MICROSatellite-based COsmic Polarization Explorer

MICROSCOPE

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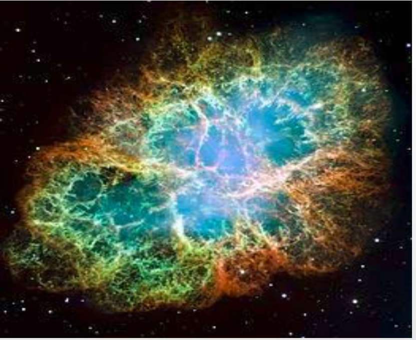
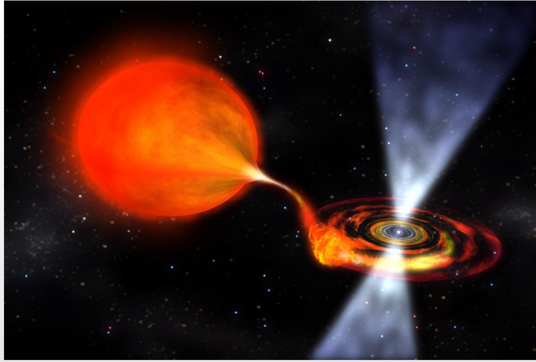


Why X-ray polarimetry?



Objects:

- Supernova Remnants;
- Pulsar Wind Nebulae
- Microquasars
- Accreting X-ray pulsars;
- Any jetted system, for that matter!

Observable effects:

- Probing emission in strong magnetic fields
- Differences between ICS/EC vs SSC in the jet for different states in microquasars
- Distinction between “pencil” and “fan” radiation patterns in X-ray pulsars
- Clean view of magnetized plasma dynamics the inner regions/ near the central engine
- Constraints on the magnetic field amplification mechanisms in DSA and much more….

Hard X-ray polarimetry can give us much more information about accretion and ejection geometry and metric around a compact object and opens up new parameter space!

Table 1. Polarimetry techniques and scientific goals for different energy bands.

	< 1 keV	1–10 keV	> 10 keV
Polarimetry techniques	•Diffraction	•Photoelectric effect, •Thomson scattering (from few keV)	•Photoelectric effect (up to tens of keV), •Thomson scattering (up to tens of keV), •Compton scattering (from few tens of keV)

Fabiani+2018

A Brief history of X-ray polarization missions

- **OSO-8 (1975):** Bragg reflection. Crab degree of polarization 19.2% ± 1.0% (Weisskopf+1976) and upper limits to a few other sources
- **CGRO (1991):** Crab
- **INTEGRAL (2002):** polarization of a few bright GRB, Crab
- **AstroSat CZTI (2015):** a few bright GRB, Crab (phase resolved), Cyg X-1 (ongoing)
- **POGO-plus** (balloon borne, 2018): Crab

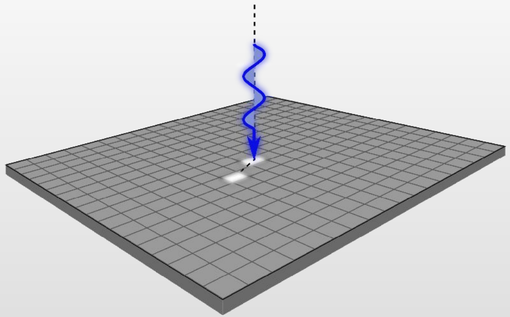
- **Why so serious(-ly little has been done)?**
- **Photon hungry nature, difficult to achieve**
- Most of these cases emerged as secondary objective

Polarization detection technique

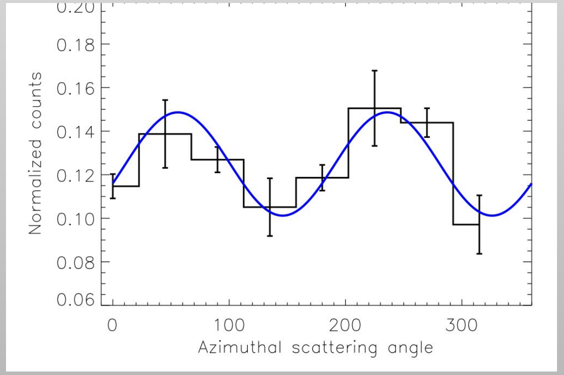
- Based on Compton scattering
- Polarized photons are scattered preferentially in the perpendicular to the direction of polarisation
- By measuring the azimuthal distribution of photons we can determine the angle of polarization.

$$C(\varphi) = A\cos(2(\varphi - \varphi_0 + \pi/2)) + B$$

- Already demonstrated technique on AstroSAT/CZTI and two phase on INTEGRAL/ IBIS.



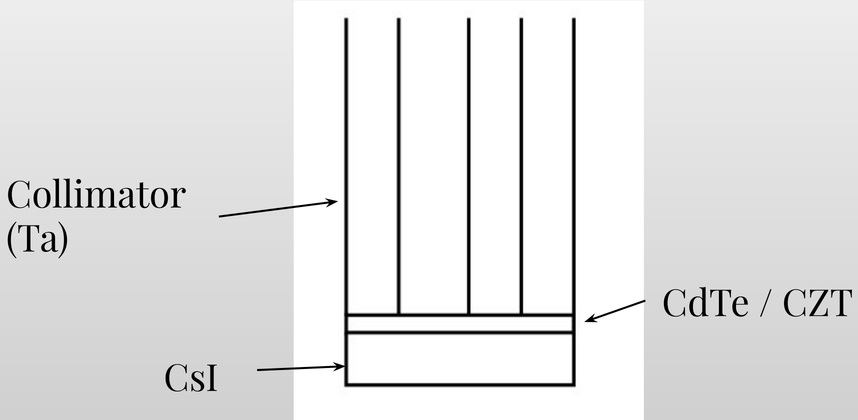
(Krawczynski et al., 2011; Lotti et al., 2012)



(Chattopadhyay et al, 2017)

Detector Configuration

- Cluster of 9 satellites
- 5 satellite observing at given time
- Total area of ~2000 cm^2



Specifications:

Targeted minimum flux	~100 mCrab 
Energy range	50-200 keV
Resolution	~ 1.6 keV @ 60 keV (CdTe / CZT)
Weight of each payload	10 kg
Time for each object*	~ a few Ms
Area of each detector	400 cm^2
Number of satellites	9 (5 always looking towards source), inspired by CAMELOT
Field of view	1x1 deg^2

* We will take into account time for background observation and source flux when planning the observation

Mission requirements

Satellite resources

- Microsatellite (30 kg) (DEFIANT platform)
- Payload up to 10 kg
- Navigation GPS, 5-10m
- Peak Power 25°C, BOL: 50 – 100 W

Estimated cost	
Instruments + Launch	<55M
Research	15M
Detector	<3M
Unpredicted corruption	50M
Total	**110M**

Medium mission

Launcher:

- Orbit and trajectories - LEO, altitude ~ 550 km)
- Life duration - 3 years

Bonus facts:

Anyone up for a secondary science objective?

- Beyond 100 keV, Tl becomes transparent.
- What do we get? An all-sky high energy transient monitor!
- Give us some more funding? Add trilateration facilities in each satellite, and voila!
- Immediate (rough) localization of GRBs (**Great Relativistic Bazookas**), great for GW follow-up and other usual stuff...

Some objects of interest:

- Crab nebula
- Cyg X-1
- GRS 1915+105
- GX 301-2
- Vela X-1
- Cyg X-3
- Any unanticipated SUPERbright X-ray binary and so on

Thank you!