	yes (but absorption)	yes	difficult
	AMS	no	yes	yes
	X-ray pulsator	difficult	yes (no cyclotron)	yes
	Magnetar	yes (better)	yes	no
Scattering in aspherical geometries	Corona in XRB & AGNs	difficult	yes	yes (difficult)
	X-ray reflection nebulae	no	yes (long exposure)	yes
Fundamental Physics	QED (magnetar)	yes (better)	yes	no
	GR (BH)	no	yes	no
	QG (Blazars)	difficult	yes	yes
	Axions (Blazars, Clusters)	yes ?	yes	difficult

XIPE Science Requirements

General requirements

Parameter	Quantity	Scientific driver
Scientific requirements		
Polarimetric sensitivity	MDP<10% for 100ks observation of source with flux 2×10^{-11} erg/s/cm^2 (1 mCrab) in the 2-8 keV band	NGC1068, GC, …
Spurious polarization	<0.5%	GRS1915, Cyg X-1
Angular resolution	<30 arcsec	Crab, jet in CenA, SNR, GC, …
Field of View	>10 arcmin	PWNe, SNRs, …
Spectral resolution	<20% at 5.9 keV	Black hole spin
Timing resolution	8 µs	Accreting millisecond pulsars
Timing synchronization with the Universal Time	10 µs	Accreting millisecond pulsars
Dead time for one telescope	<100 µs	Crab Nebula, Cyg X-1, …
Mission duration	3 yr	Core program and population studies
TOO	Repointing <12 hr during working hours	Bursters
Sky accessibility	1/3 of the sky accessible at any time	Observation of galactic and extragalactic sources
Forbidden directions	None over one year	Core program and population studies

XIPE Science Requirements

Payload and mission requirements

	Payload requirements	
Total collecting area	>1100 cm^2 at 3 keV	See Req-Sci-010
Modulation factor	>30% at 3 keV	See Req-Sci-010
Detector efficiency	>10% at 3 keV	See Req-Sci-010
	High Level Mission Requirements	
Orbit	LEO, altitude<600 km, inclination<6°	Background for GC
Absolute Pointing Error (APE)	≤1 arcmin	SNR, PWNe, …
Absolute Pointing Drift (APD)	≤1 arcmin	SNR, PWNe, …
Relative Pointing Error (RPE)	≤1 arcmin	SNR, PWNe, …
Absolute Measurement Accuracy (AMA)	≤10 arcsec/5 Hz	SNR, PWNe, …
Observation length	5 ks – 2 Ms	Crab – GC
Number of pointings	150/year	Population studies
Telescope optical axis mutual alignment	<3 arcmin	SNR, PWNe, …
Telescope optical axis alignment to the	<2 arcmin	SNR, PWNe, …

XIPE Observing Plan

How many sources?

Target Class	Ttot (days)	Tobs/ source (Ms)	MDP (%)	Number in 3 years	Number available
AGN	219	0.3	< 5	73	127
XRBs (low+high mass)	91	0.1	< 3	91	160
SNRe	80	1.0	< 15 % (10 regions)	8	8
PWN	30	0.5	<10 % (more than 5 regions)	6	6
Magnetars	50	0.5	< 10 % (in more than 5 bins)	10	10
Molecular clouds	30	1-2	< 10 %	2 complexes or 5 clouds	2 complexes or 5 clouds
Total	**500**			**193**	**316**

XIPE Observing Plan

First six months observing plan

Object	Class	$F_{2\text{-}8\,keV}$ (10^{-11} cgs)	T_{exp} (ks)	MDP (%) or ΔP/Δφ	Expected Polarization	Science goal
Crab Nebula	PWN	1950	20	ΔP<1% and Δφ <1deg	>19% (Weisskopf et al. 1978, Volpi et al. 2008)	Map of the Nebula
Vela PWN	PWN	6.0	100	MDP=6.0%	>10% (Volpi et al. 2008)	Mean polarization
Cas A	SNR	116	1000	MDP=3-5%	>10% in selected regions (Bykov et al. 2009, Fabiani et al. 2014)	Map of the remnant
Cyg X-1	µQSO	1000	170	MDP=0.5%	<5%@2.6 keV (Weisskopf et al. 1977)	Jet, corona
Mrk 421	Blazar	27	100	MDP=3%	>10-20% (Poutanen 1994, Celotti & Matt 1994)	Jet
Cen A (jet)	Radiogalaxy	4	200	MDP=5%	>10-20% (Poutanen 1994, Celotti & Matt 1994)	Jet (spatially resolved)
Am Her	MCV	10	1000	MDP=3.0% /10 phase bins	5-10% (Matt 2004)	Accretion column
SAXJ1808	AMP	100	100	MDP=3.0% /10 phase bins	>5-10% (Viironen & Putanen 2004)	Scattering corona
Her X-1	LMXRB/ Pulsator	90	100	MDP=3.0% /10 phase bins	>10% (Meszaros et al. 1988)	Fan vs. Pencil beam
1RXS J1708	Magnetar	4	250	MDP=9.3% /10 phase bins	>50% (Taverna et al. 2014, Van Adelsberg & Lai 2006)	Vacuum polarization
GX 339-4 (outburst)	XRB	500	100	MDP=0.6%	>a few % (Schnittman & Krolik 2010)	Corona
GX 339-4 (quiescence)	XRB	4	1000	MDP=2.2%	Unknown	Corona
NGC 1068	AGN	0.5	1000	MDP=4%	10% (Goosmann & Matt 2011)	Torus geometry
IC4329A	AGN	10	100	MDP=3%	> a few % (Schnittman & Krolik 2010)	Corona
SGR B complex	Molecular cloud	0.3	1000	ΔP<4%, Δφ<3°	>40% (Churazov et al. 2002, Marin et al. submitted)	Past activity of SgrA*
GRS1915+105	µQSO	1300	500	ΔP<0.5% and Δφ <1 deg	>5% (Dovciak et al. 2008, Schnittman et al. 2009)	BH spin
MCG-6-30-15	AGN	4	1000	MDP=1.3%	5% (Dovciak et al. 2011)	BH spin

XIPE Design

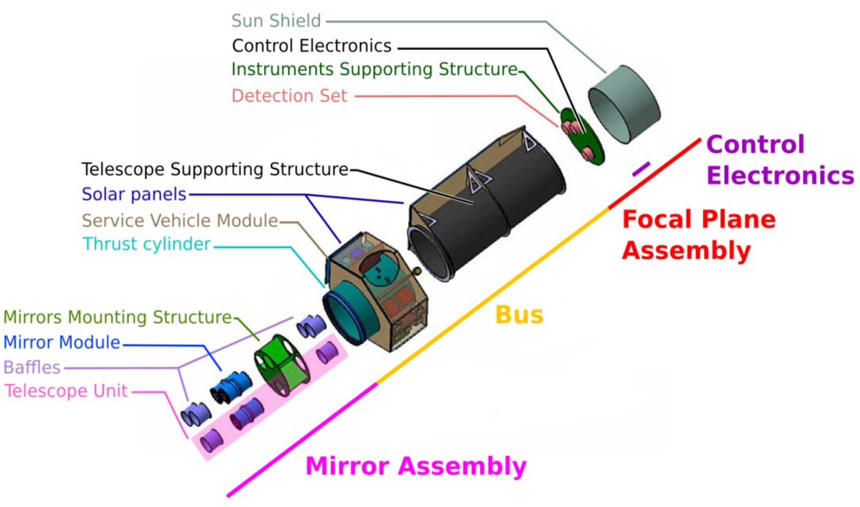
Overview

- Three telescopes with 3.5 m focal length to fit within the Vega fairing:

Long heritage: SAX → XMM → Swift → eROSITA → XIPE

- Pioneering, yet mature detectors: conventional proportional counter but with a revolutionary readout, already studied by ESA during XEUS/IXO.
- Mild mission requirements: 1 mm alignment, 1 arcmin pointing.

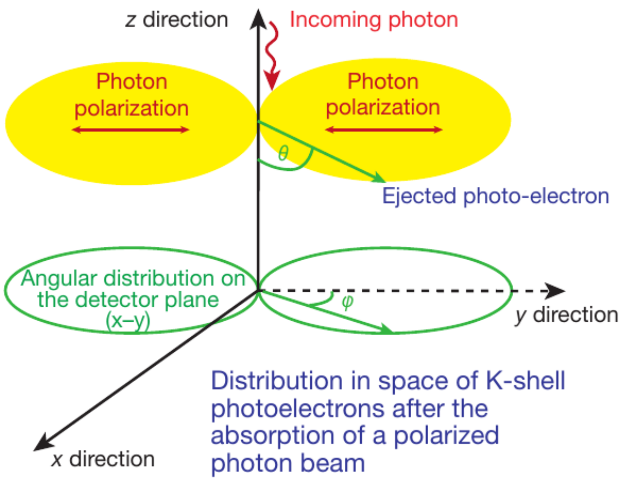
- Fixed solar panel. No deployable structure. No cryogenics. No movable part except for the filter wheels.
- Three years of nominal operation. No consumables.
- Optics designed by the XIPE consortium and procured by ESA; Focal Plane Assembly and Control Electronics procured by the XIPE consortium.



The Gax Pixel Detector

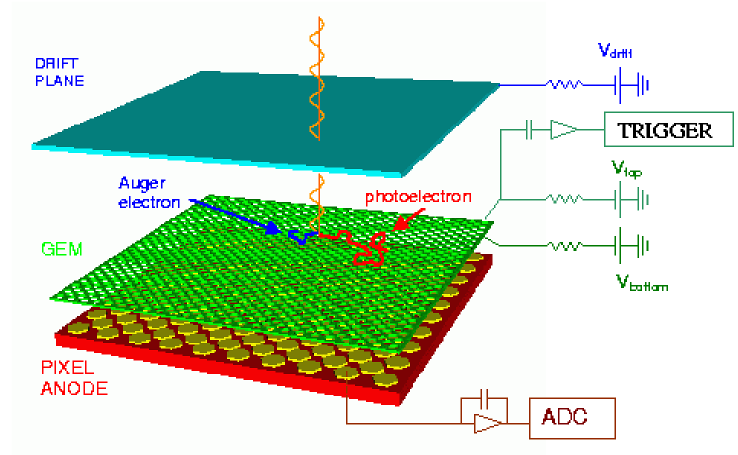
The Gas Pixel Detector (Costa et al. 2001, Bellazzini et al. 2006, 2007) is a polarization-sensitive instrument capable of imaging, timing and spectroscopy

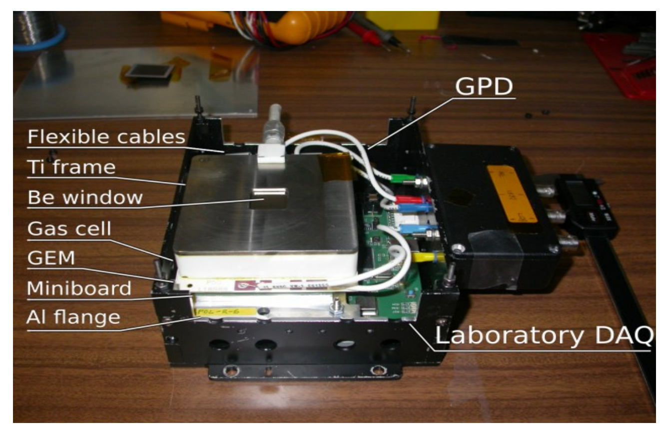
$$\frac{\partial\sigma}{\partial\Omega} = r_0^2 \frac{Z^5}{137^4}\left(\frac{mc^2}{h\nu}\right)^{7/2} \frac{4\sqrt{2}\sin^2(\theta)\cos^2(\varphi)}{(1-\beta\cos(\theta))^4}$$



The direction of the ejected photoelectron is **statistically** related to the polarisation of the absorbed photon.

The Gas Pixel Detector





XIPE Design

The Gax Pixel Detector

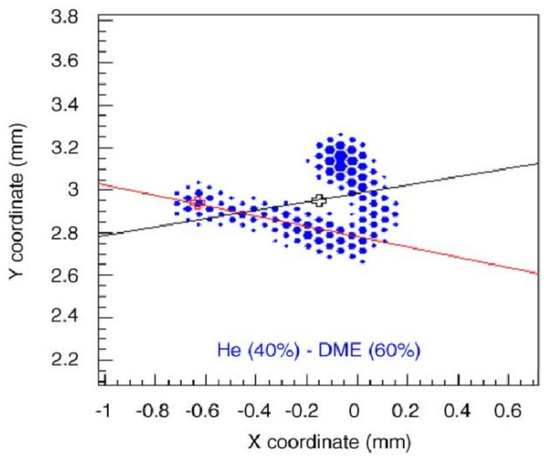
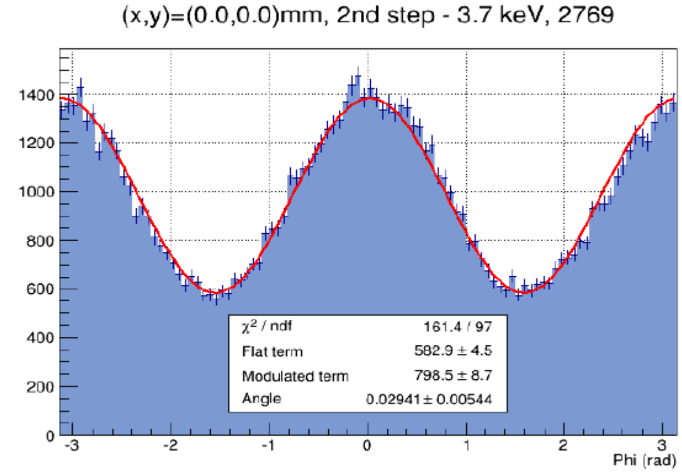
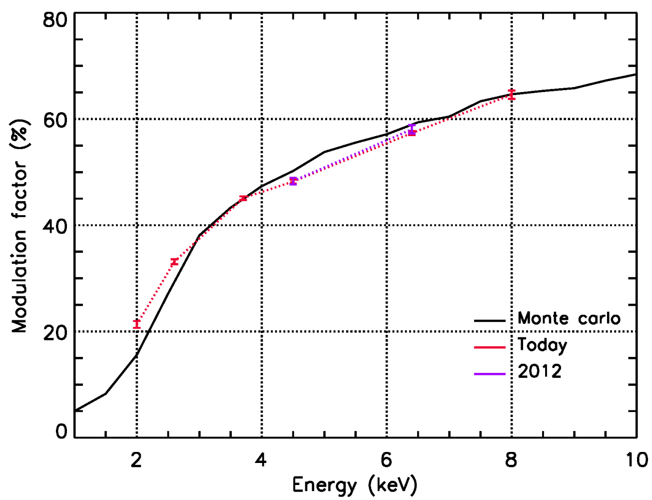


Image of a real photoelectron track. The use of the gas allows to resolve tracks in the X-ray energy band.

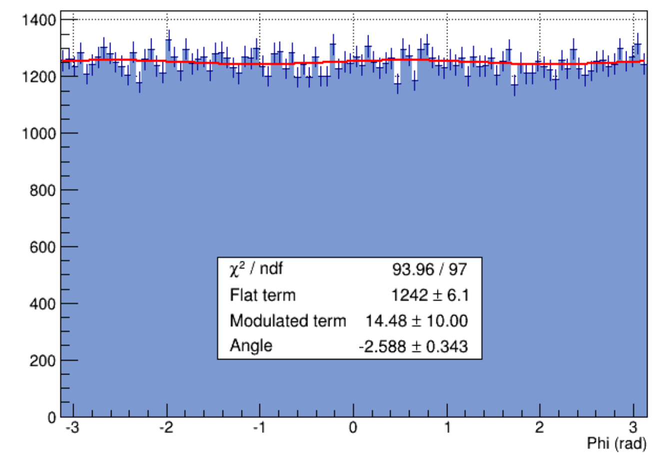


Real modulation curve derived from the measurement of the emission direction of the photoelectron.



Modulation factor as a function of energy.

Muleri et al. 2008, 2010

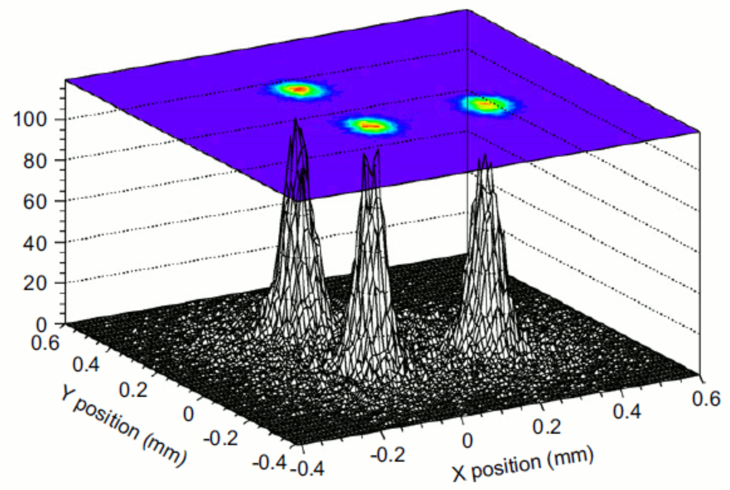


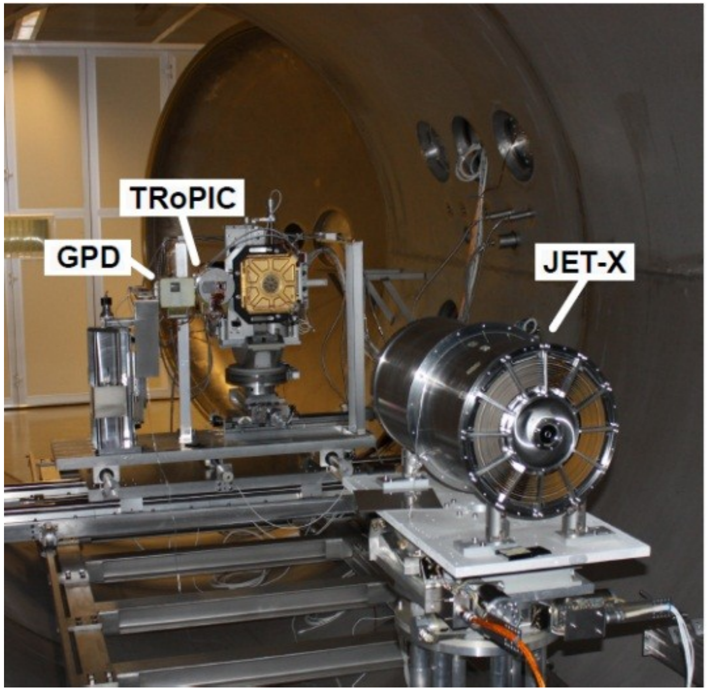
Residual modulation for unpolarized photons.

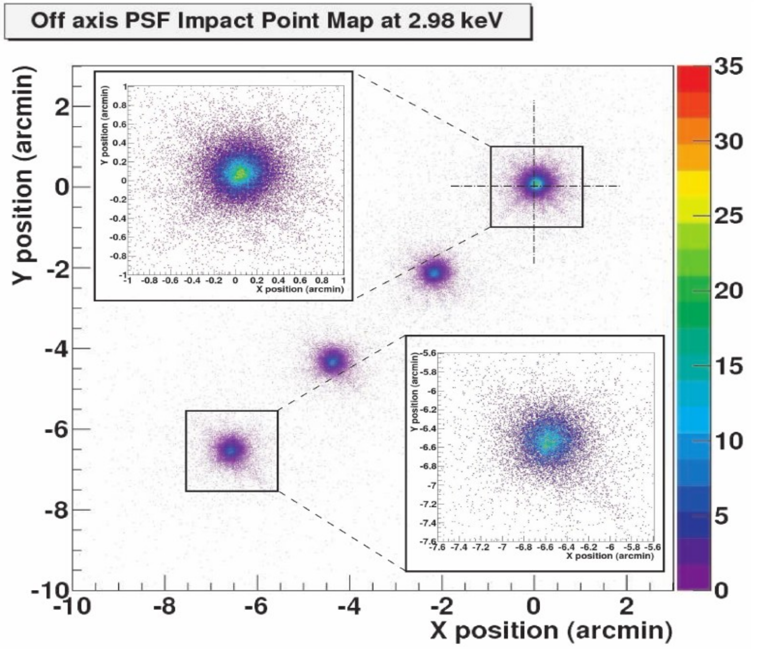
XIPE Design

Imaging capability

- Good spatial resolution: 90 µm HEW
- Imaging capabilities on- and off-axis measured at the PANTER X-ray testing facility of the MPE with a JET-X telescope (Fabiani et al. 2014)
- Angular resolution for XIPE: <26 arcsec

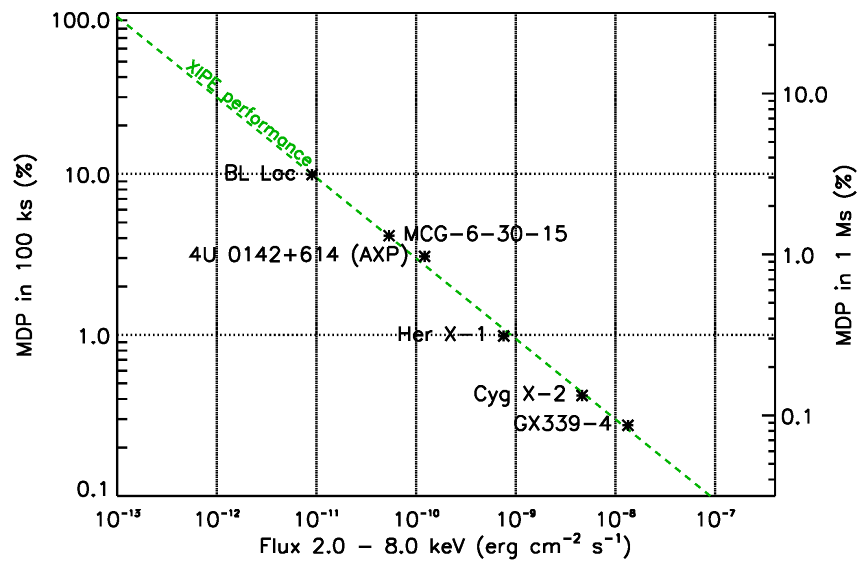






XIPE in a nutshell

Polarisation sensitivity	1.2% MDP for 2×10^{-10} erg/s cm2 (10 mCrab) in 300 ks **or** 6.7% MDP for 2x10-11 erg/s cm2 (1 mCrab) in 100 ks
Energy range	2-8 keV
Angular resolution	<26 arcsec (goal: 20 arcsec)
Field of View	15x15 $arcmin^2$
Spectral resolution	16% @ 5.9 keV
Timing	Resolution <8 µs
Dead time 200 µs	
Stability	>3 yr
Spurious polarization	<0.5 % (goal: <0.1%)
Background	2×10^{-6} c/s or 4 nCrab



$$MDP = \frac{4.29}{\mu\sqrt{S}}\frac{1}{\sqrt{T}}$$

The MDP is the minimum detectable polarisation at the 99% confidence level.

μ: modulation factor
S: collecting area
T: observing time

XIPE Team

XIPE Science Study Team

Soffitta Paolo (Lead Scientist) (INAF-IAPS, I)

Bellazzini Ronaldo (INFN-Pi, I)

Courvoisier Thierry (University of Geneva, CH)

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Matt Giorgio (Univ. Roma Tre, I)

Reglero Victor (Univ. of Valencia, E)

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Tagliaferri Gianpiero (INAF-OA Brera, I)

Vink Jacco (Univ. of Amsterdam, NL)

Zane Silvia (MSSL-UCL, UK)

XIPE Team

XIPE Science Working Groups

WG 1. Acceleration mechanisms (leaders: G. Tagliaferri, J. Vink)

WG1.1. Pulsar Wind Nebulae (chair: M. Weisskopf)
WG1.2. Supernova Remnants (chair: A. Bykov)
WG1.3. Blazars (chair: I. Agudo)
WG1.4. Microquasars (chair: E. Gallo)
WG1.5. Gamma-ray Bursts (chair: C. Mundell)
WG1.6. Tidal Disruption Events (chair: I. Donnarumma)
WG1.7. Active Stars (chair: N. Grosso)
WG1.8. Clusters of Galaxies (chair: S. Sazonov)

WG 2. Magnetic Fields in Compact Objects (leaders: A. Santangelo, S. Zane)

WG2.1. Cataclysmic Variables and Novae (chair: D. De Martino)
WG2.2. Accreting millisecond pulsars (chair: J. Poutanen)
WG2.3. Accreting X-ray Pulsars (chair: V. Doroshenko)
WG2.4. Magnetars (chair: R. Turolla)

WG 3. Scattering in Aspherical Geometries and Accretion Physics (leaders: E. Churazov, R.Goosmann)

WG3.1 X-ray binaries and QPOs (chair: J. Malzac)
WG3.2. Active Galactic Nuclei (chair: P.O. Petrucci)
WG3.3. Molecular Clouds and SgrA (chair: F. Marin)*
WG3.4. Ultraluminous X-ray sources (chair: H. Feng)

WG 4. Fundamental Physics (leaders: E. Costa, G. Matt)

WG4.1 QED and X-ray polarimetry (chair: R. Perna)
WG4.2. Strong Gravity (chair: J. Svoboda)
WG4.3. Quantum Gravity (chair: P. Kaaret)
WG4.4. Axion-like particles (chair: M. Roncadelli)

M4 Timeline

Activity	Date
Phase 0 kick-off	Jun-2015
Phase 0 completed (ARIEL, THOR, XIPE)	Oct-Nov 2015
ITT for Phase A industrial studies	Nov-2015
Phase A kick-off	Mar-2016
Preliminary Requirement Review completed	Apr-2017
Down-selection recommendation for M4 mission	May-2017
SPC selection of M4 mission	Jun-2017
Phase B1 kick-off for the selected M4 mission	Jul-2017
Phase B1 completed	Sep-2018
SPC adoption of M4 mission	Nov-2018
Phase B2/C/D kick-off	2019
Launch	2026

Table 1: Tentative timeline for M4 activities

How to pronounce XIPE?

In Aztec mythology and religion, Xipe Totec (/ˈʃiːpə ˈtoʊtɛk/; Classical Nahuatl:
Xīpe Totēc [ˈʃiːpe ˈtoteːkʷ]) ("Our Lord the Flayed One") was a life-death-rebirth deity, god of agriculture, vegetation, the east, disease, spring, goldsmiths, silversmiths, liberation and the seasons.

Xipe Totec is represented wearing flayed human skin, usually with the flayed skin of the hands falling loose from the wrists.

(from Wikipedia)

Sure the selecting committee will not dare disappointing so nice and kind god.....

Summary

XIPE will open a new observational window, adding the two missing observables in X-rays.

Many X-ray sources are aspherical and/or non-thermal emitters, so radiation must be highly polarised.

XIPE is simple and ready, using pioneering, yet mature, technology.

First XIPE Science Conference
Valencia, May 24-26, 2016