XMM2ATHENA - Crossmatching Tools for MWL studies

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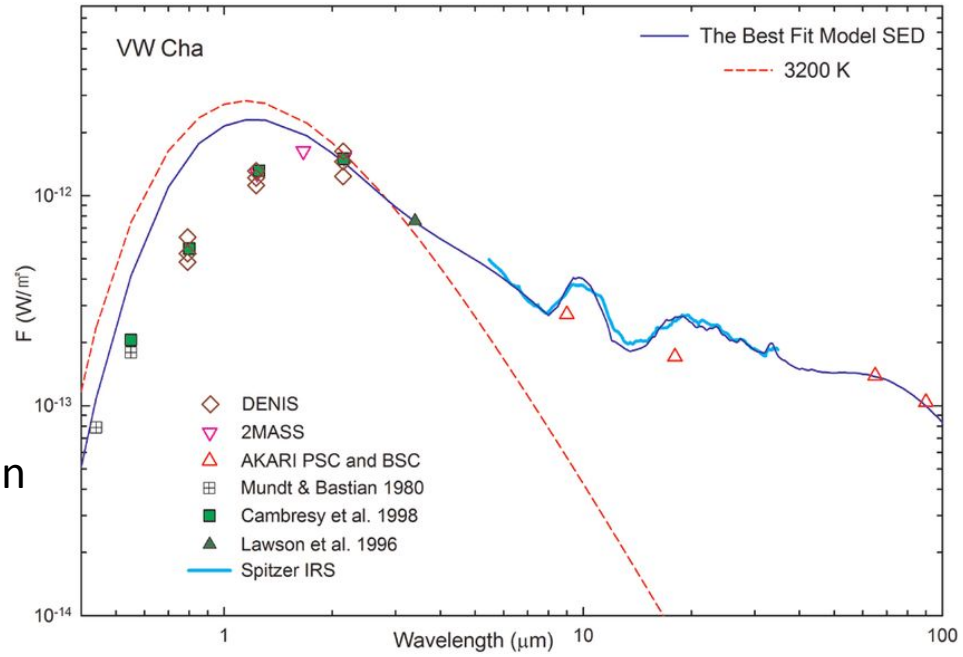
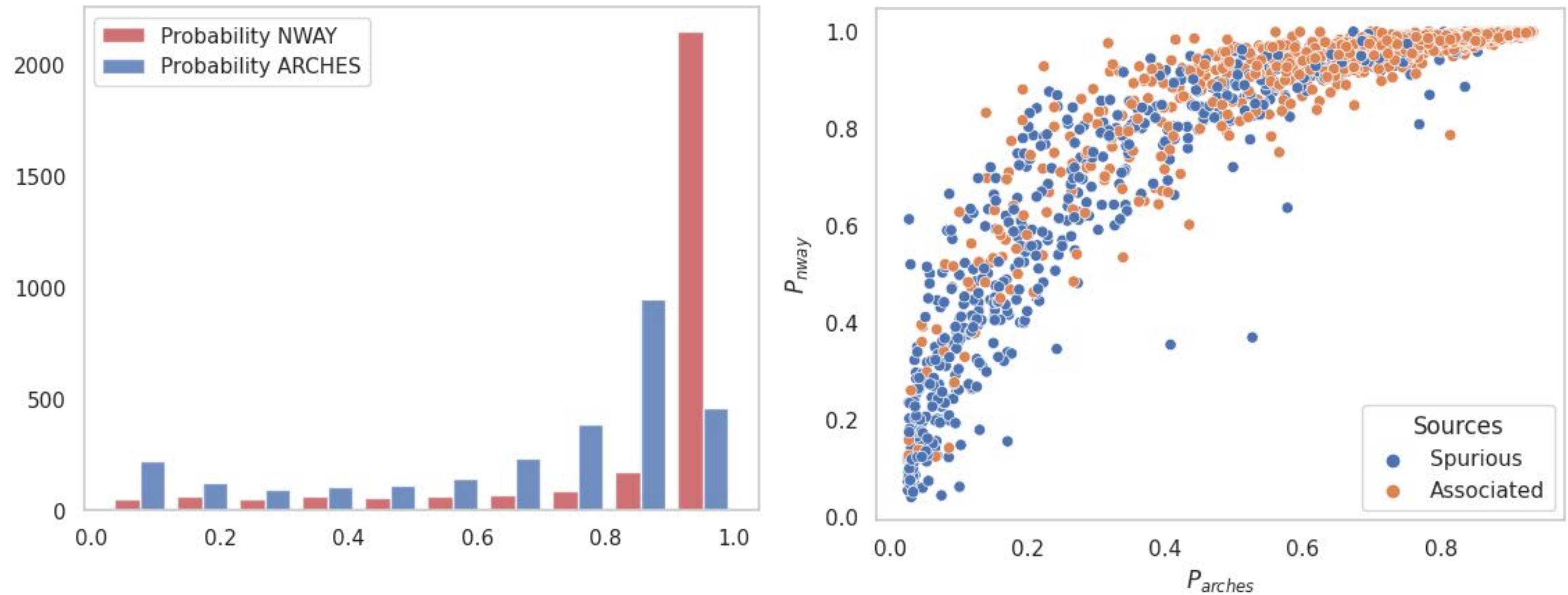
MWL Studies

- Physical processes have a characteristic fingerprint (shape)
- Different mechanisms dominate at different wavelengths
- Distribution of flux at different wavelengths - Spectral Energy Distribution
- Theory + observations provide physical information



Cross-matching tools - NWAY & ARCHES

- SED Challenge: to find counterparts: surveys obtained at different wavelengths have different spatial resolution
- NWAY cross-match requires surface area, radius (r_{max} … r_{max}), completeness (0.997)



NWAY assigns much higher probabilities to sources, and over-predicts the #associated sources.
At low and high probabilities, both NWAY and ARCHES follow a similar trend.

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Reliability & Completeness

Reliability refers to the accuracy of the matches found during the cross-matching process.

Completeness refers to the fraction of true astronomical objects that are successfully matched during the cross-matching process.

Two different ways of defining Reliability & Completeness: Based on # of sources (input) or based on probabilities

$$completeness = \frac{Number\ of\ associated\ sources\ above\ a\ threshold(P > P_{Threhold})}{Total\ number\ of\ associated\ sources}$$

$$Reliability = \frac{Number\ of\ associated\ sources\ above\ a\ threshold(P > P_{Threhold})}{Number\ of\ associated\ sources\ above\ a\ threshold + Number\ of\ spurious\ sources\ above\ a\ threshold}$$

$$completeness = \frac{Sum\ of\ probability\ \ above\ a\ threshold(P > P_{Threhold})}{sum\ of\ total\ probability^{*}\ (1/completeness\ factor)}$$

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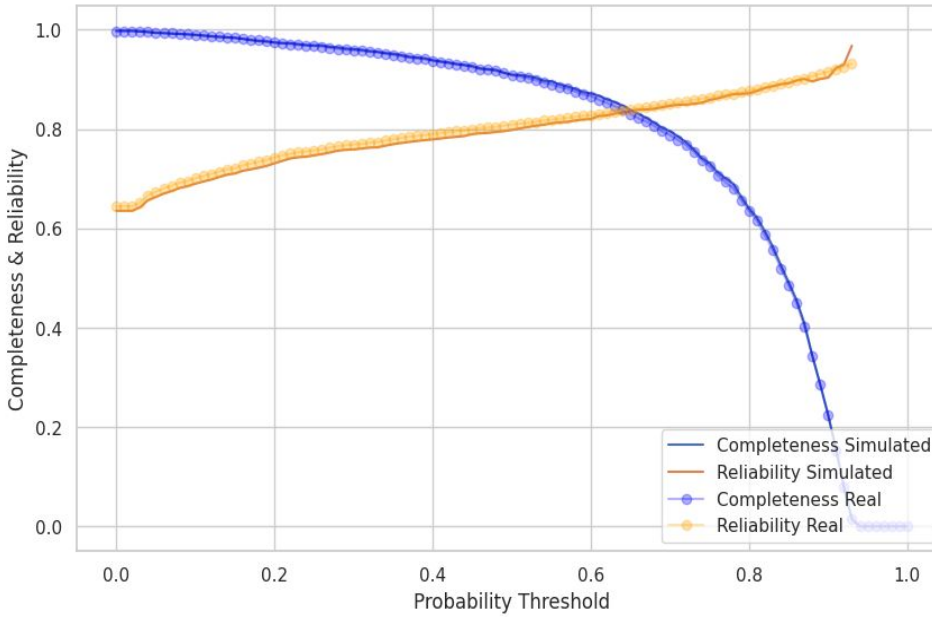
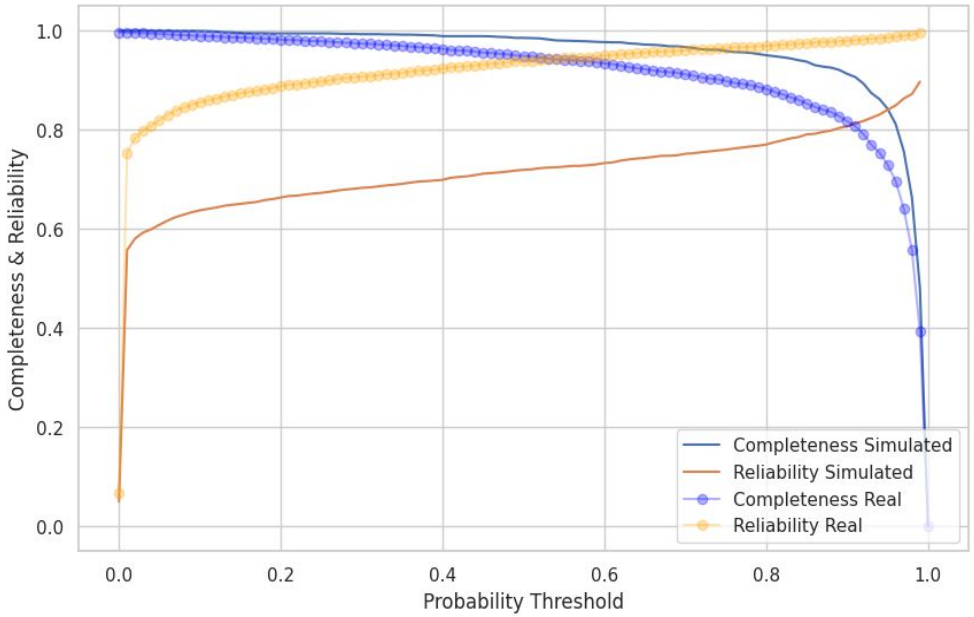
Reliability & Completeness

ARCHES



NWAY



For ARCHES, R & C curve follow the same trend for the two different cases

For NWAY, in the second case, the C drops a bit, however, the R shifts by 20% compared to the first case

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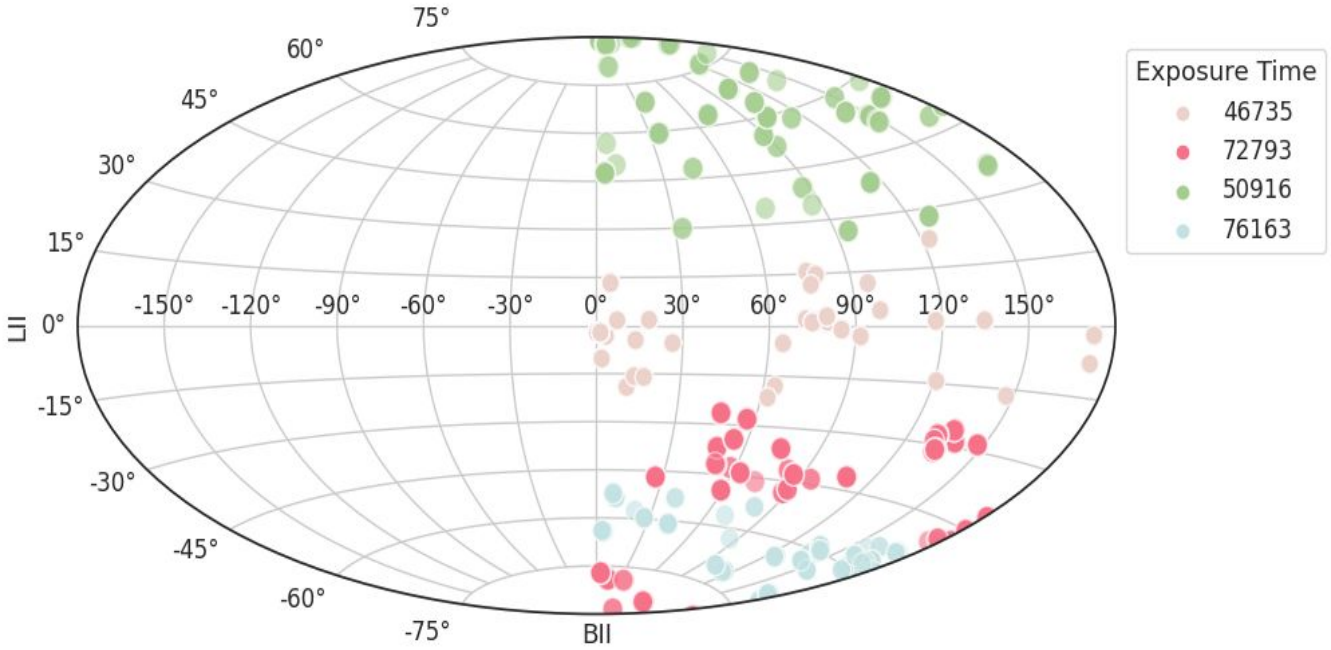
4XMM DR13 Catalogue

Aim - Creating a physically motivated X-ray catalogue of stellar objects in our Galaxy, given the limitations of the instrument.

- - 25 <= 'BII' <= 25
- 'BII' <= - 25 (without over density)
- 'BII' >= 25
- - 75 <= 'BII' <= - 50 (Over Density)

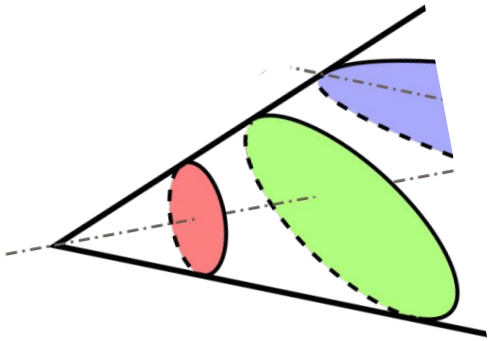
- Divided the sources based on flux intervals
- Effective area varies with flux and exposure time
- The exposure time can be assumed to be constant for a small flux range

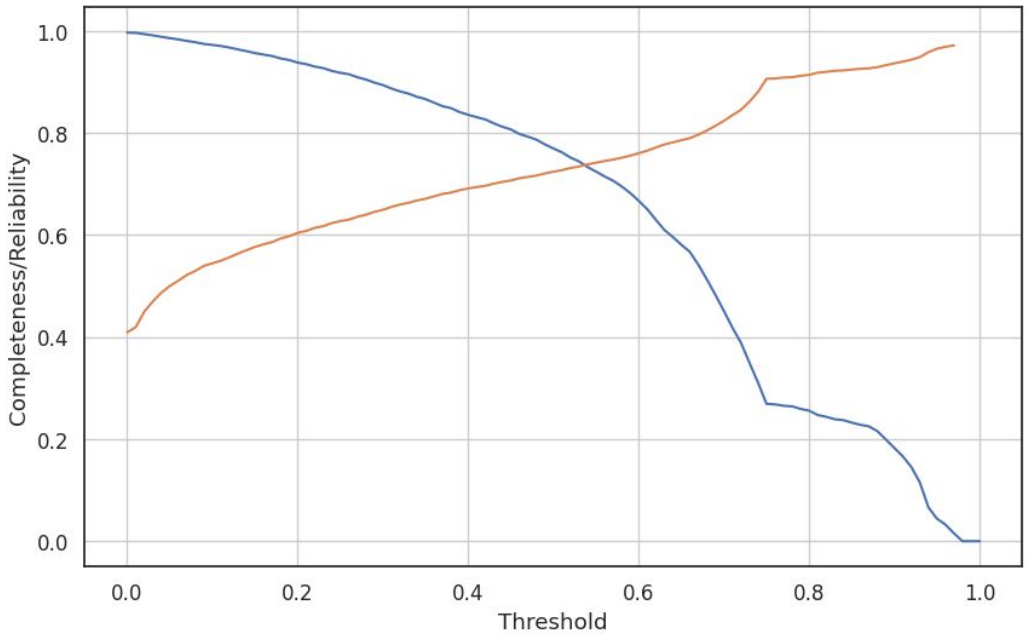
The preliminary study focuses on the first 100 unique observations coming from 4 different regions of the sky:



Cross-match XMM-DR13 & GAIA DR3 with ARCHES

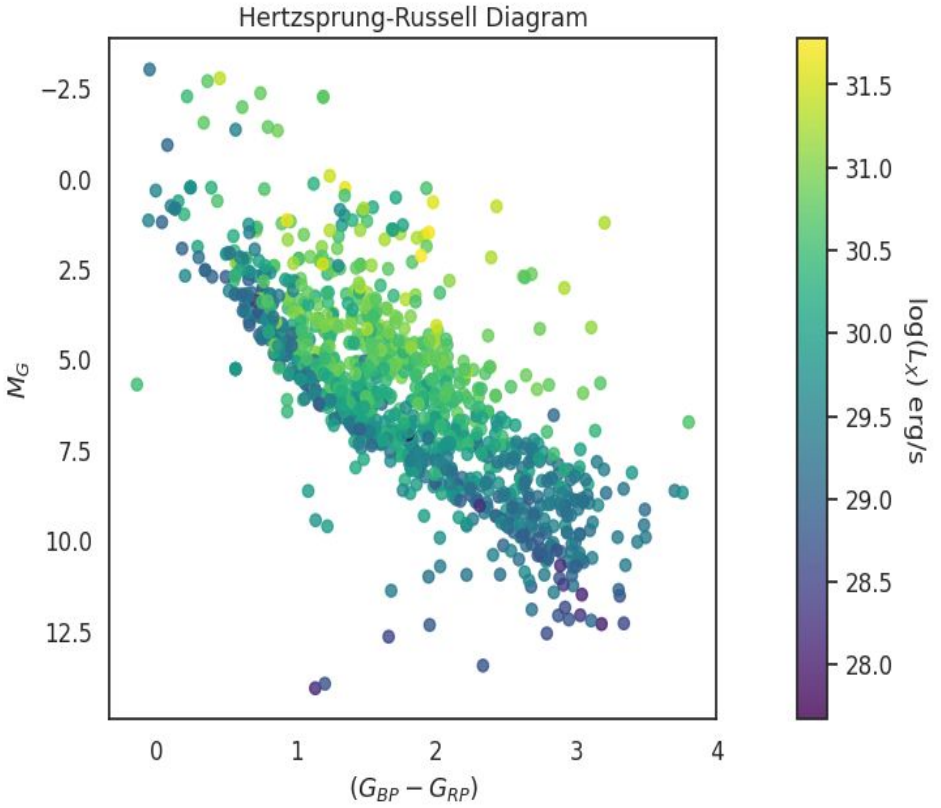
- A cone search (17’) around each unique OBSID was performed using Vizier to retrieve all potential GAIA counterparts
- Cross-match was performed using ARCHES
- R & C of 72% at a threshold of 0.56 (geometrical consideration)





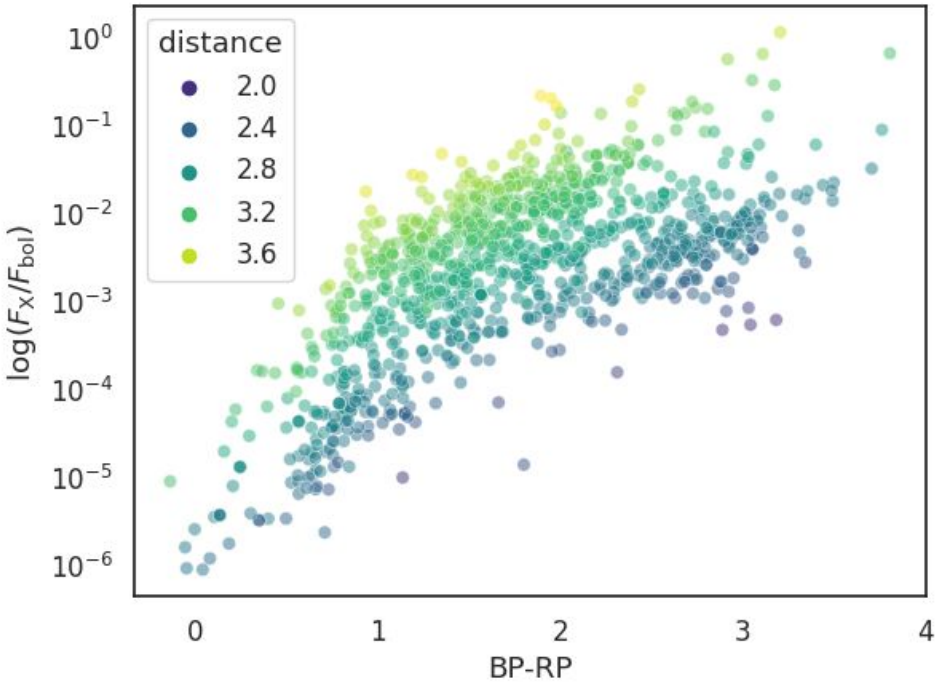
Physical Properties

- Colour-magnitude diagram (CMD) of XMM sources identified as stars
- The hue scales with X-ray Luminosity
- Our sample contains from early M-type to A-type.
- Most stars lie in the main-sequence branch with almost constant X-ray luminosities, with more luminous stars scattered towards the red giant branch. Red giants with Lx > 31 ergs/s - active binaries (RS CVn systems)
- Scatter below MS (Soft X-ray WD, Hard-X-ray - CVs)
- Aim to gather more information, need to study entire sample



Physical Properties

- Plot of X-ray to bolometric flux ratio as a function of the BP-RP colour of XMM sources identified as stars
- The hue scales with distance of the counterparts
- Our sample contains stars ranging from spectral type A to M
- F_X/F_{bol} distribution should peak around 10^{-3} , need to investigate why we don't see a similar trend
- $F_X/F_{bol} > 10^{-2}$; are often attributed to large flares

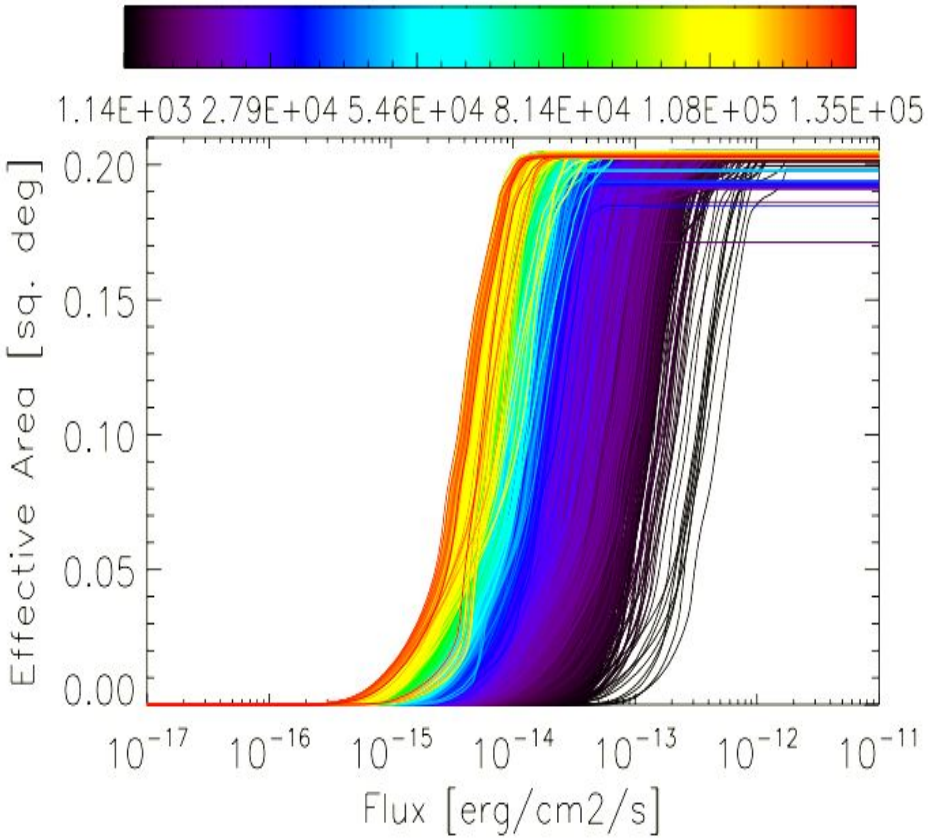


Future Studies

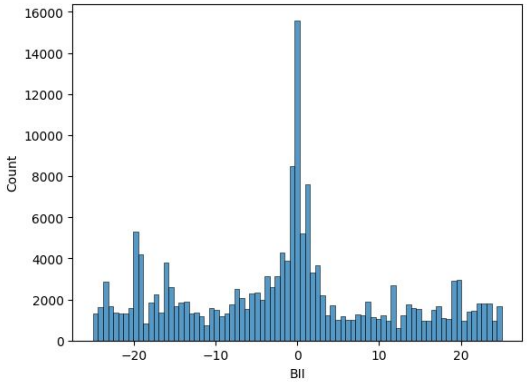
- Extend this study for the entire XMM DR13 Catalogue and perform population studies
- Perform MWL studies based on the resultant catalogue to characterise stellar objects in our Galaxy
- Introduce physical priors in the cross-matching process to increase R, such as proper motions, photometric data, expected shape of the SED and more.

Effective area VS Flux with a hue of Exposure time

- Effective area varies with energy and exposure time.
- Larger effective area →X-ray photons → higher observed flux → higher sensitivity to faint sources.
- The plot of the effective area with respect to the total flux for different exposure times is shown.
- As exposure time increases, fainter flux can be detected.
- The effective area can be assumed to be constant for a small energy range.



Dividing fields by BII



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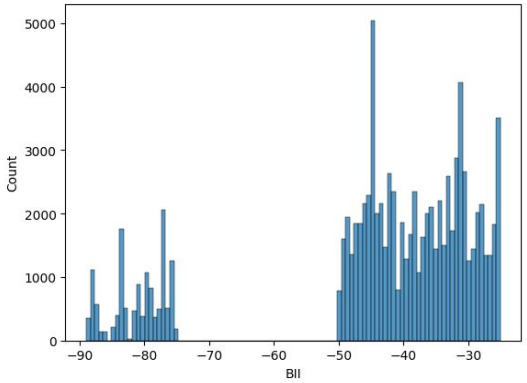

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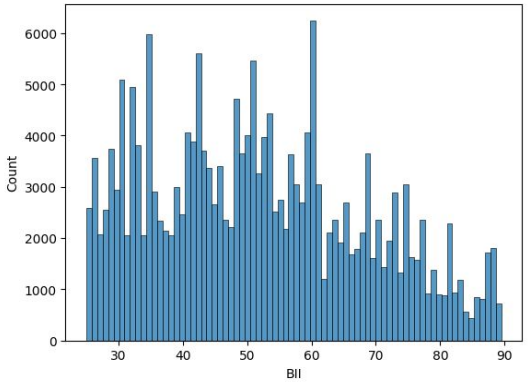

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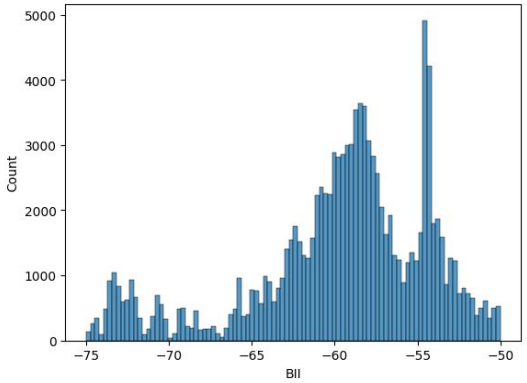

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