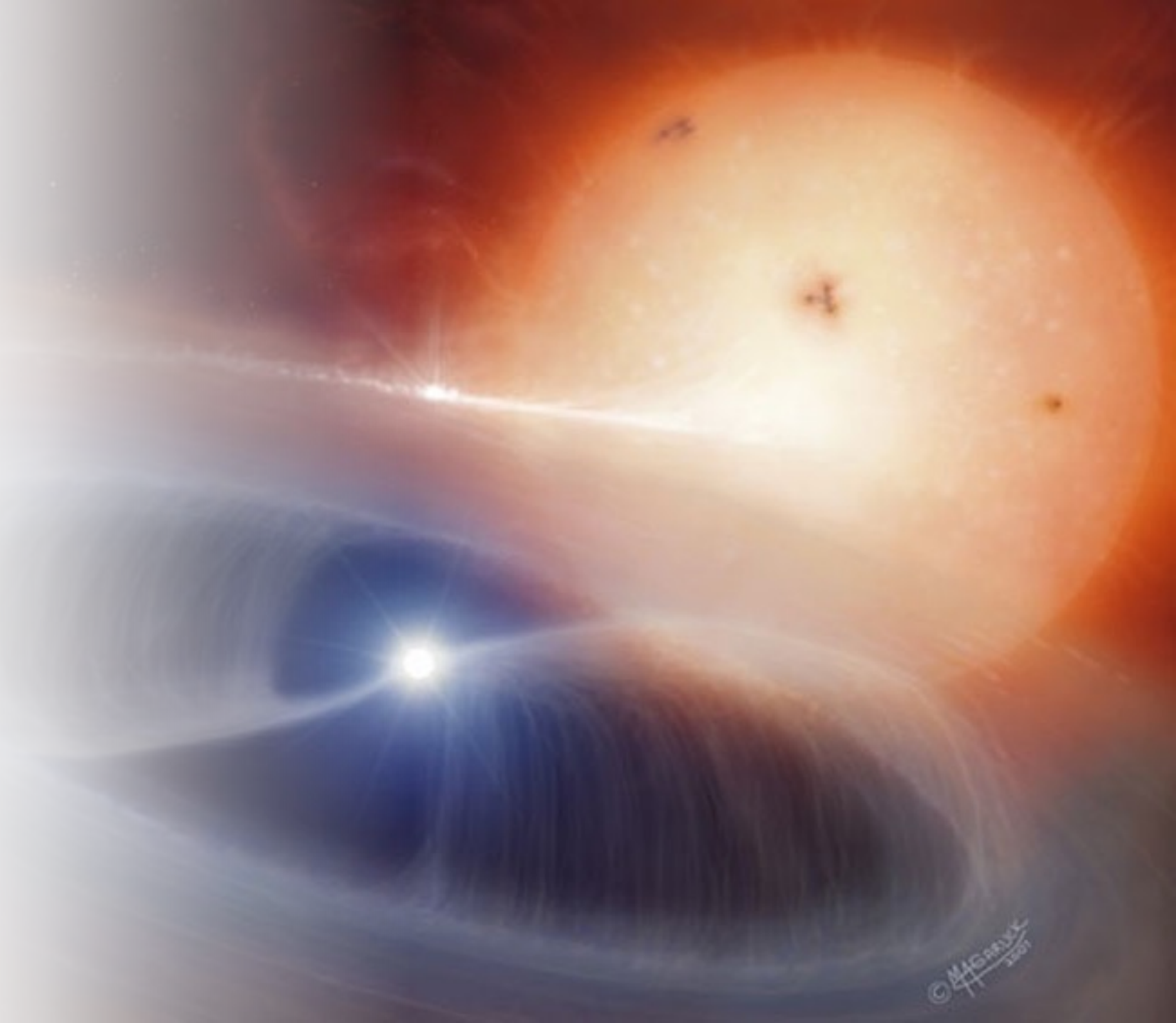


The Galactic X-ray Excess Problem is Not Solved

Tony Rodríguez (Caltech)
NSF GRFP Fellow | Ford Foundation Fellow

Chandra HRXS Workshop

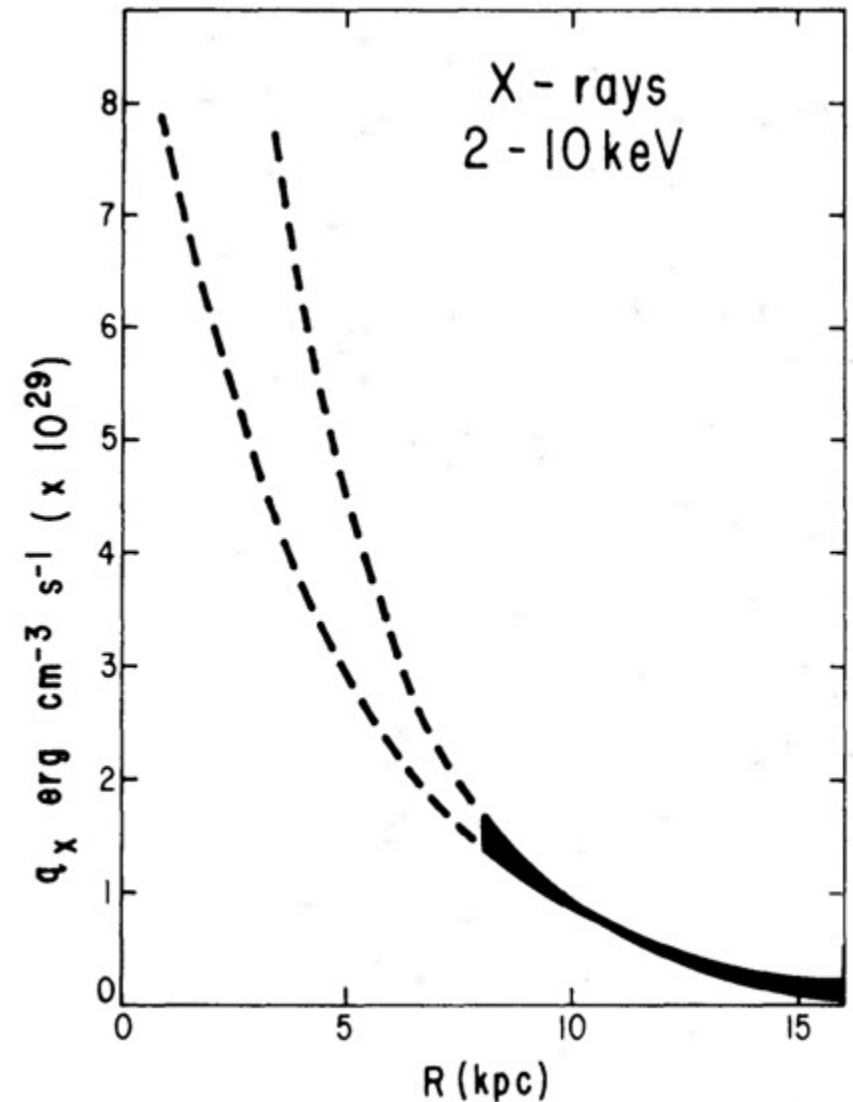
MIT, 3 August 2023



Galactic Ridge Soft X-rays

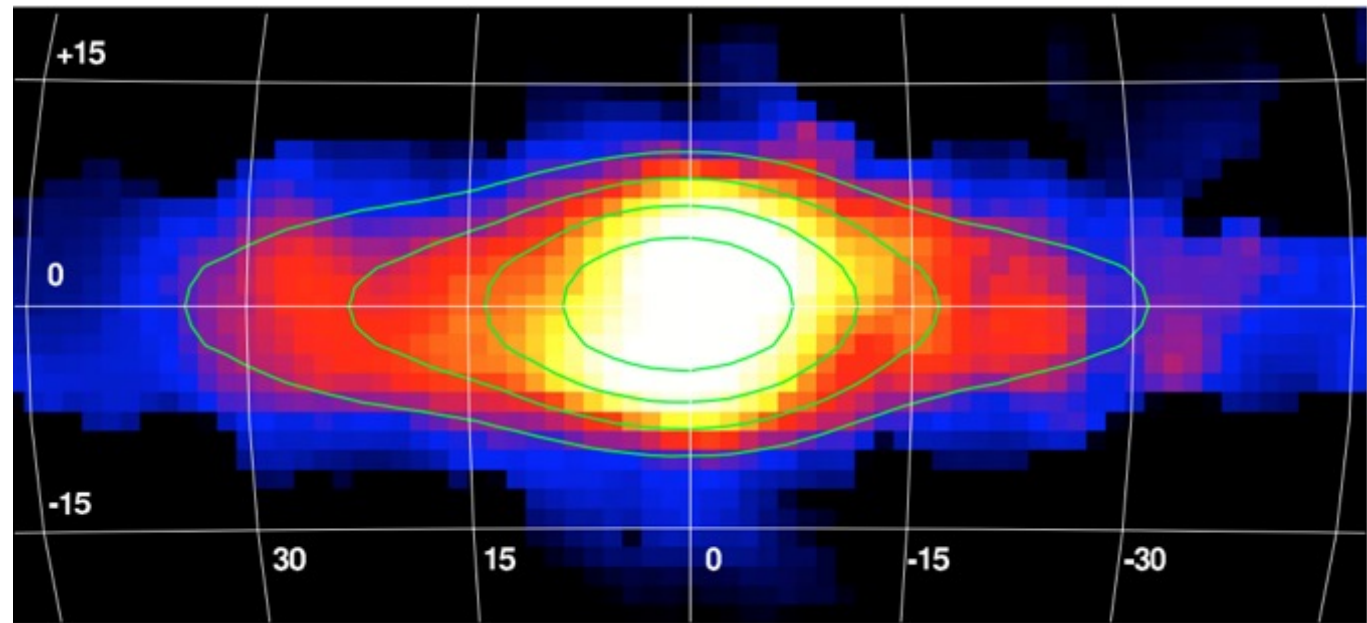
- Galactic Ridge: $l < 40$ deg, $b < 4$ deg
 - Discovered by HEAO-1 in 1982.

Worrall 1982



Galactic Ridge Hard X-rays

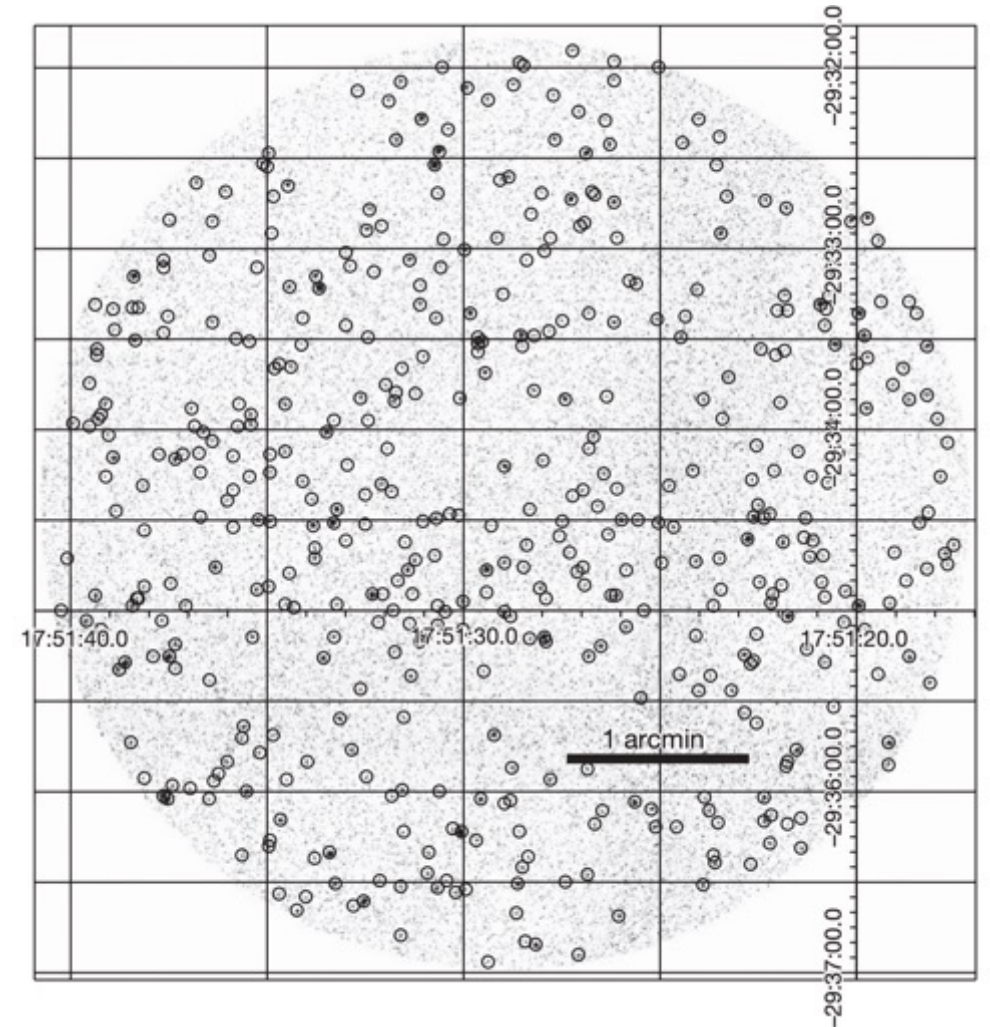
- Galactic Ridge: $l < 40$ deg, $b < 4$ deg
 - Discovered by HEAO-1 in 1982.
 - *INTEGRAL* hard X-rays in 2007.



Krivonos 2009

Galactic Ridge Resolved

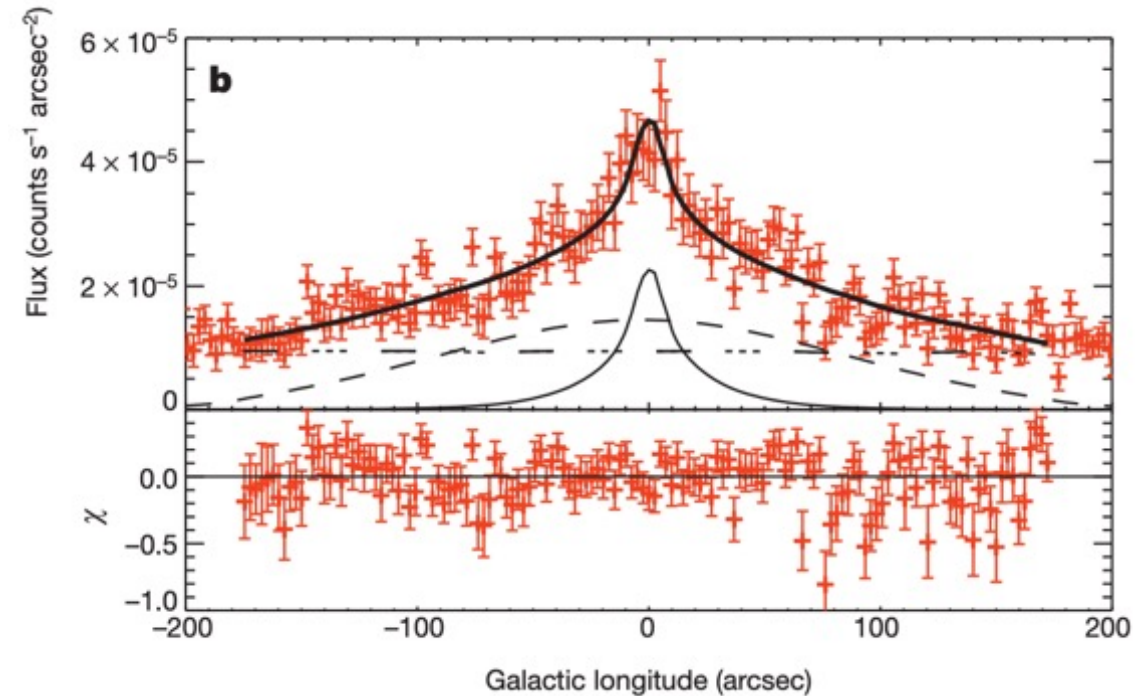
- Galactic Ridge: $l < 40$ deg, $b < 4$ deg
 - Discovered by HEAO-1 in 1982.
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 - *Chandra* resolved it into discrete sources in 2009.



Revnivstev 2009

Galactic Center Resolved

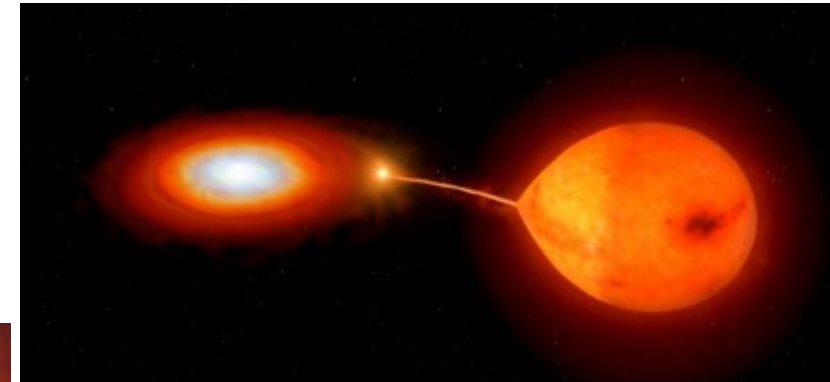
- Galactic Ridge: $l < 40$ deg, $b < 4$ deg
 - Discovered by HEAO-1 in 1982.
 - *INTEGRAL* hard X-rays in 2007.
 - *Chandra* resolved it into discrete sources in 2009.
- Galactic Center: Inner few pc
 - *NuSTAR* observed a distinct increase in hard X-rays in the nuclear star cluster (NSC) in 2015.



Perez 2015

Solution: Cataclysmic Variables

- Non-magnetic CVs (64%)

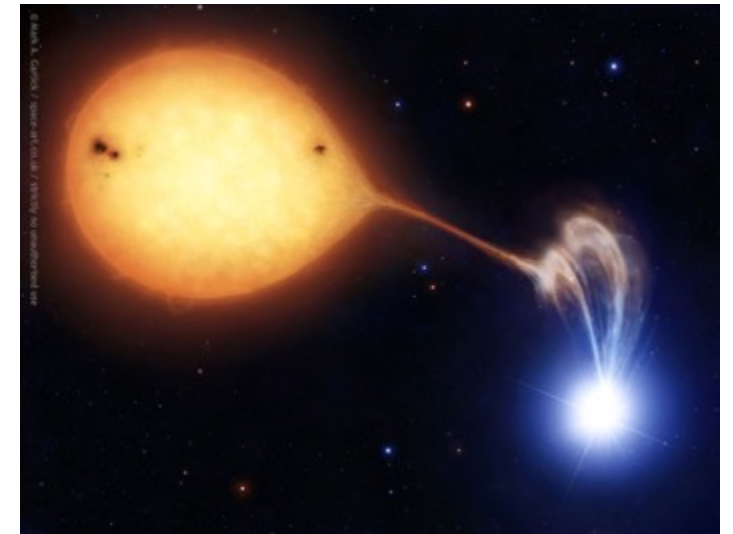


- Intermediate Polars (7%)



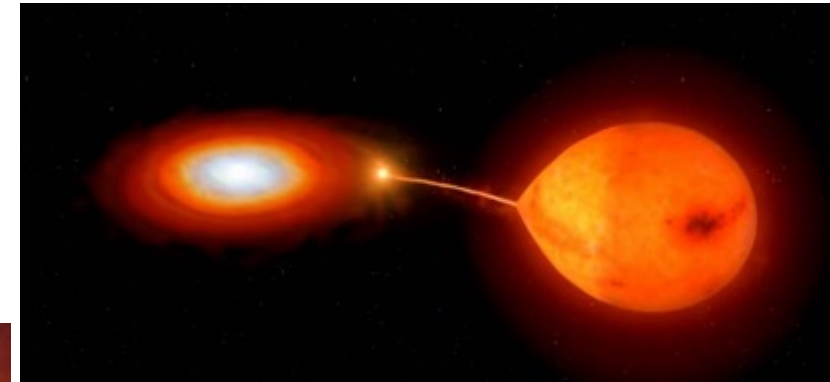
- Polars (29%)

$$kT_{\text{shock, brems}} \approx \frac{3}{8} \frac{GM_{\text{WD}} \mu m_H}{R_{\text{WD}}}$$



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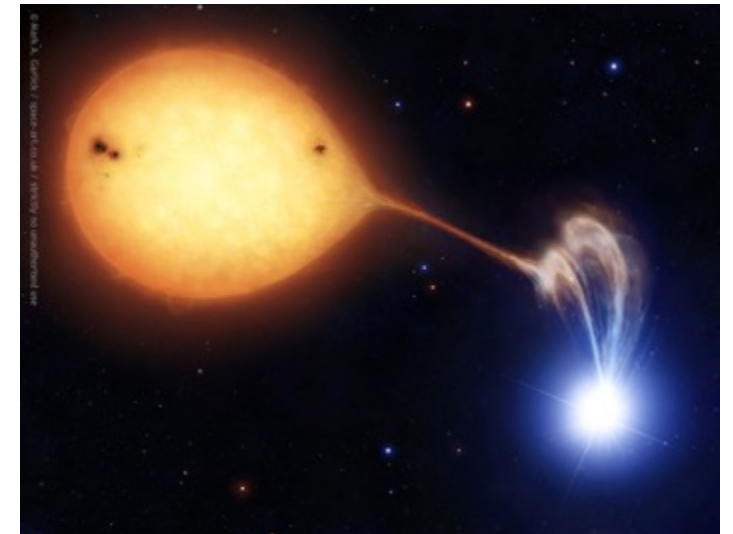


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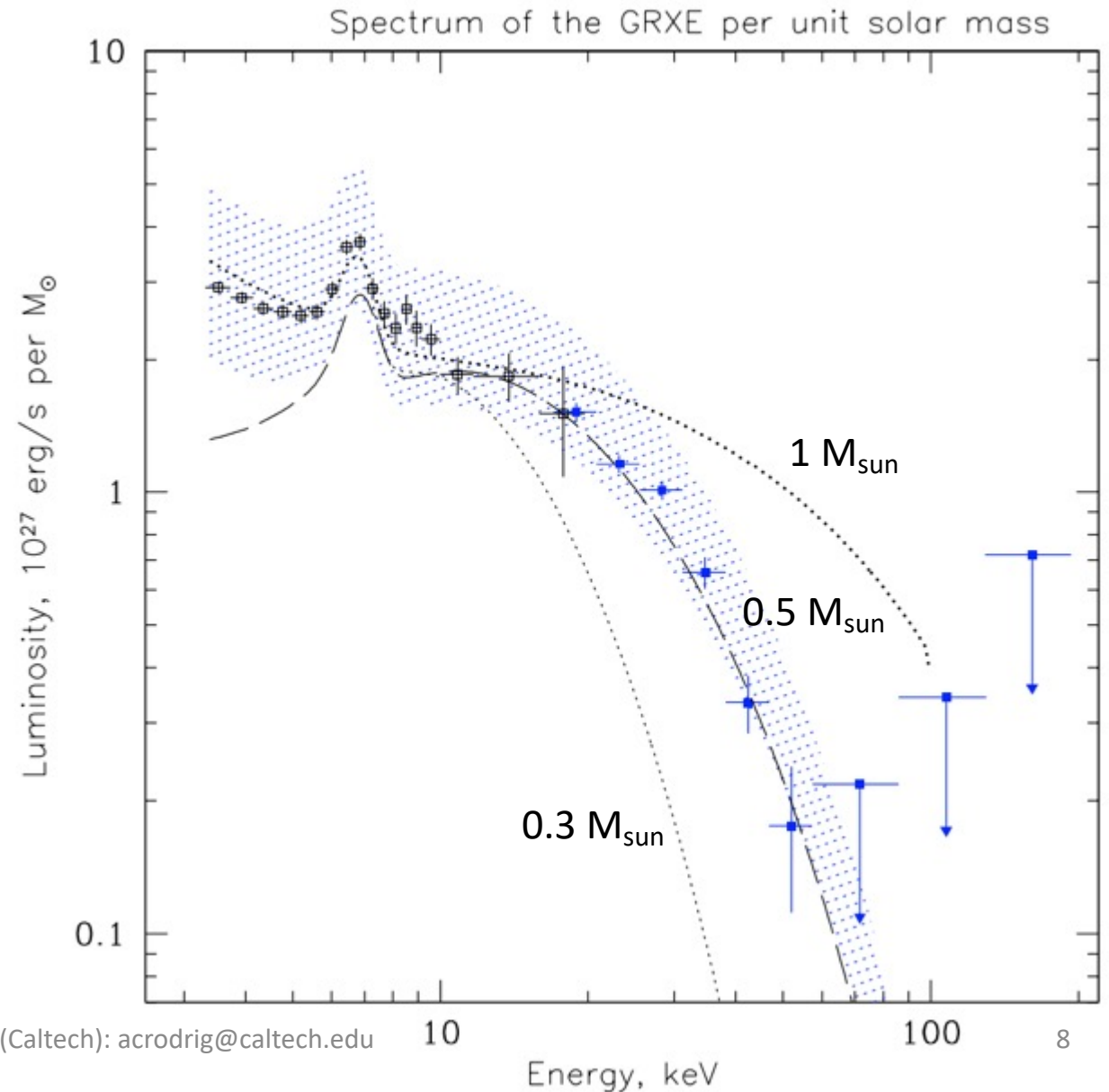
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Broadband Fit

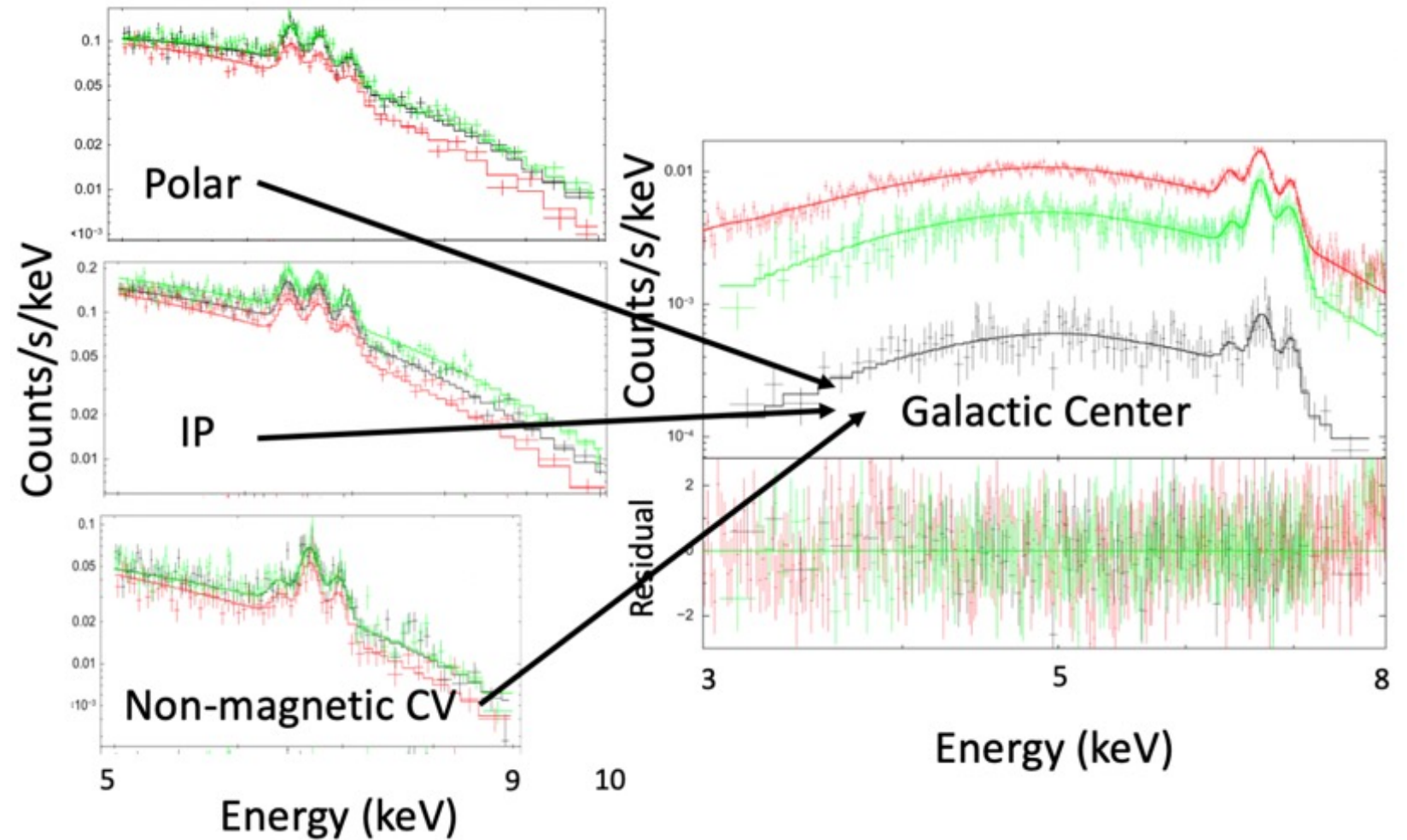
- Thermal Brems: Magnetic CVs with $M_{\text{WD}} = 0.5M_{\text{Sun}}$



Krivonos 2009

Spectral Fit

- Assuming all subtypes contribute:

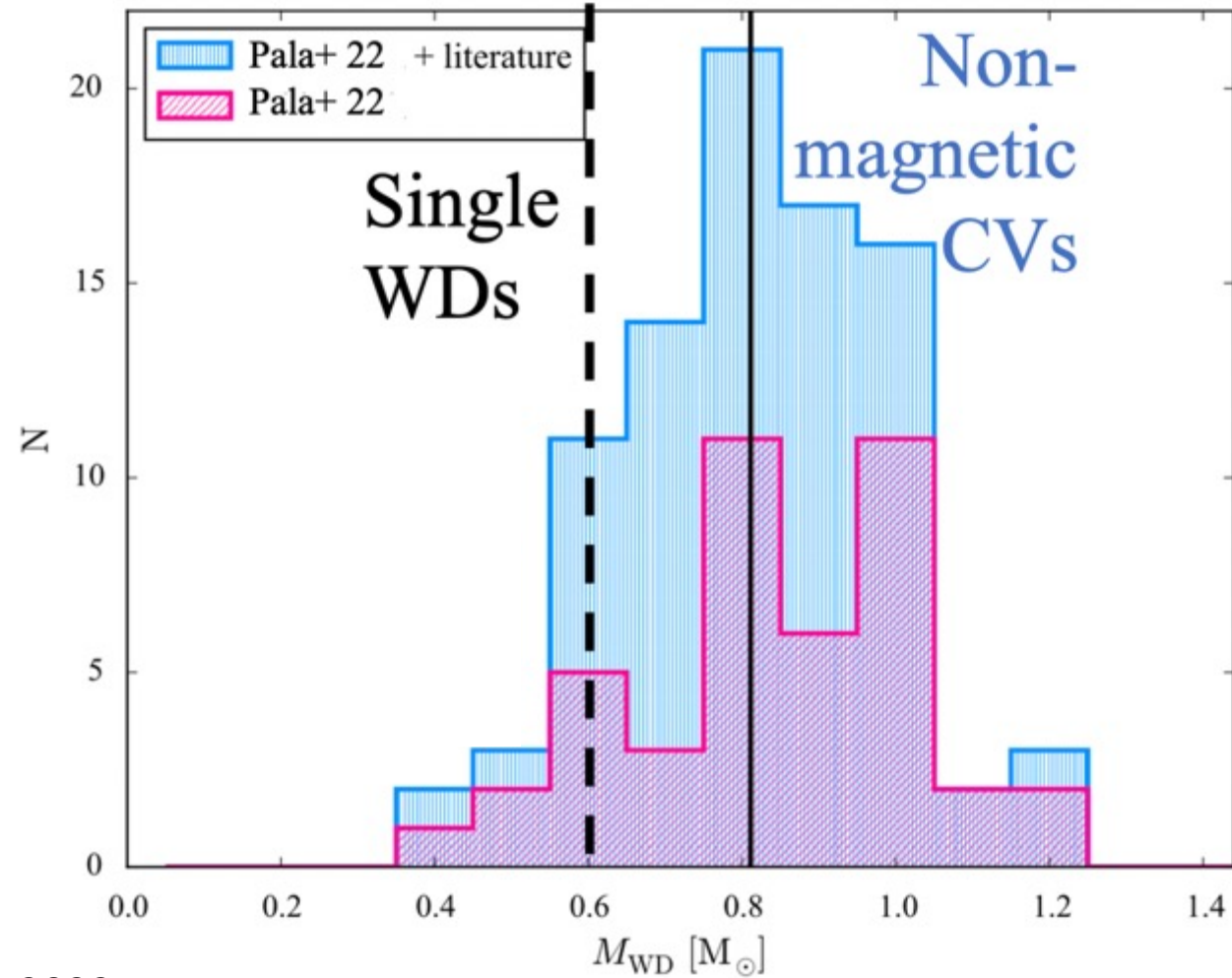


Xu 2016

The Problem is Not Solved

Region	Modeling	Dominant CV class	WD mass	Ref.
Galactic Ridge	Continuum	IP	$0.5M_{\odot}$	[2] Krivonos+ 07
Galactic Ridge	Fe Line Emission	Non-magnetic	-	[5] Xu+ 16
Galactic Center	Continuum	IP	$0.9M_{\odot}$	[3] Perez+ 15
Galactic Center	Fe Line Emission	Non-magnetic or IP	$1.0 - 1.25M_{\odot}$ or $0.6 - 0.8M_{\odot}$	[6] Xu+ 19

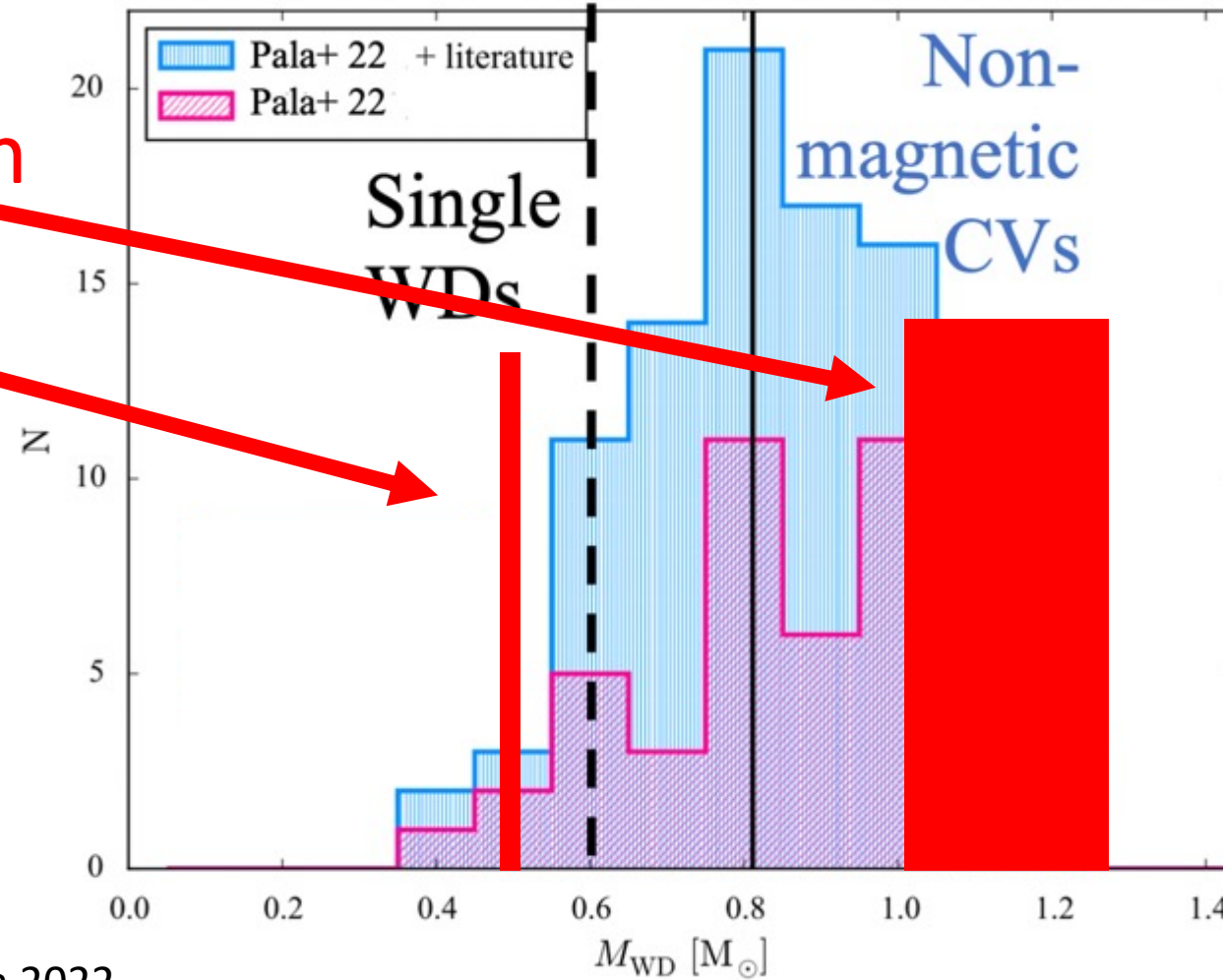
The Problem is Not Solved



Pala 2022

The Problem is Not Solved

Estimates span
the entire
distribution!



Pala 2022

What Next?

1. More X-ray discoveries of magnetic CVs to reveal the diversity of the population.
2. More *Chandra* HETG spectra of polars.

