Population study of Accreting White Dwarfs in M33 based on X-ray emission

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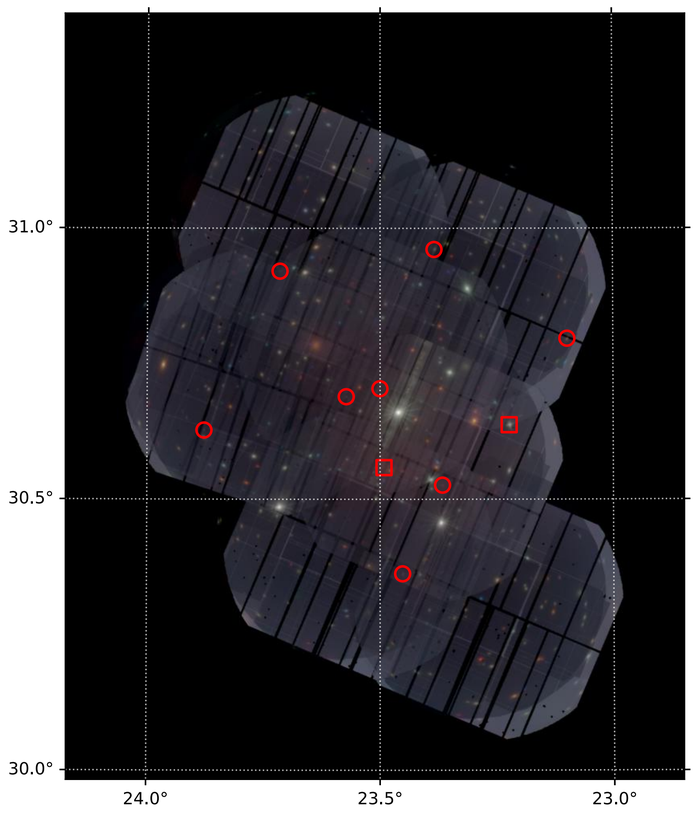
Preliminary Results:

In the ongoing investigation **10 X-Ray-Sources** have been identified which classify as candidates for **Accreting White Dwarfs**.

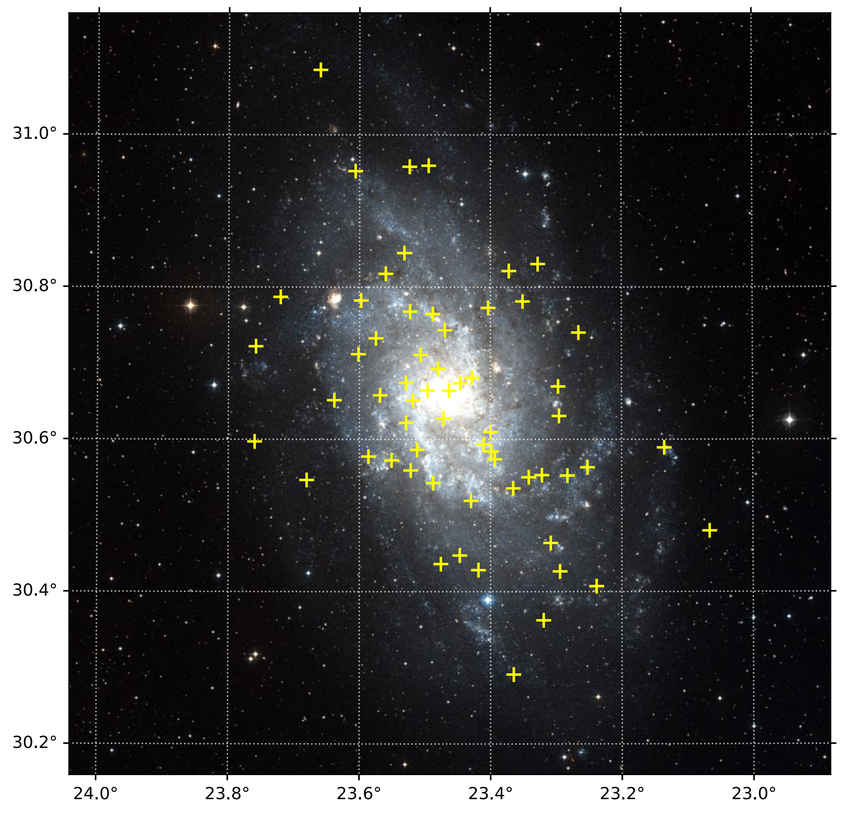
Abstract:

A common population of stellar endpoints in galaxies are **accreting white dwarfs (AWDs)**. This accretion of mass from another star onto the AWD causes outbursts known as **novae**. They are detected as a bright transient source in the optical. During an optical nova, it is possible that there is **an initial short, bright and luminous flash in X-rays**[1]. After the optical maximum, the hotter layers of the burning hydrogen become detectable and the spectral peak shifts to soft X-rays. In the nearby **M33 galaxy**, a population of novae hosting massive AWDs have been found in optical surveys[2]. M33 has also been observed entirely in X-rays, however, a dedicated **study of the population of accreting white dwarfs is still missing**. In this ongoing Master Thesis project, we perform such a study on M33 based on **XMM-Newton data**. We focus on compact objects and try to identify AWDs via catalog matching and hardness-ratio considerations. Characteristics of single AWDs can potentially be worked out. This poster gives an overview of the data processing and the results of this population study.



Nova Candidates in X-ray

XMM-Newton Image of M33 with vignetting and exposure corrected data from EPIC-PN, -MOS1 and -MOS2. The colors represent the energy range of red: 0.5 – 1.0 keV, green: 1.0 – 2.0 keV and blue: 2.0 – 4.5 keV. There are 8 Soft Sources (Red circles) and 2 Optical Cross-Matches that are Novae candidates.



Nova sightings in the Optical

Optical DSS2-RGB-Image of M33 with all historical Novae sightings (yellow crosses)[3]

Legend:

- Unclassified
- Stellar Object
- Foreground Star
- Background candidate
- Background AGN
- Nova Candidate
- Flux > 5e-13

X-ray-bands:

1: 0.2 – 0.5 keV
2: 0.5 – 1.0 keV
3: 1.0 – 2.0 keV
4: 2.0 – 4.5 keV
5: 4.5 – 12 keV

WISE-bands:

W1-center: 3.4 µm
W2-center: 4.6 µm
W3-center: 12 µm
W4-center: 22 µm

Methods:

Crossmatching and Classification:

The X-ray data set was crossmatched with various catalogues (AGN[4], Gaia[5], WISE[6], Nova MPE[3]) to find counterparts and classify the sources by filtering their properties.

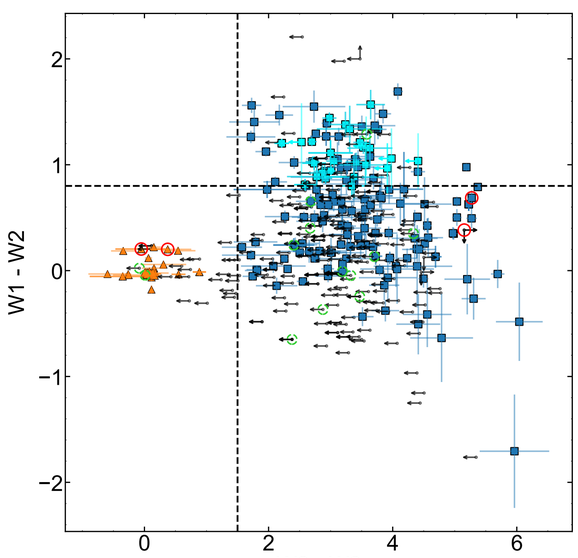
Hardness Ratio Investigations:

The emission of the sources in the X-ray data set was divided in 5 energy bands to investigate the ratios between the bands[9] and thus search for Soft Sources.

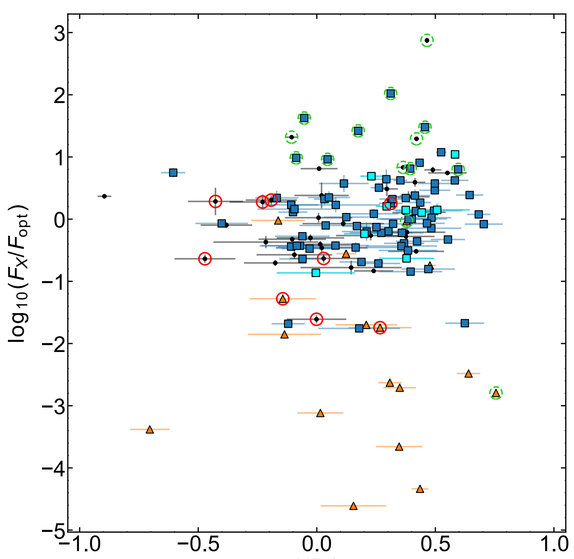
Classification[7]:

- Stellar Objects: W1 – W2 < 0.8 & W3 – W4 < 1.5 (according to Wright *et al.*[8])
- Foreground Stars: Stellar Object & Gaia-Match with valid distance
- Background Candidates: W3 – W4 > 1.5
- Background AGN: W1 – W2 > 0.8 & W3 – W4 > 1.5 & AGN-Crossmatch
- Soft Sources: High Detection Likelihood in Soft Bands and Low Detection Likelihood in Hard Bands
- Optical Nova Matches: Match with an optical historic Nova sighting
- Nova Candidates: Soft Source and/or Optical Nova Match

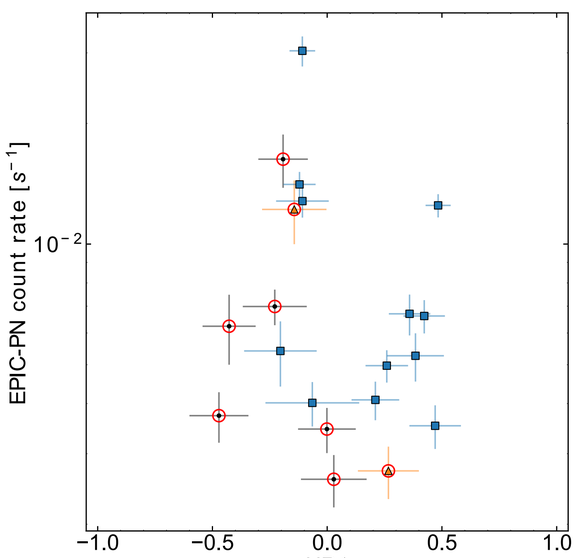
WISE-Color-Color-Diagram[8]

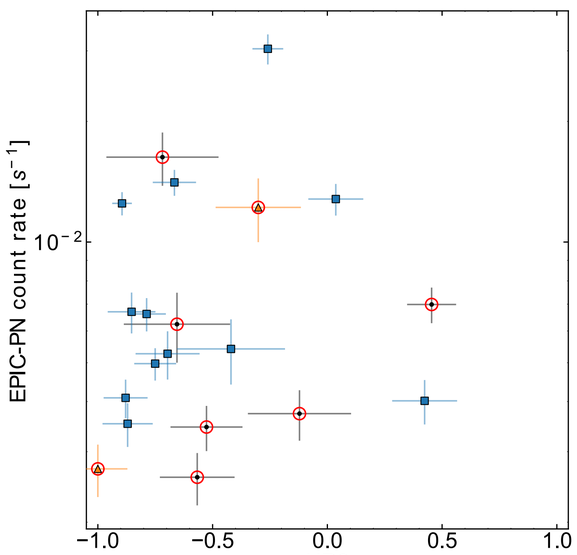


X-ray-to-optical-Flux-Ratio[9]

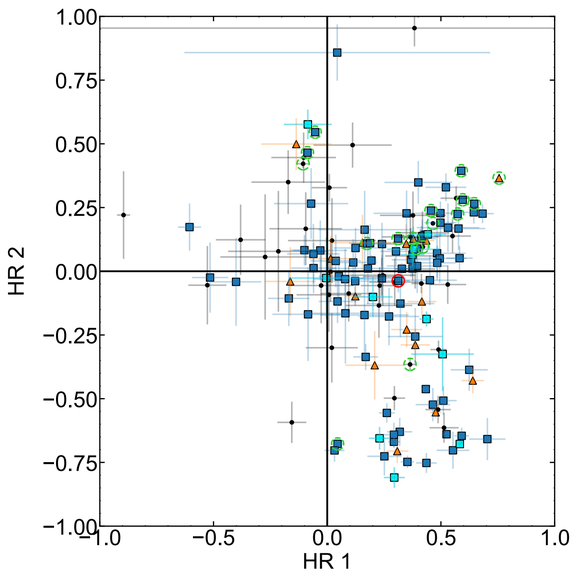


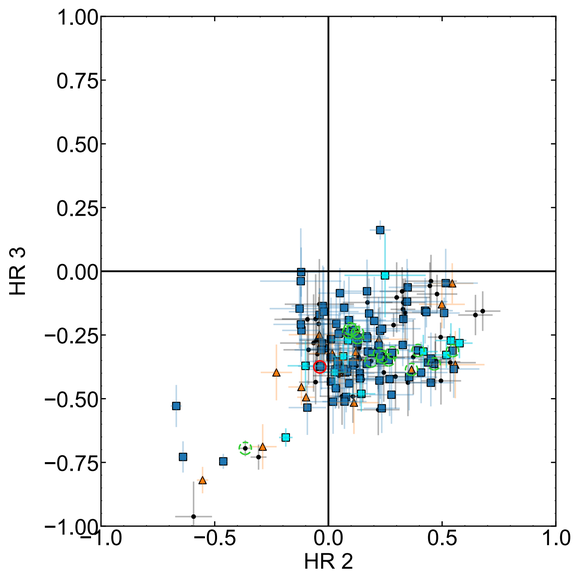
Soft Sources and their count rate

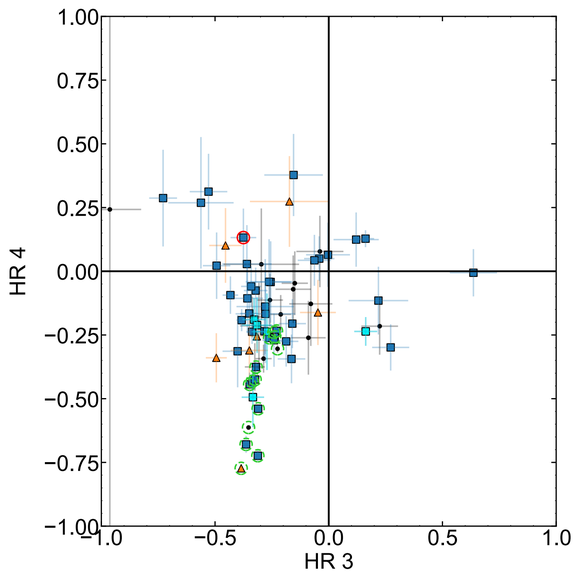




Hardness-Ratios of the X-ray data set[9]:







Sources:

- [1]König *et al* 2022, Nature, 605, 248
- [2]Shafter et al., 2012, ApJ, 752, 156
- [3]M33 Novae Table, Max-Planck-Institut für extraterrestrische Physik.
- [4]Flesch, E. W. (2023),, The Open Journal of Astrophysics, **6**, 49
- [5]Gaia Collaboration (2023), A&A, 674, A1.
- [6] Cutri, R. M., et al. (2013), *AllWISE Data Release*, IPAC/Caltech.
- [7]Sara Saeedi *et al* 2024 A&A Vol. 690, A152
- [8]Edward L. Wright *et al* 2010 *AJ* Vol. 140, 1868
- [9]Sara Saeedi *et al* 2015 A&A Vol. 586, A64