The Super-Eddington Outburst of CXOU J005245.0-722844:

Confirmation of a Rare Be/White Dwarf System in the Small Magellanic Cloud

Thomas Gaudin, Jamie Kennea, Malcolm Coe, Andrjez Udalski, Itumaleng Monangeng, David Buckley, Phil Evans

PSU Lunch Talk
9/17/24

X-ray Binaries: The Standard Theory

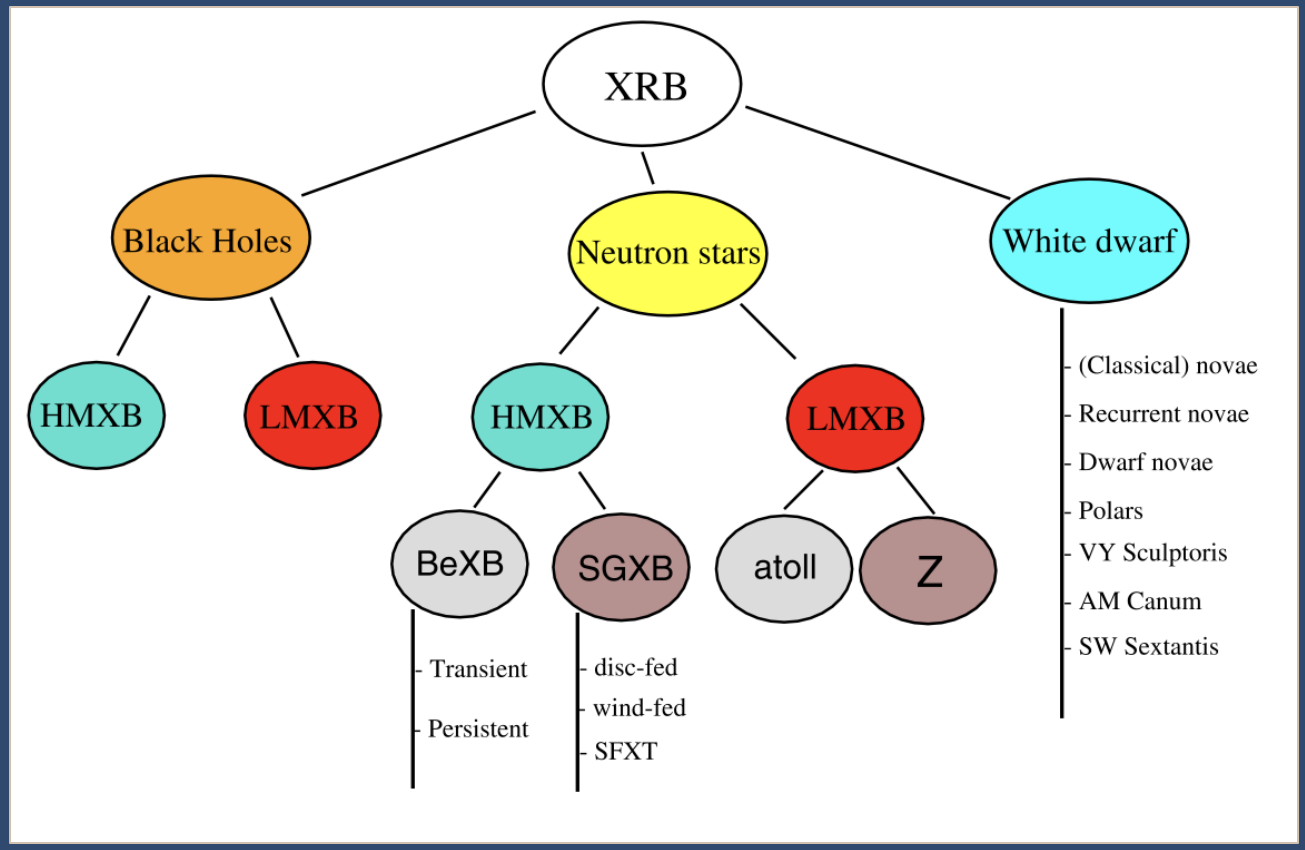

Image Credit: Reig 2011

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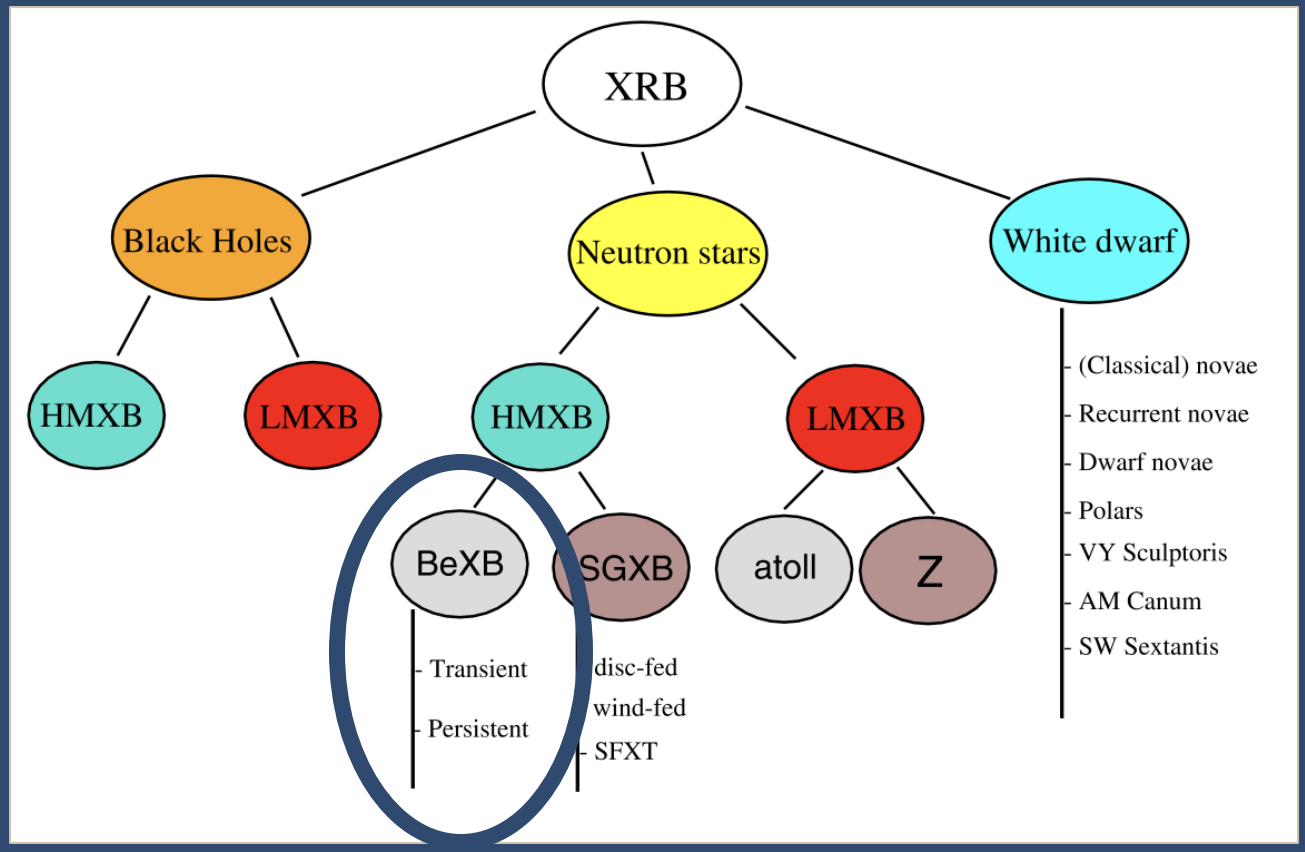

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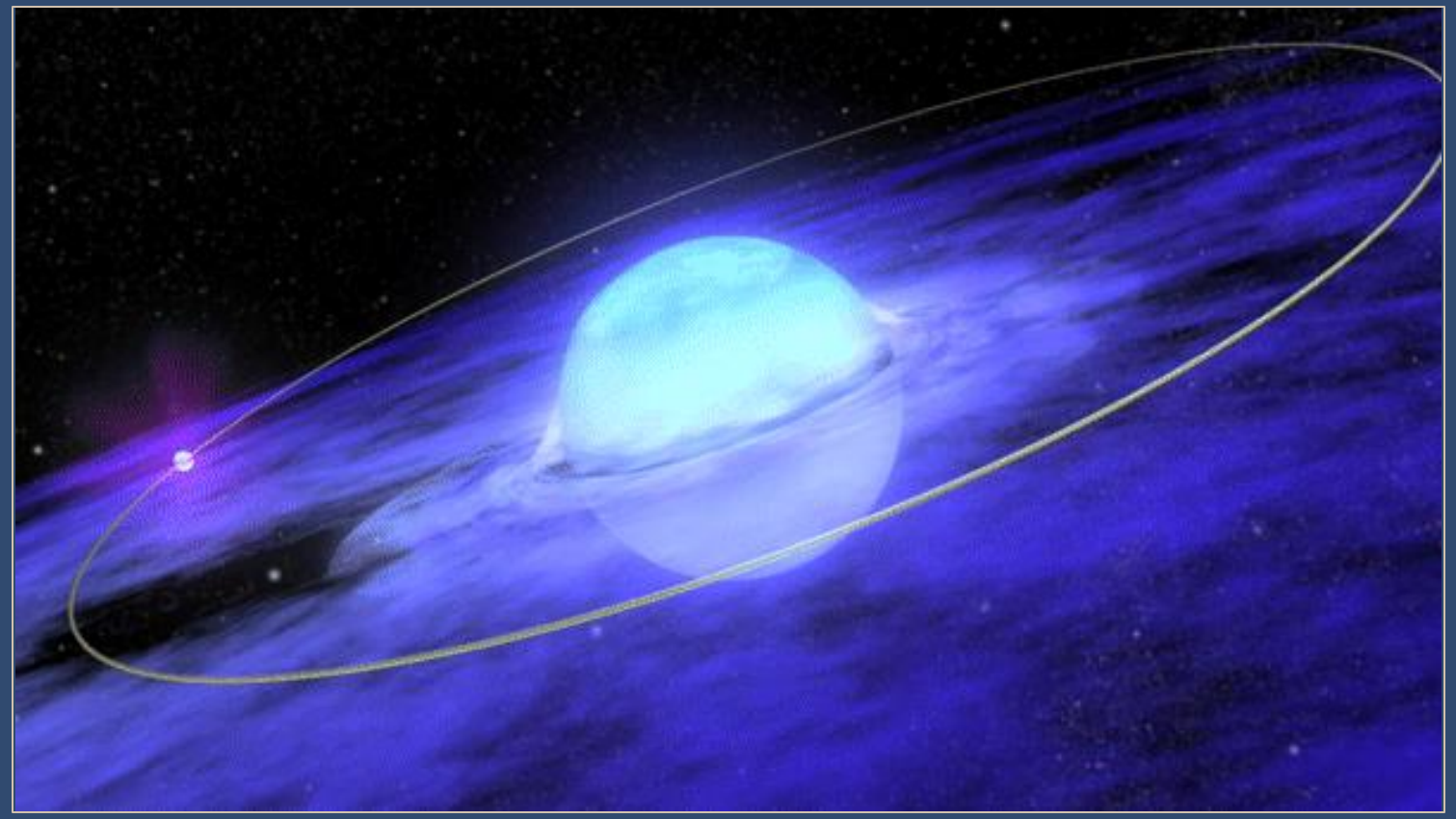
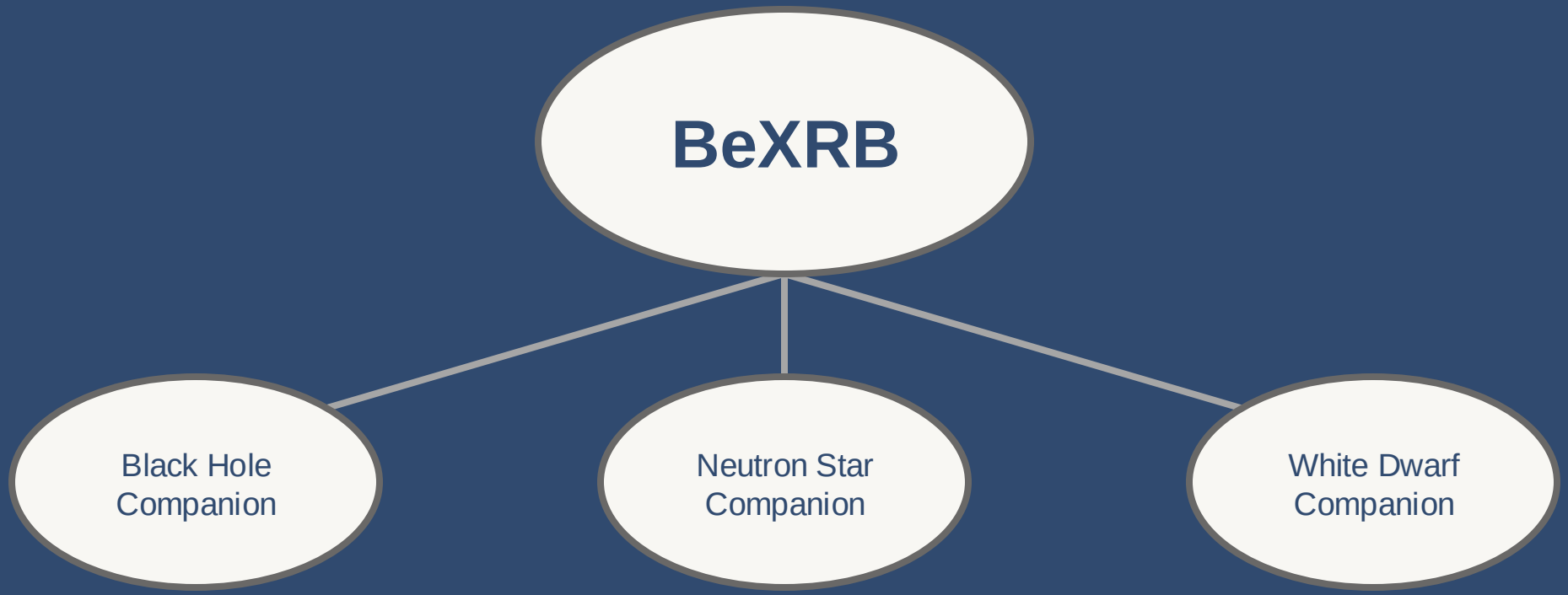


Be/X-ray Binaries: A More Complex View



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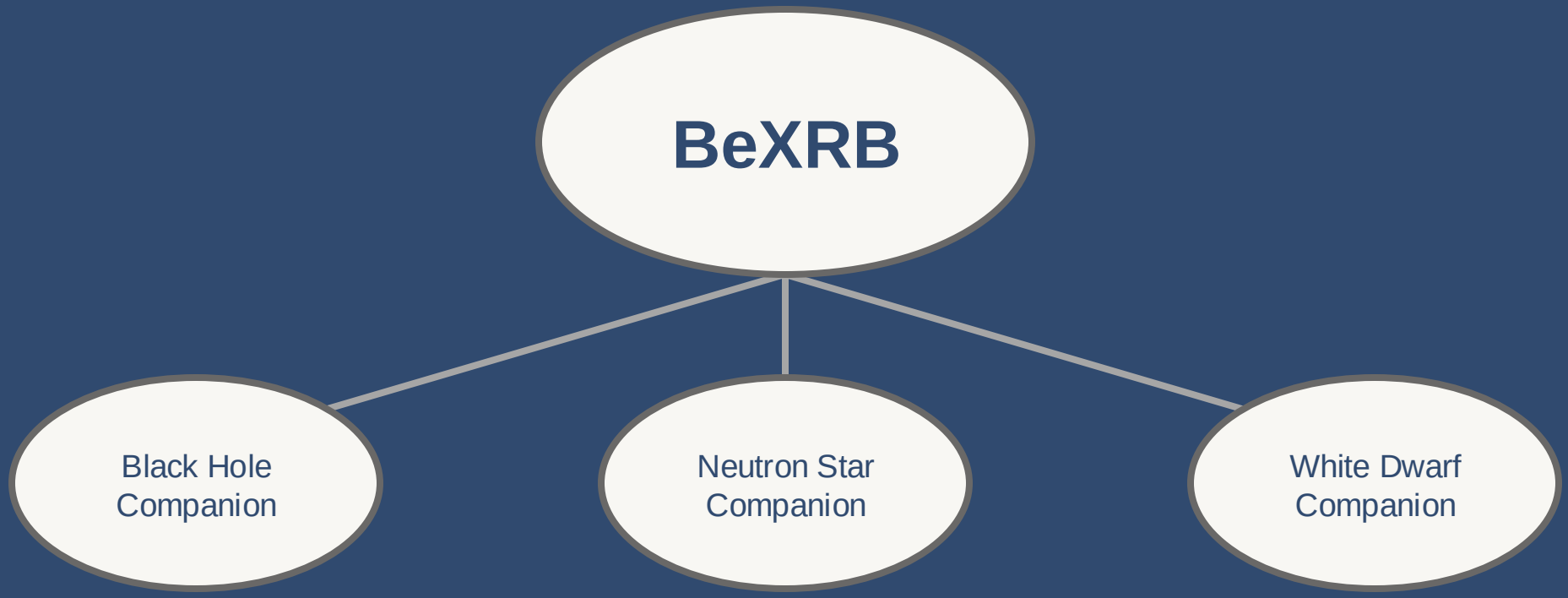
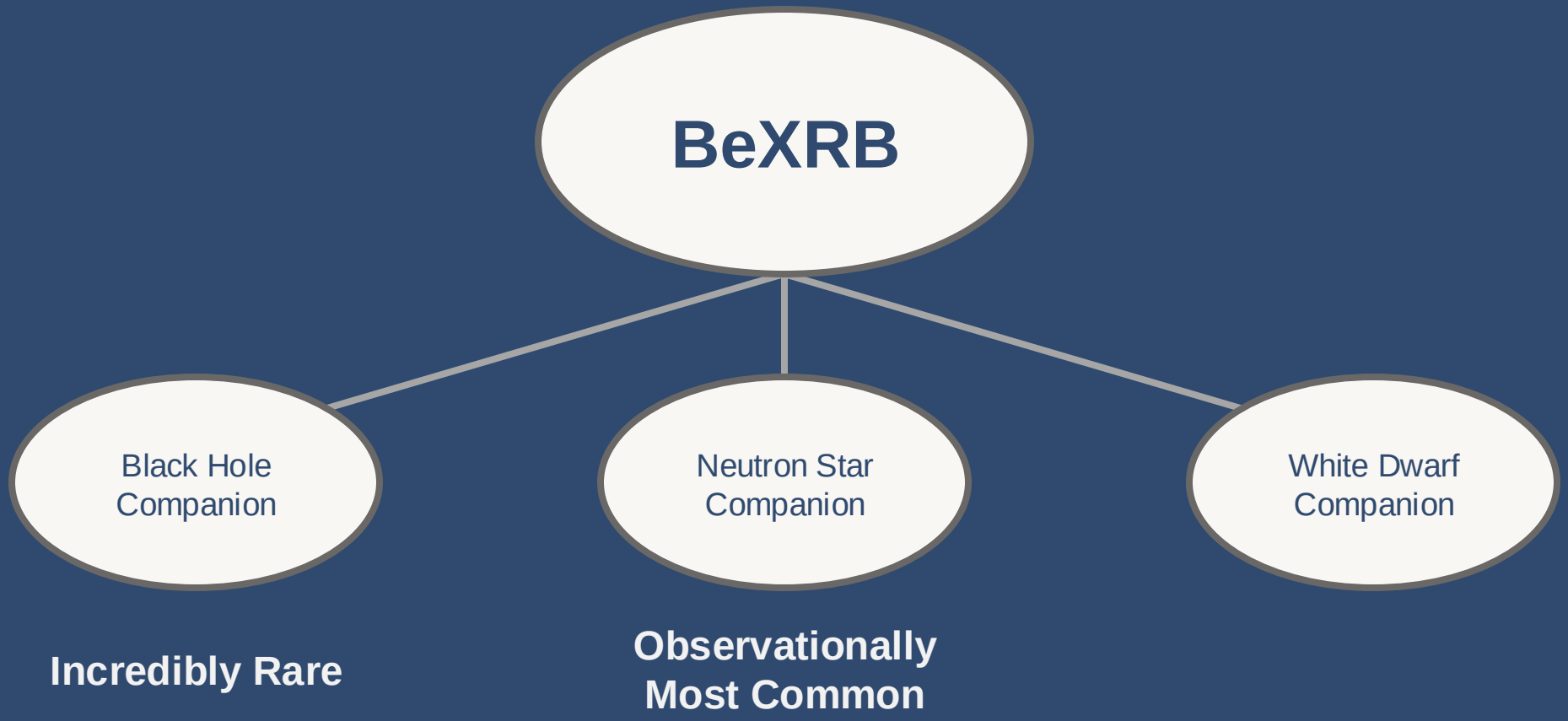


Incredibly Rare

Be/X-ray Binaries: A More Complex View



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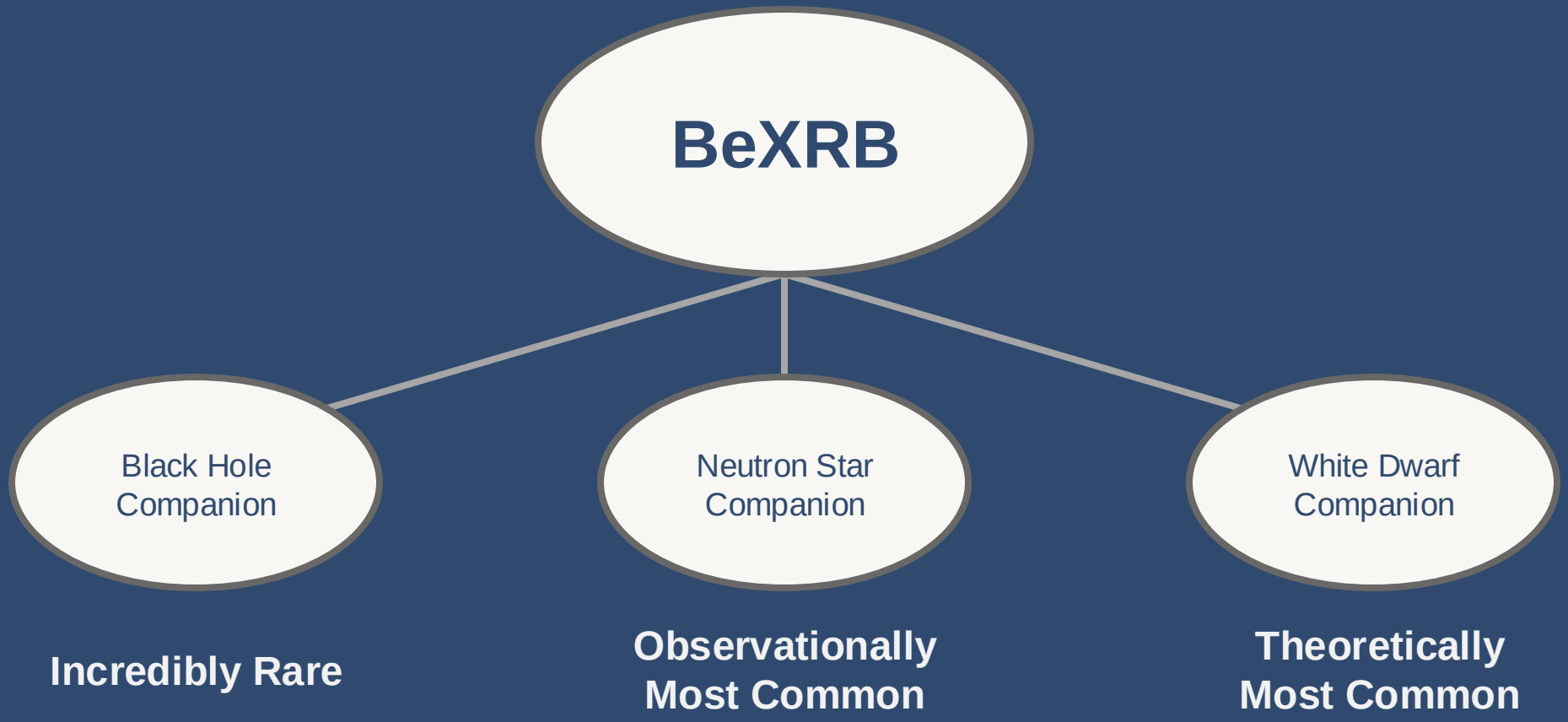

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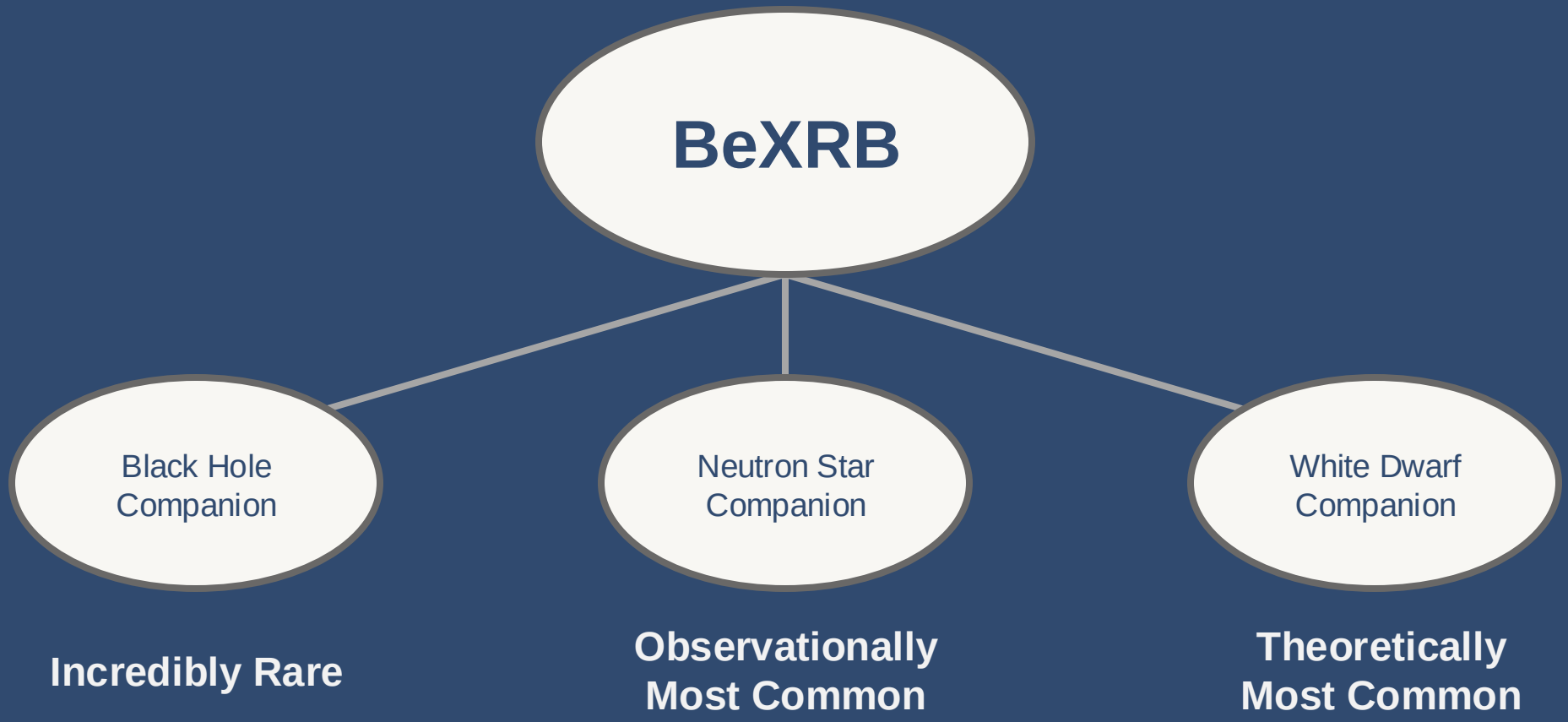
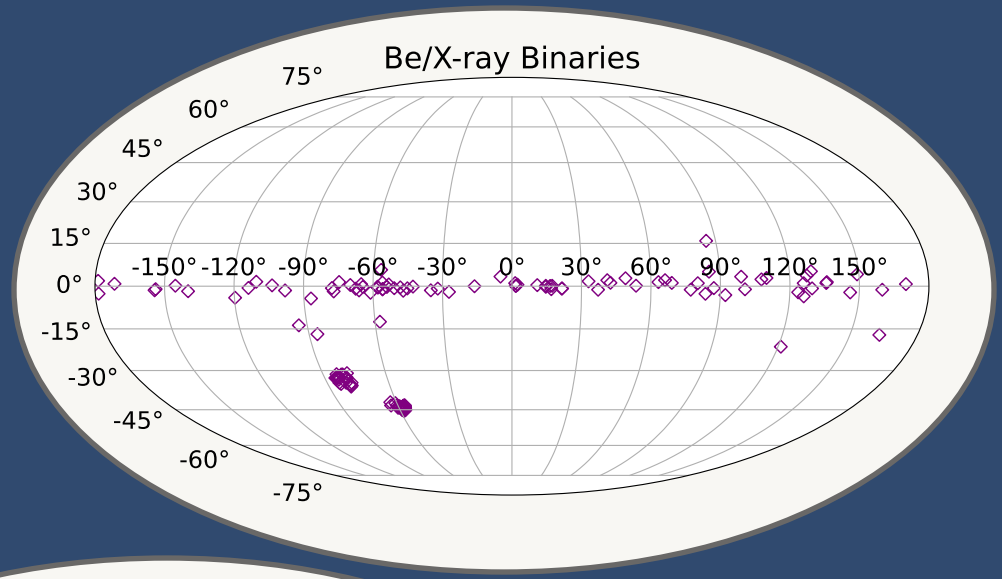


Where are all the Be/White Dwarf Systems?

Be/X-ray Binaries vs. Be/White Dwarfs

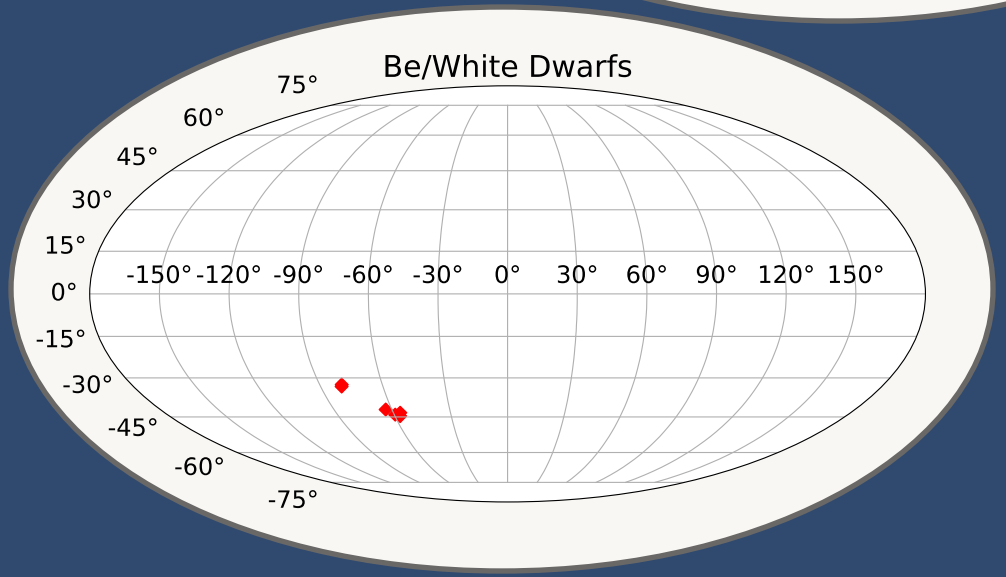
Be/X-ray Binaries

- Faint hard X-ray emission in quiescence
  - $L_X \sim 10^{34} - 10^{35}$ erg s^{-1}
- Transient Hard X-ray Outbursts
  - $L_X \sim 10^{36} - 10^{39}$ erg s^{-1}



Be/White Dwarfs

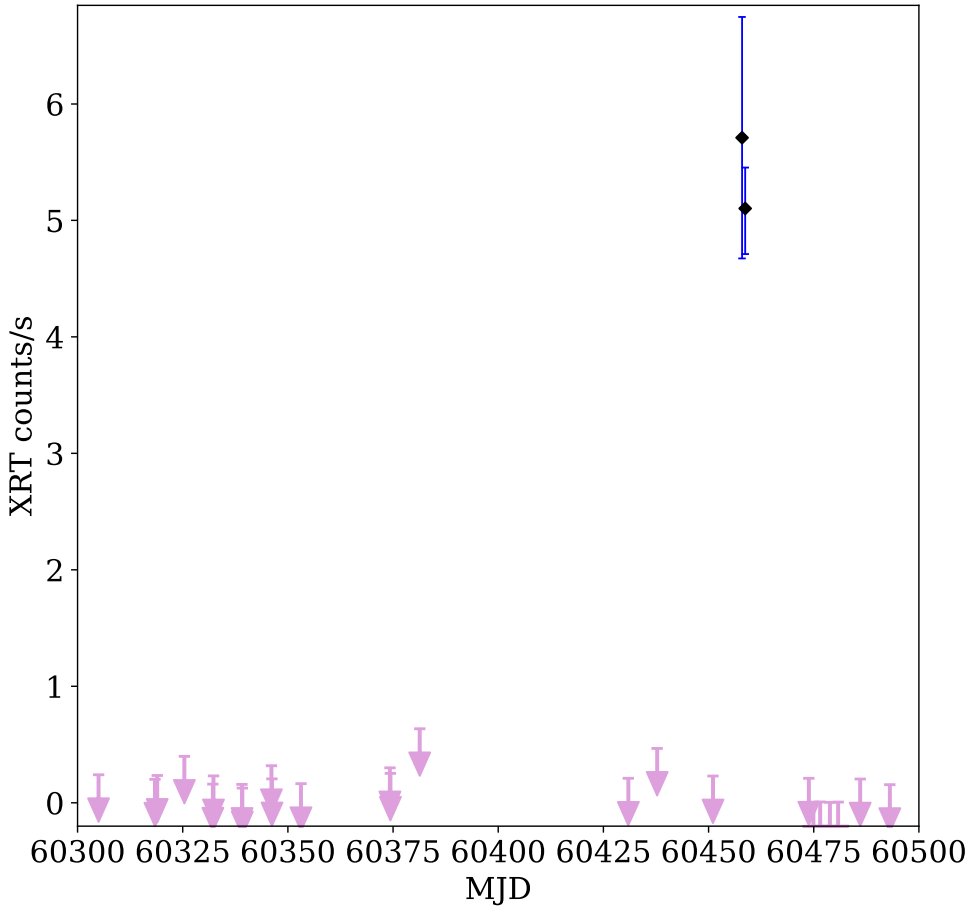
- Faint hard X-ray emission in quiescence
  - $L_X \sim 10^{29} - 10^{33}$ erg s^{-1}
- Transient Soft X-ray emission from rare, short-duration outbursts



A New System Enters Outburst

Outburst of CXOU J005245.0-722844

- Previously known to be a BeXRB
- First Detected by Einstein Probe at 08:41 UTC on 5/27/24
- First Observed by pre-planned Swift observation at 22:29 UTC on 5/27/24
- Max Luminosity:
  - $L_X = 6.51^{+2.5}_{-1.2} \times 10^{38}$ erg s^{-1}



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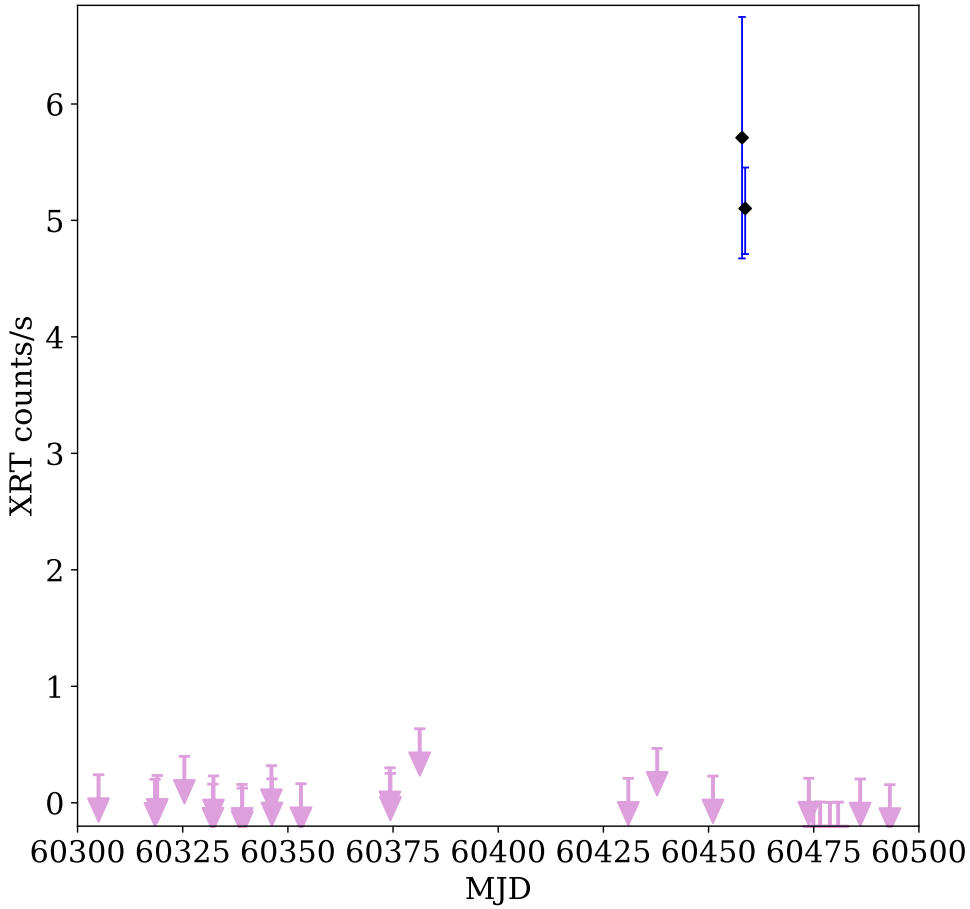
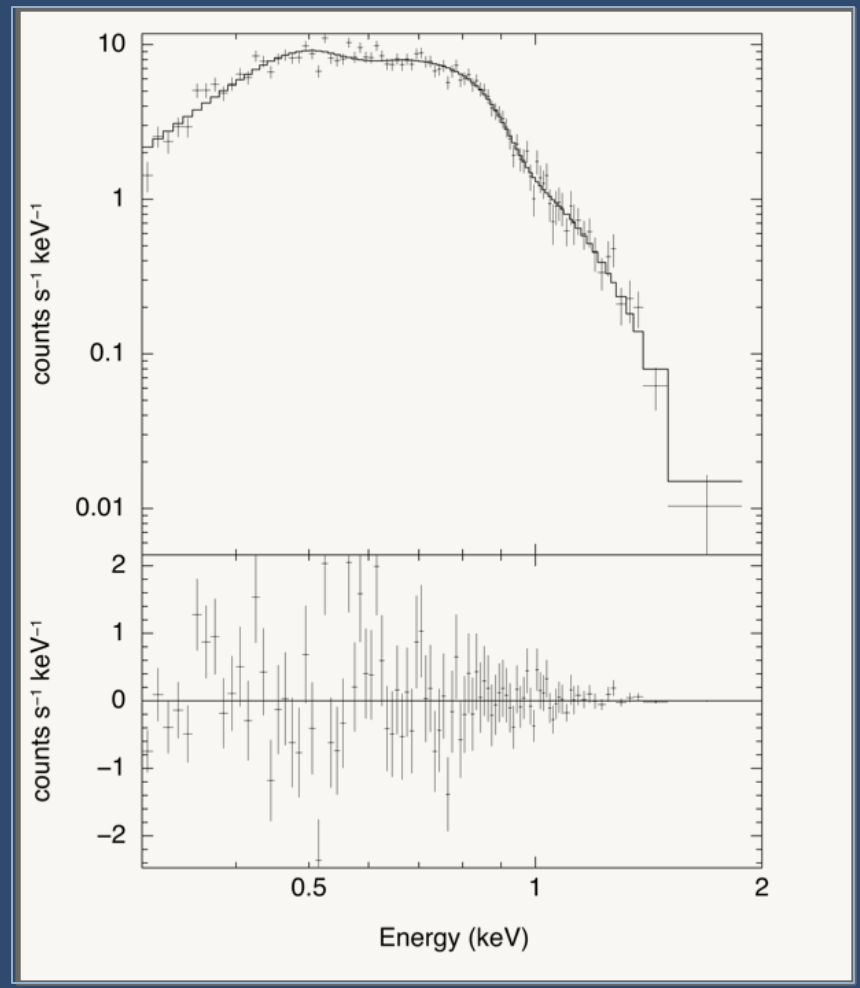
Greater than the Eddington Luminosity for a 1 $M_\odot$ object



X-ray Spectrum of CXOU J005245.0-722844

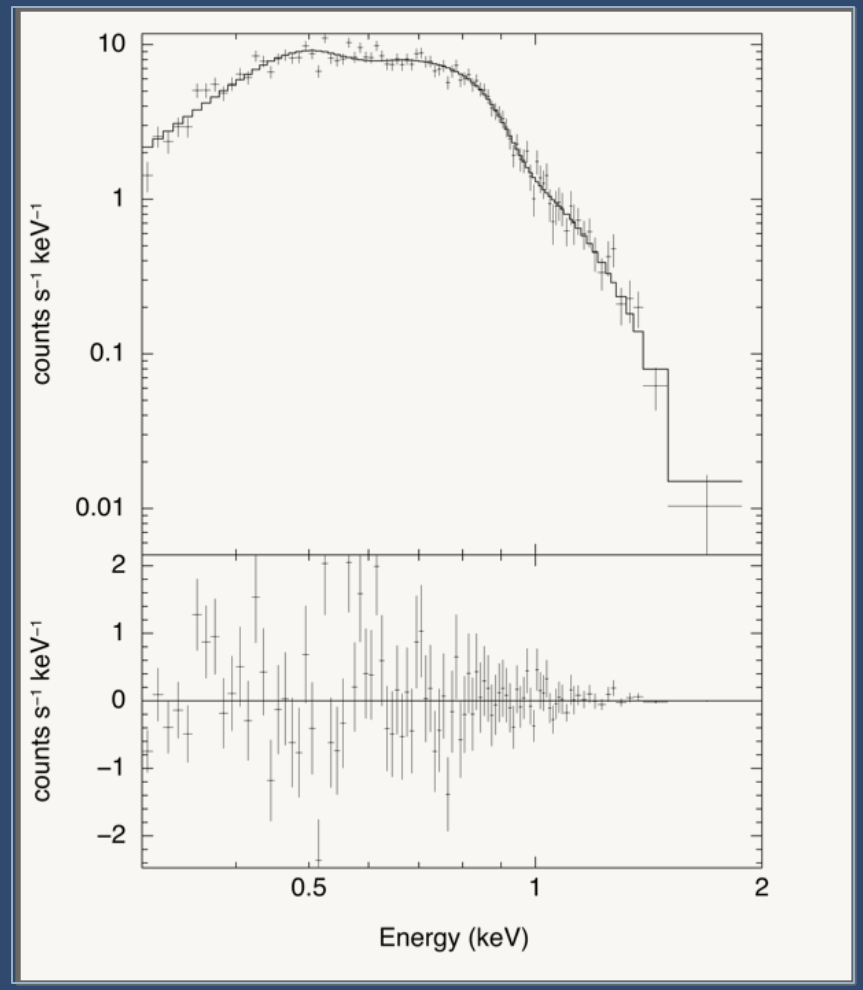
- **Best-Fitting Model**: Absorbed Thermal Blackbody with 2 Absorption Edges
  - $T_{BB} = 91.3$ kT
  - $E_{edge,1} = 0.385$ keV → **C VI edge**
  - $E_{edge,2} = 0.896$ keV → **O VIII edge**
  - $R_{emit} = 11{,}600$ km



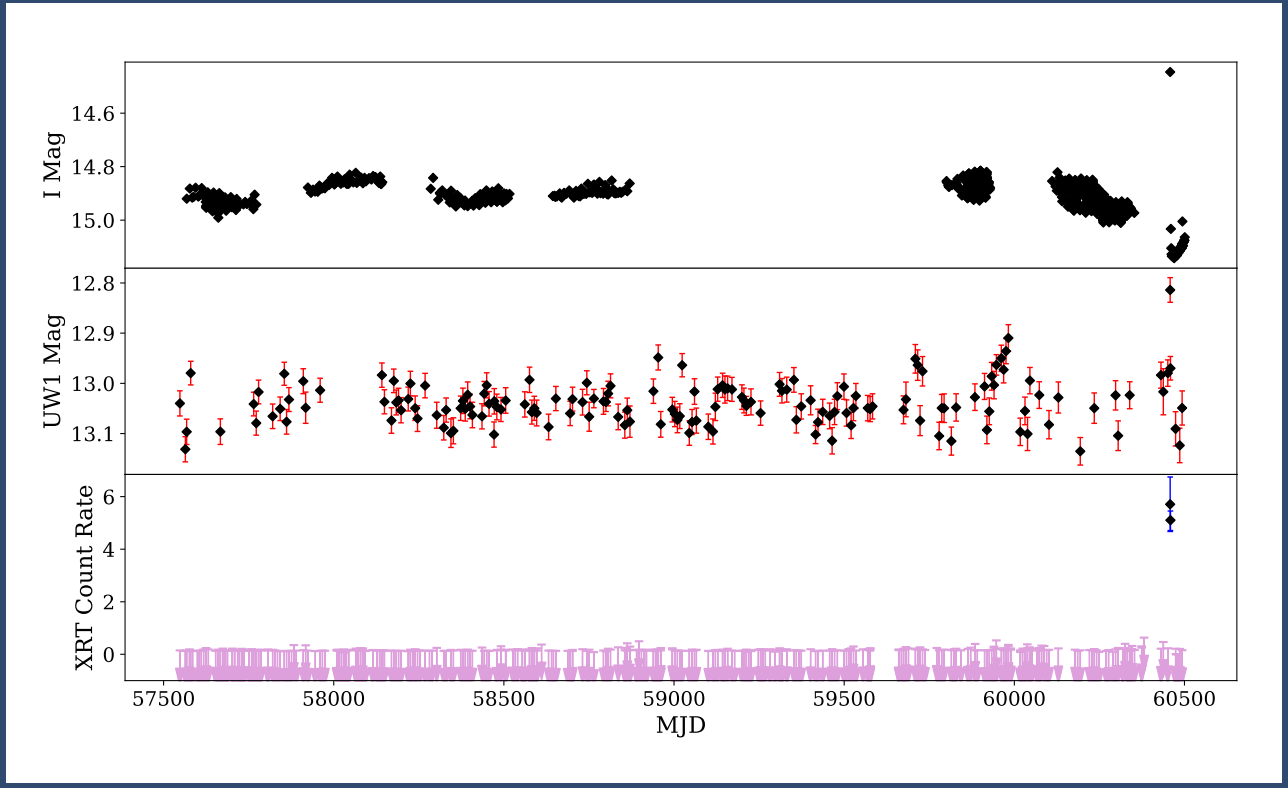
X-ray Spectrum of CXOU J005245.0-722844

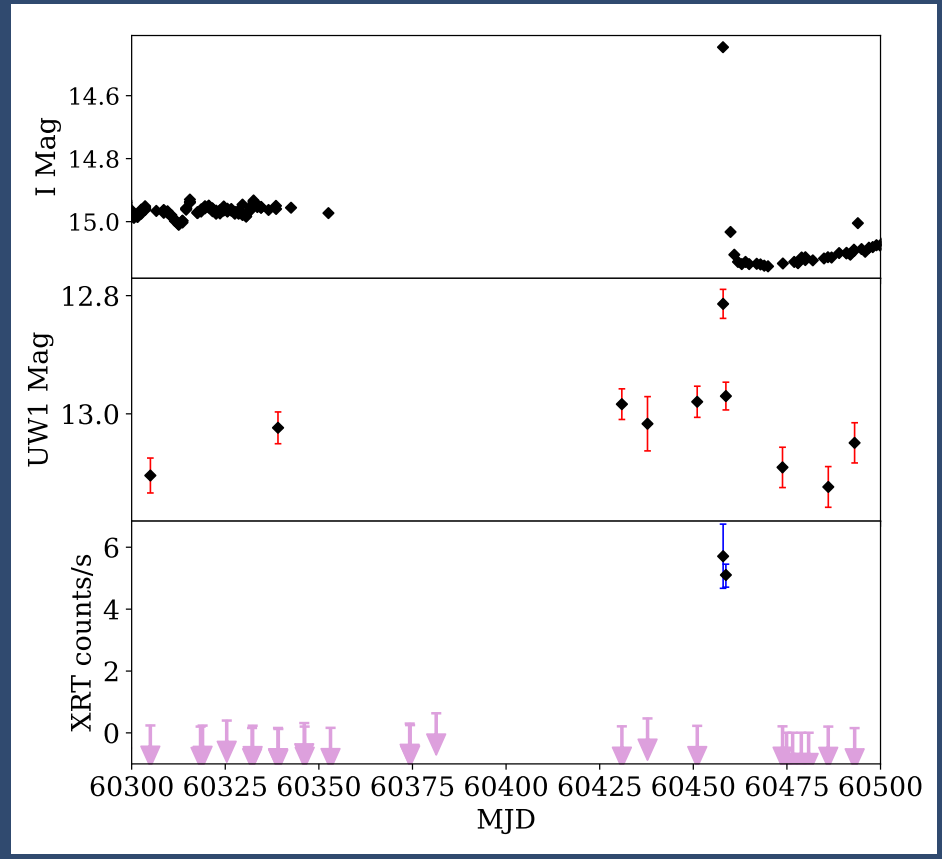
- **Best-Fitting Model**: Absorbed Thermal Blackbody with 2 Absorption Edges
  - $T_{BB} = 1.06 \times 10^6$ K
  - $E_{edge,1} = 0.385$ keV → **C VI edge**
  - $E_{edge,2} = 0.896$ keV → **O VIII edge**
  - $R_{emit} = 11{,}600$ km

Conclusion: Compact Object is a 1.2 $M_\odot$ Carbon/Oxygen White Dwarf



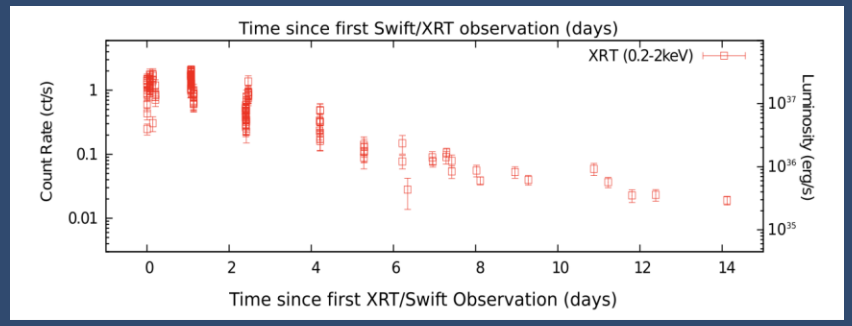
Optical Counterpart



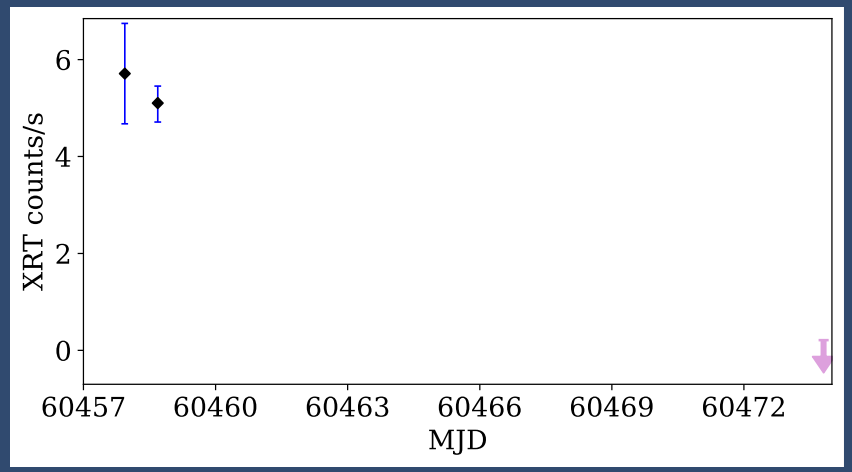


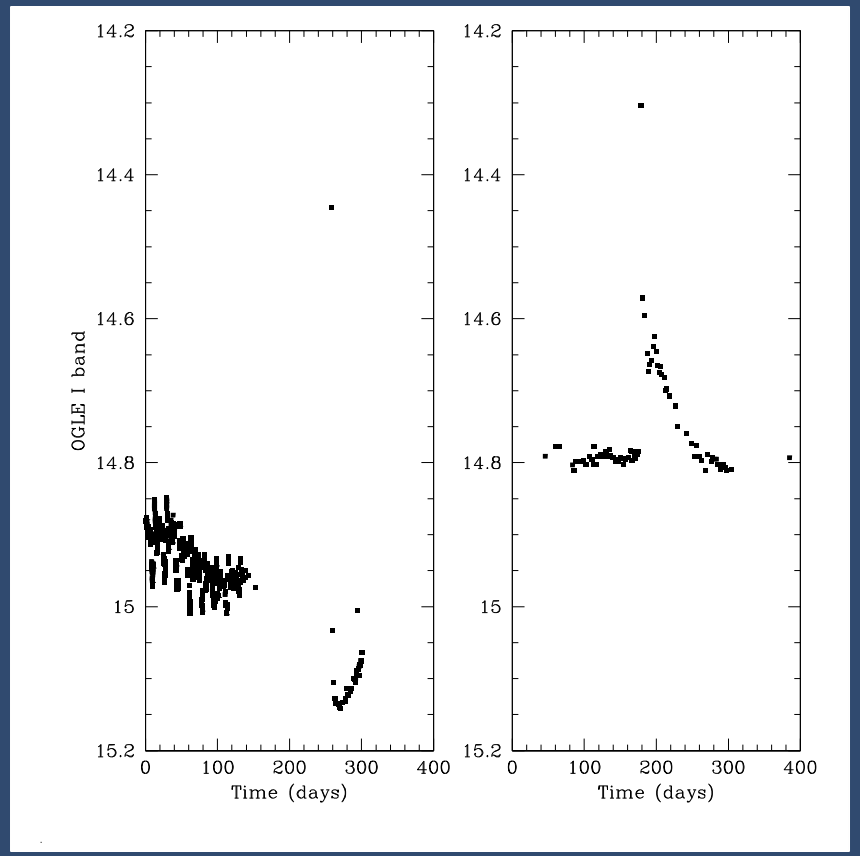
A Super-Luminous, Very Fast Nova?

2011
MAXI J0158-477



2024
CXOU J005245.0-722844





2024
CXOU J005245.0-722844

2011
MAXI J0158-477

Conclusions

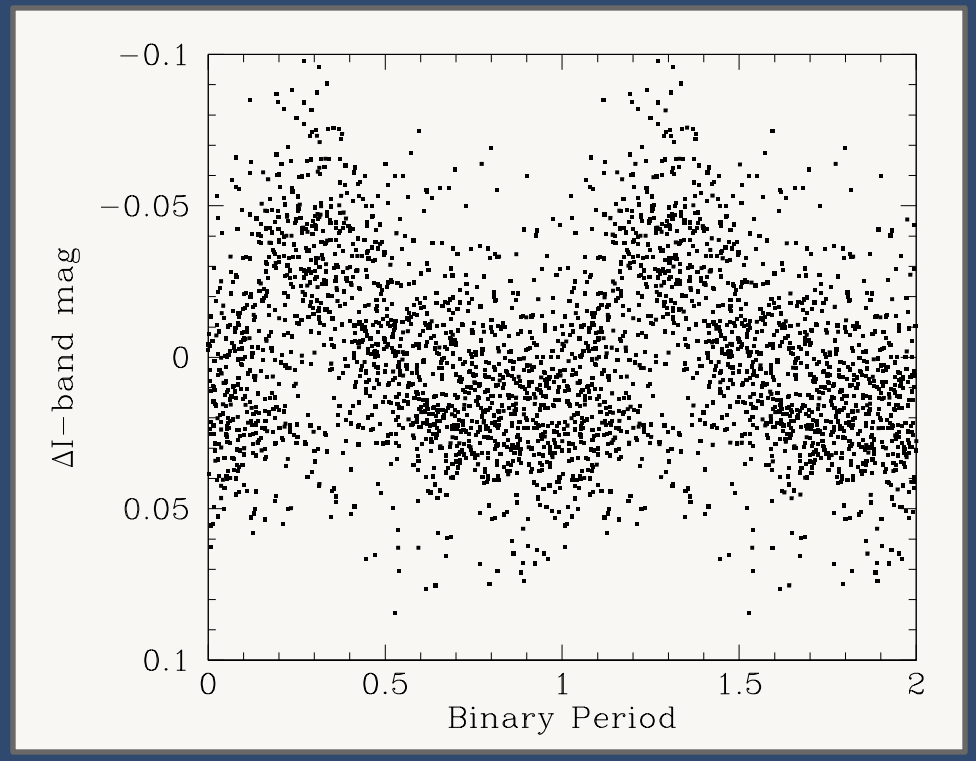
- CXOU J005245.0-722844 is detected as a new ultraluminous supersoft X-ray transient
  - Confirmed to be an outburst from a new Be/White Dwarf System
  - 7^{th} known BeWD system, 5^{th} in the SMC

- Likely the second BeWD to produce a Super-Eddington nova eruption
  - More work needed to understand how these novae are produced

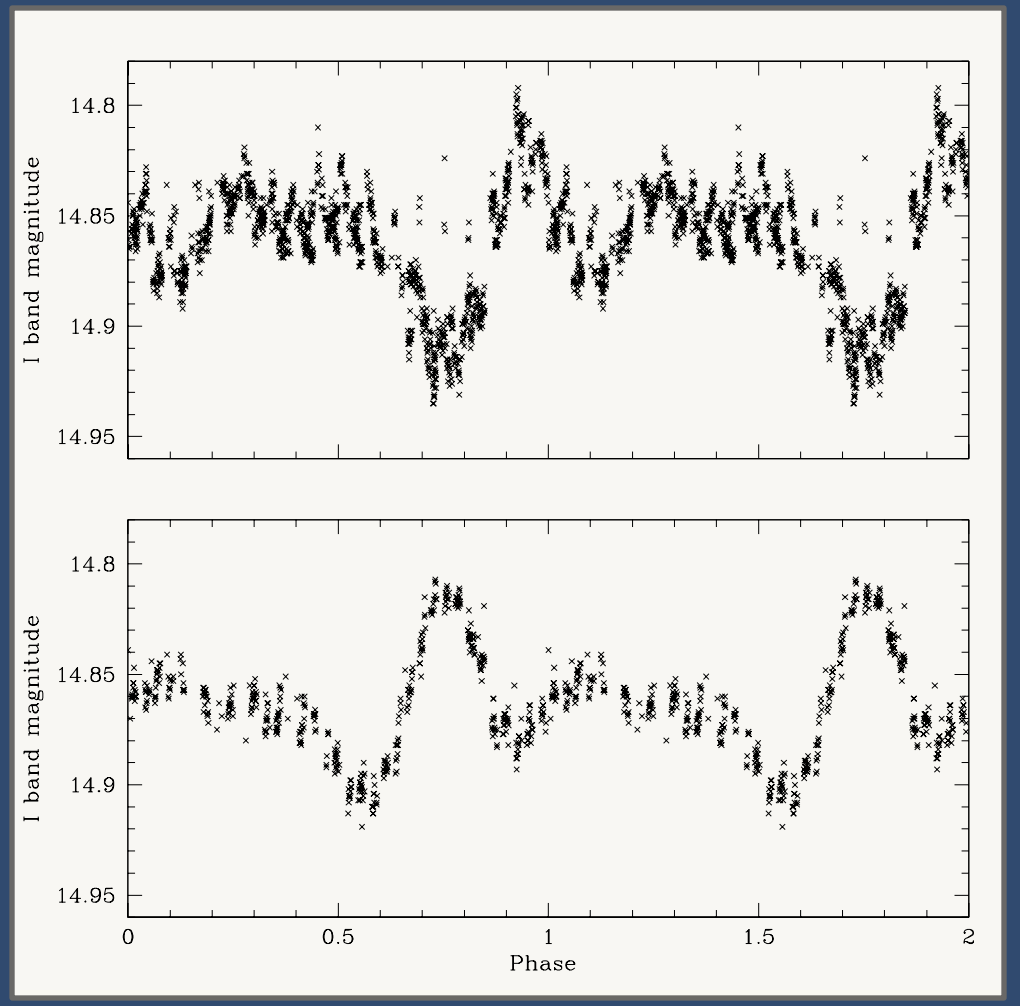
Pre-Print is now on ArXiv and Accepted by MNRAS!

Any Questions?

Periodicity Problems



1992 – 2020
P = 17.55 Days

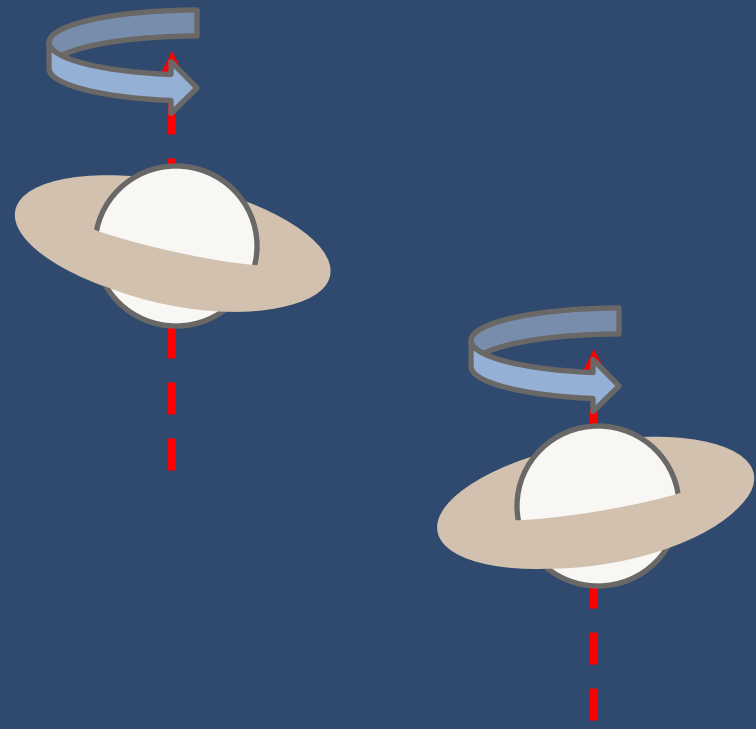


2022 – 2023
P = 17.41 Days

2023 – 2024
P = 17.17 Days

Periodicity Problems – Negative Superhumps?

- Can rule out the orbit having changed so rapidly
- Assume that the WD Accretion Disk is responsible
- Similar phenomena observed in cataclysmic variable stars



S-CUBED: The Swift SMC Survey

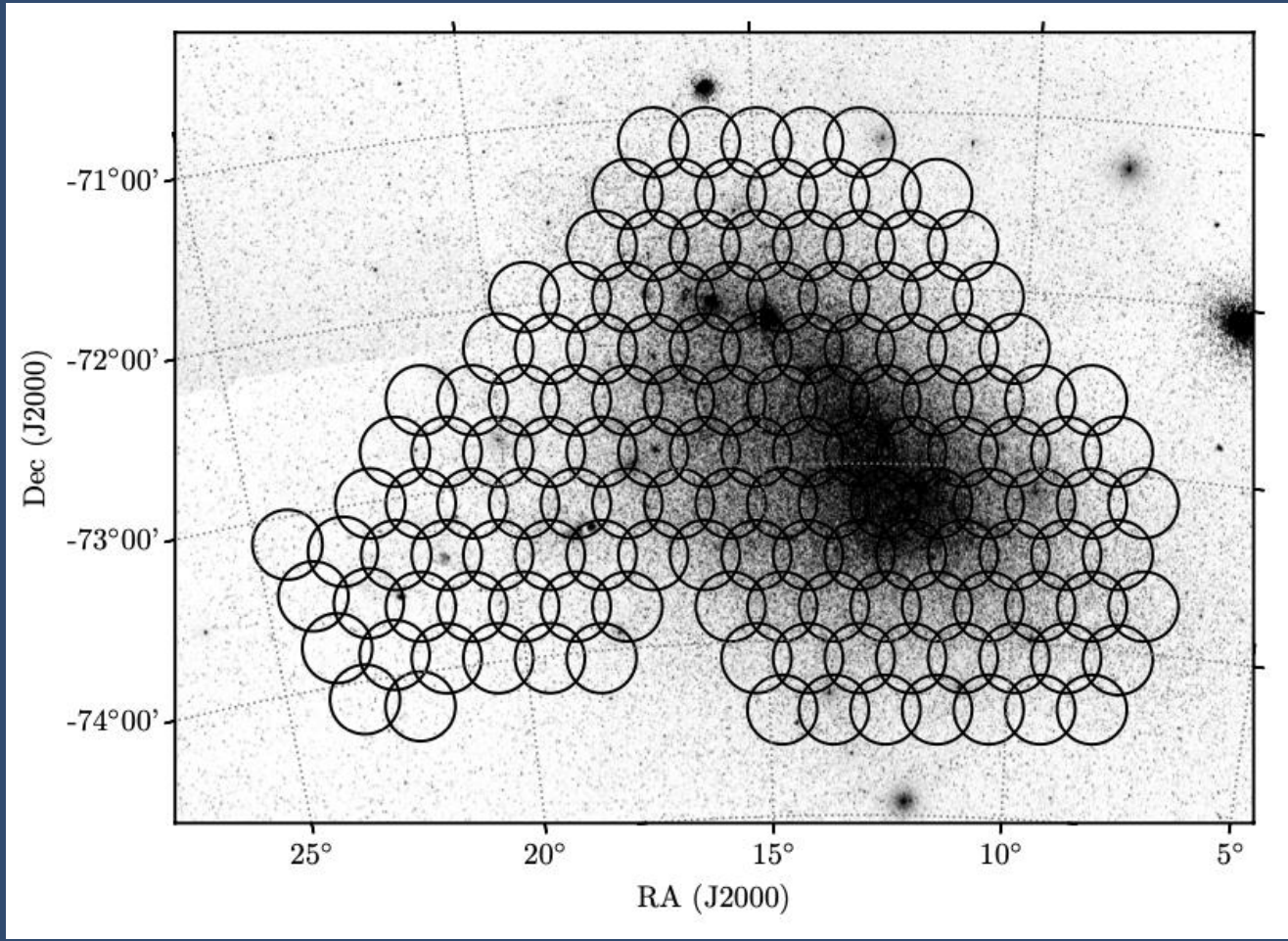


Image Credit: Kennea et al. 2018