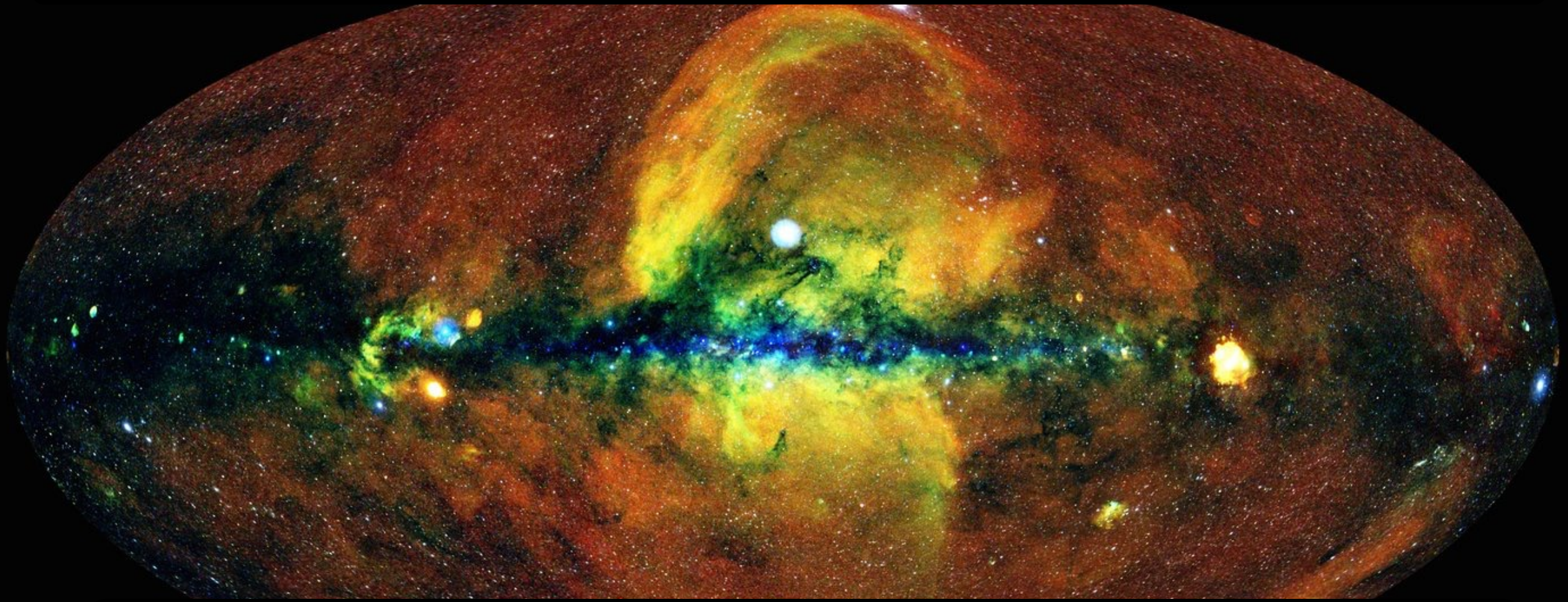
Old novae in the eROSITA All Sky Survey (eRASS)



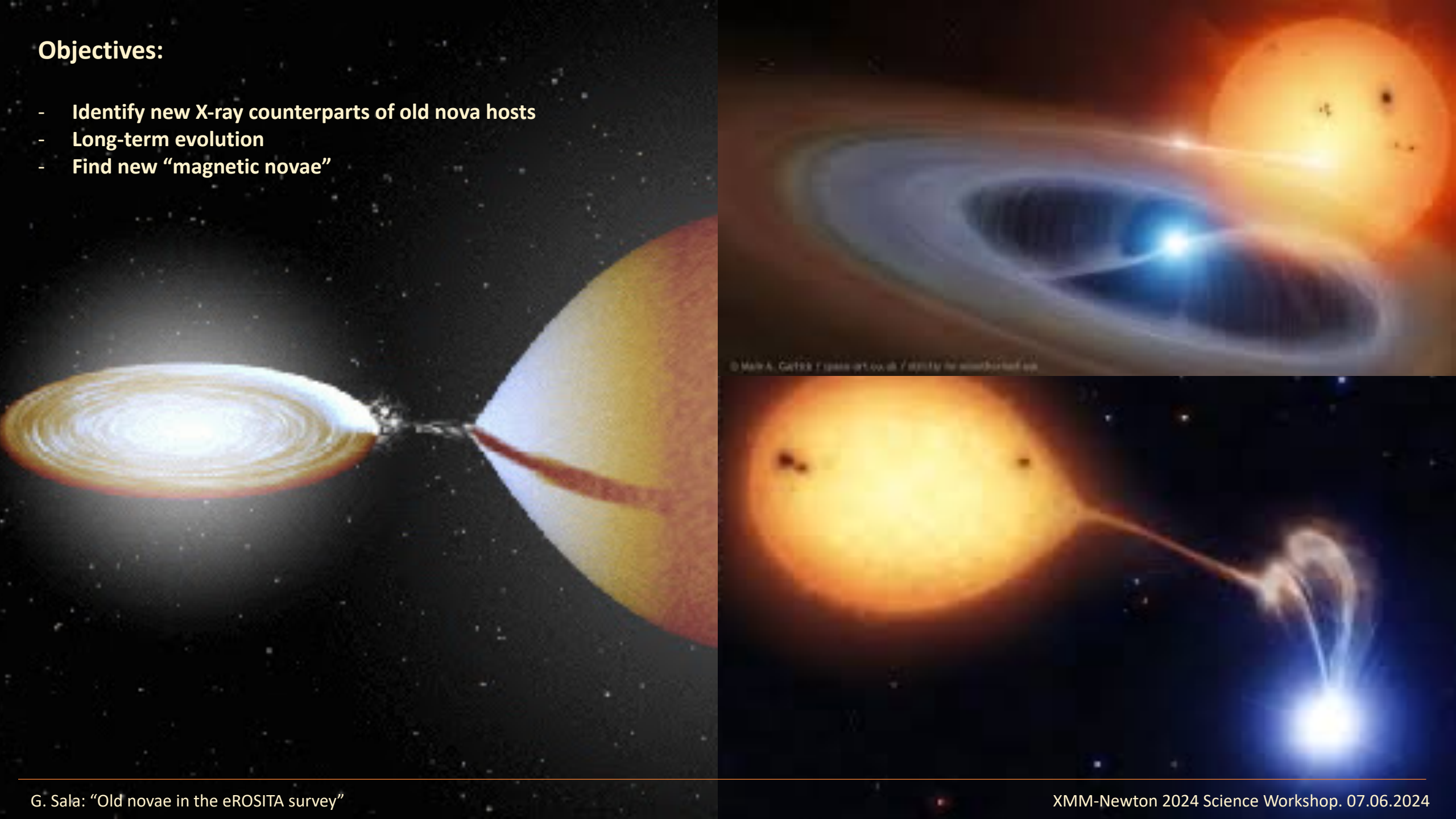
Glòria Sala (UPC, Barcelona)
Frank Haberl(MPE), Axel Schwope (AIP), Elif Safak (UPC),
Chandreyee Maitra(MPE), Robert Willer (MPE), Jochen Greiner (MPE)

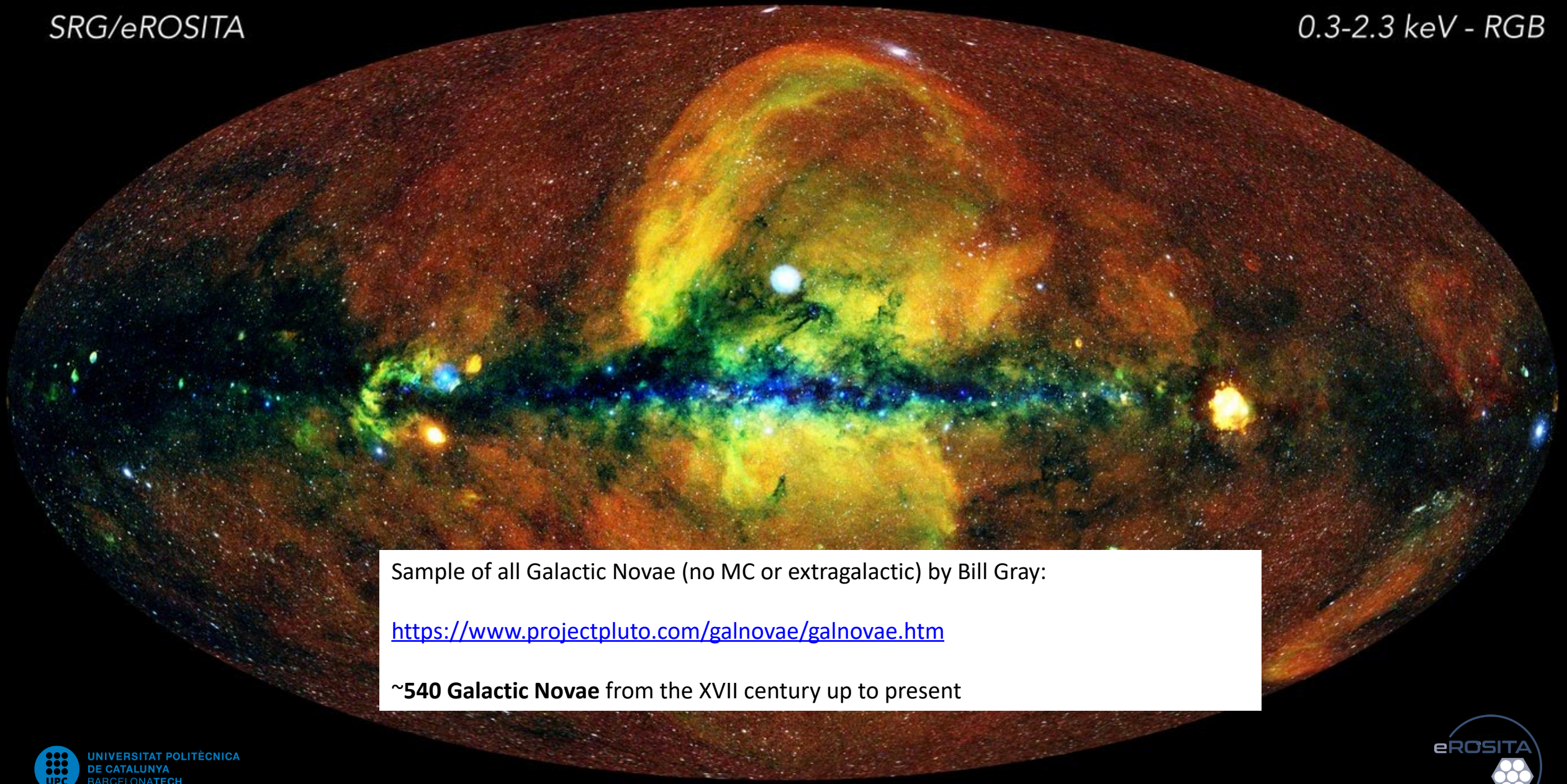
UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

eROSITA

Objectives:

- Identify new X-ray counterparts of old nova hosts
- Long-term evolution
- Find new “magnetic novae”





Sample of all Galactic Novae (no MC or extragalactic) by Bill Gray:

https://www.projectpluto.com/galnovae/galnovae.htm

~**540 Galactic Novae** from the XVII century up to present

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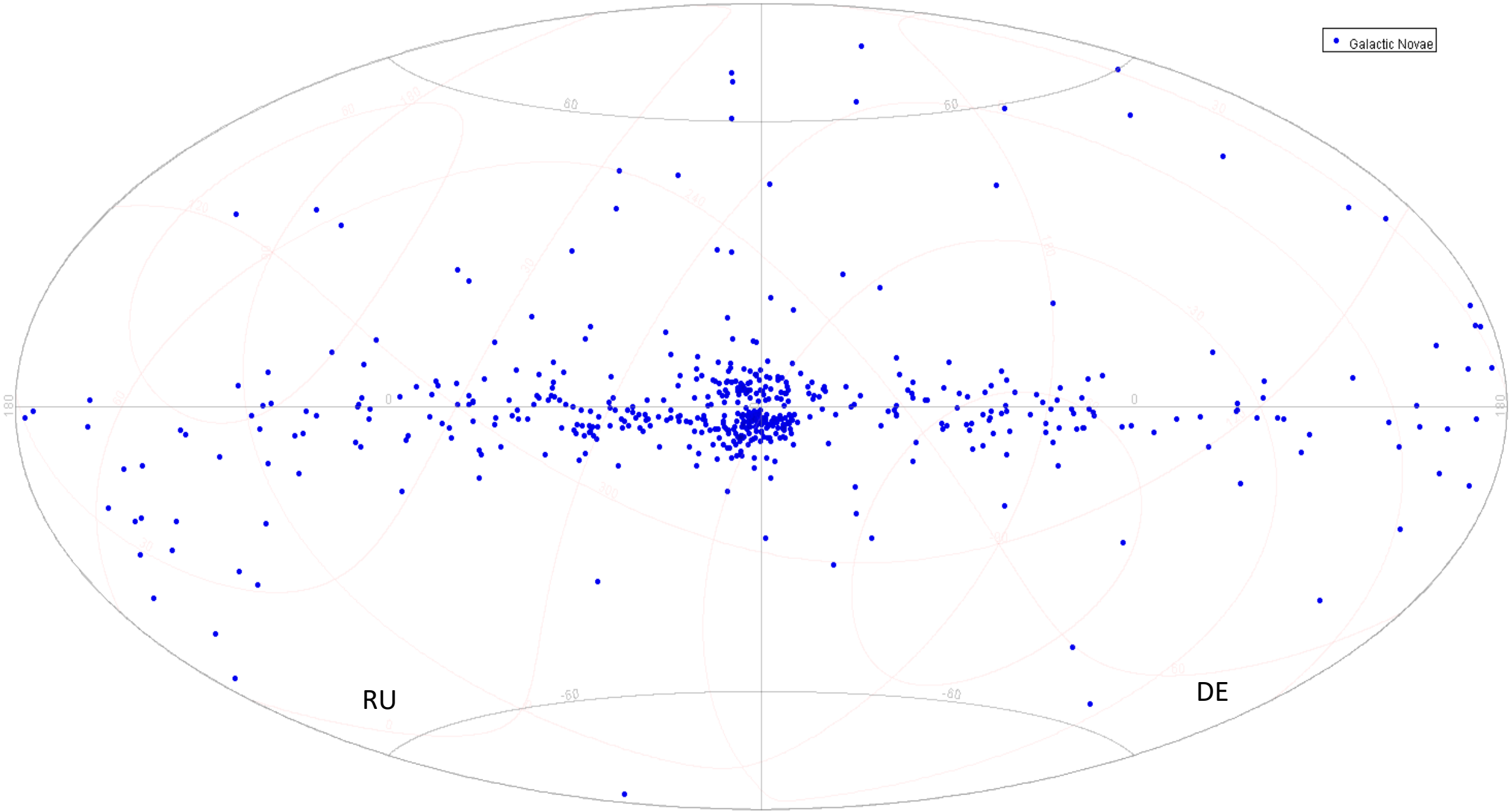
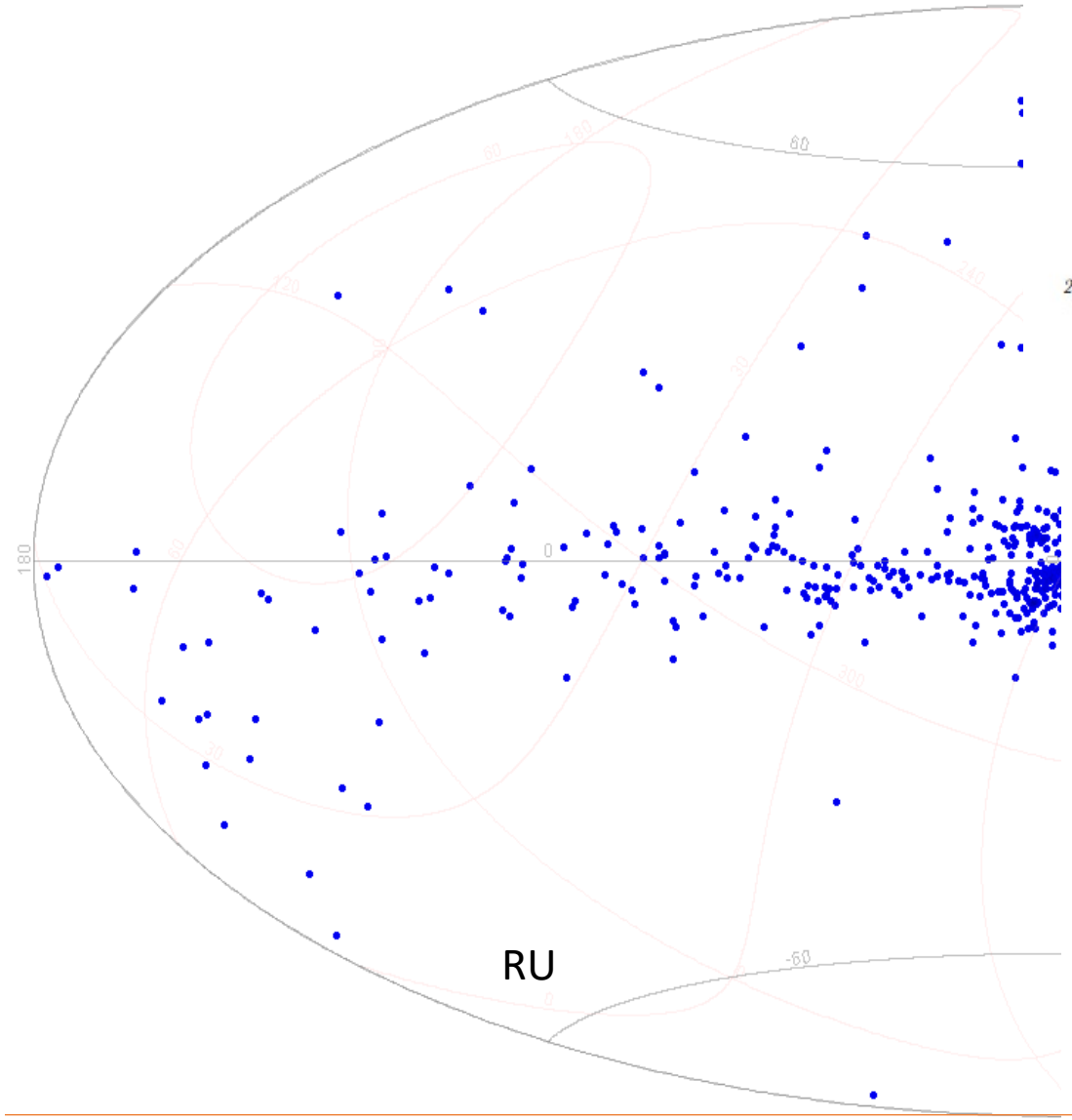
eROSITA


Galactic Novae
RU
DE



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Russian Text © The Author(s), 2021, published in Pis'ma v Astronomicheskii Zhurnal, 2021, Vol. 47, No. 9, pp. 613–633.

X-ray Observations of Historical Classical Nova Counterparts with eROSITA Telescope Onboard the SRG Orbital Observatory during the All-Sky Survey

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Received August 5, 2021; revised August 5, 2021; accepted August 5, 2021

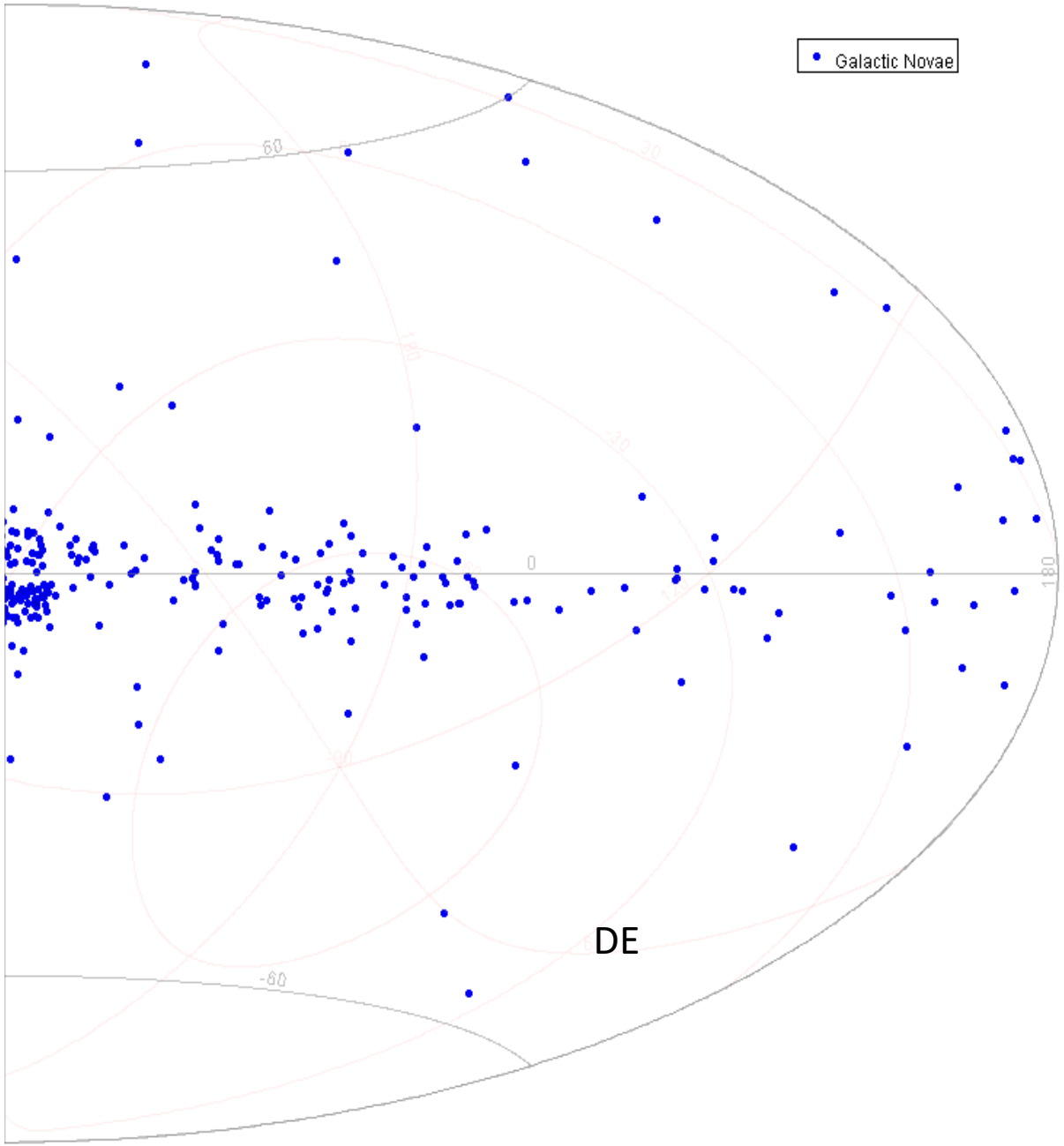
50 nova counterparts (+2 in outburst SSS)
11 with more tan 50 counts in merged spectra

Three old novae in quiescense with soft excess:

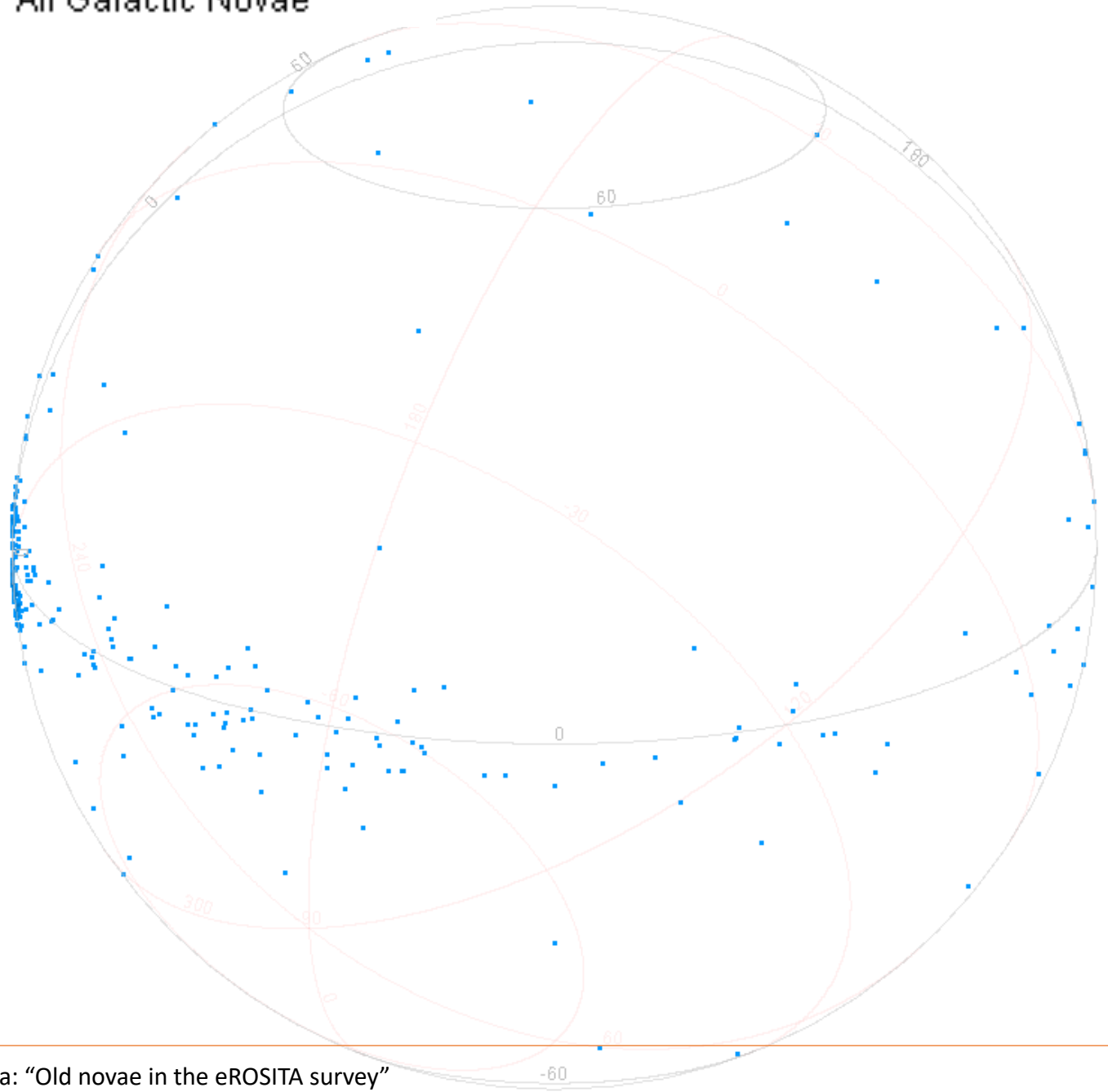
V1500 Cyg => confirmed polar

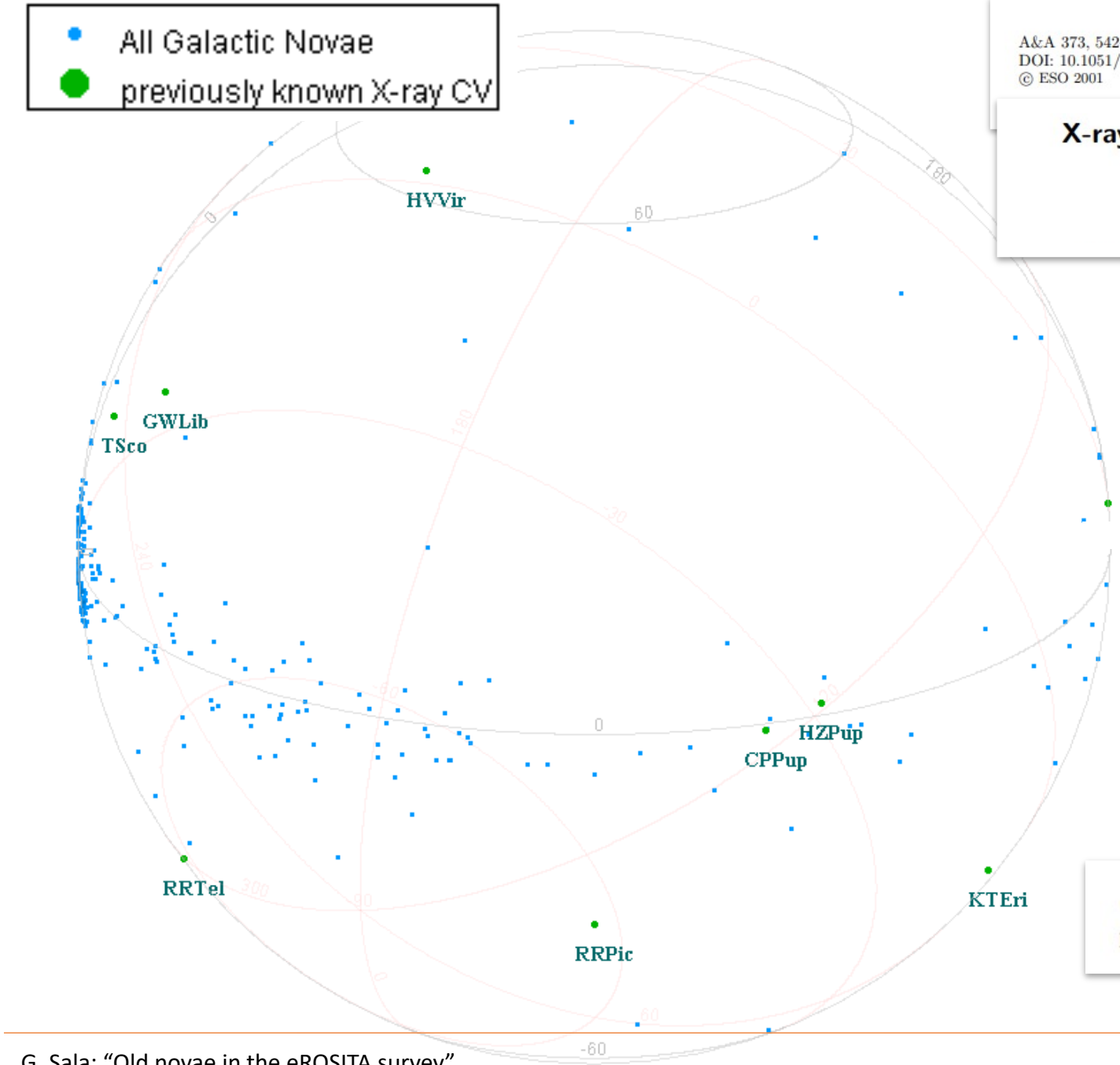
V5856 Sgr
V2491 Cyg

New magnetic novae?


Galactic Novae
60
30
0
-30
-60
180
DE

All Galactic Novae





A&A 373, 542–554 (2001)
DOI: 10.1051/0004-6361:20010537
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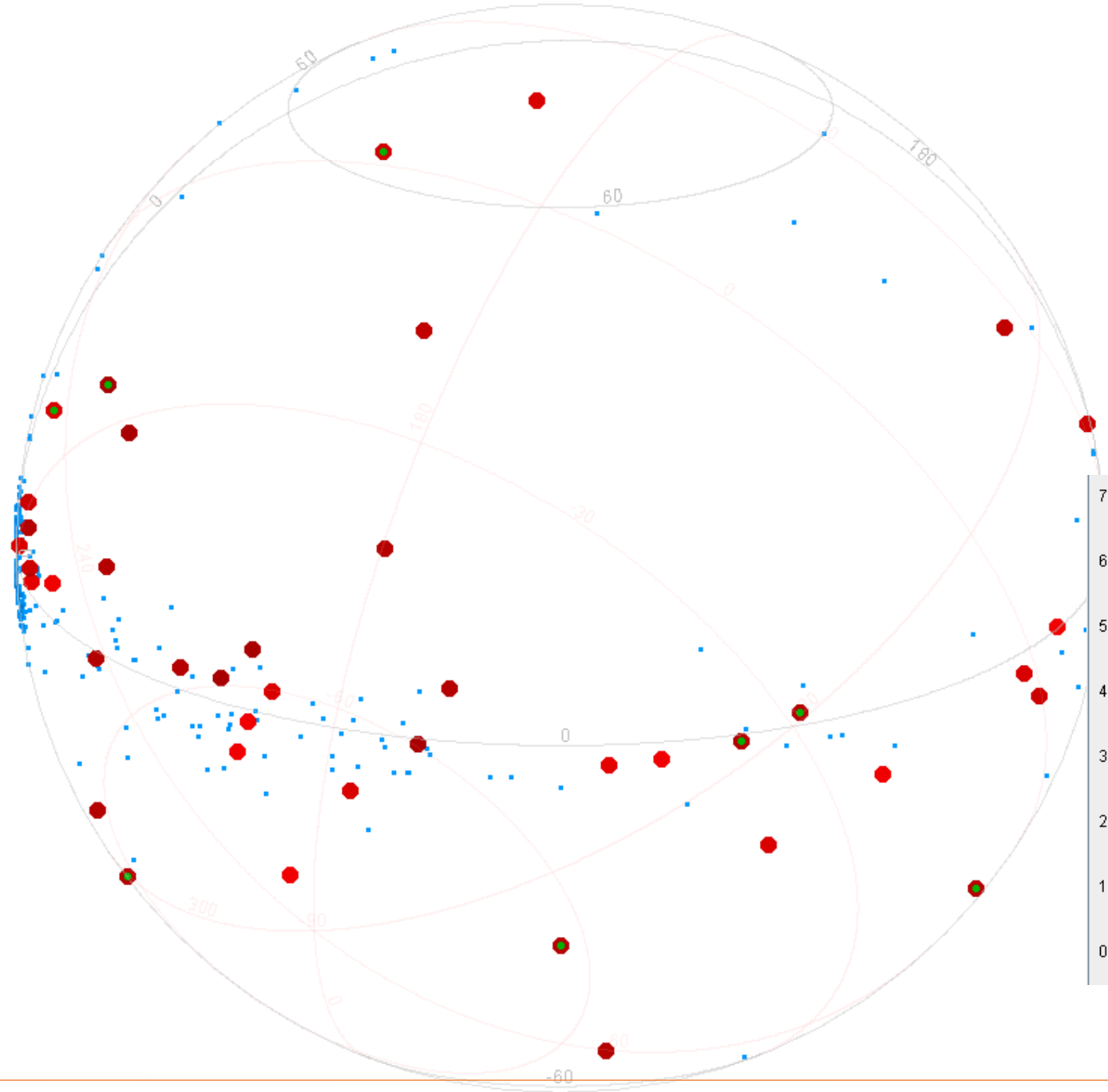
Astronomy & Astrophysics

X-ray emission from classical and recurrent novae observed with ROSAT

M. Orio[1,2], J. Covington[3], and H. Ögelman[3]

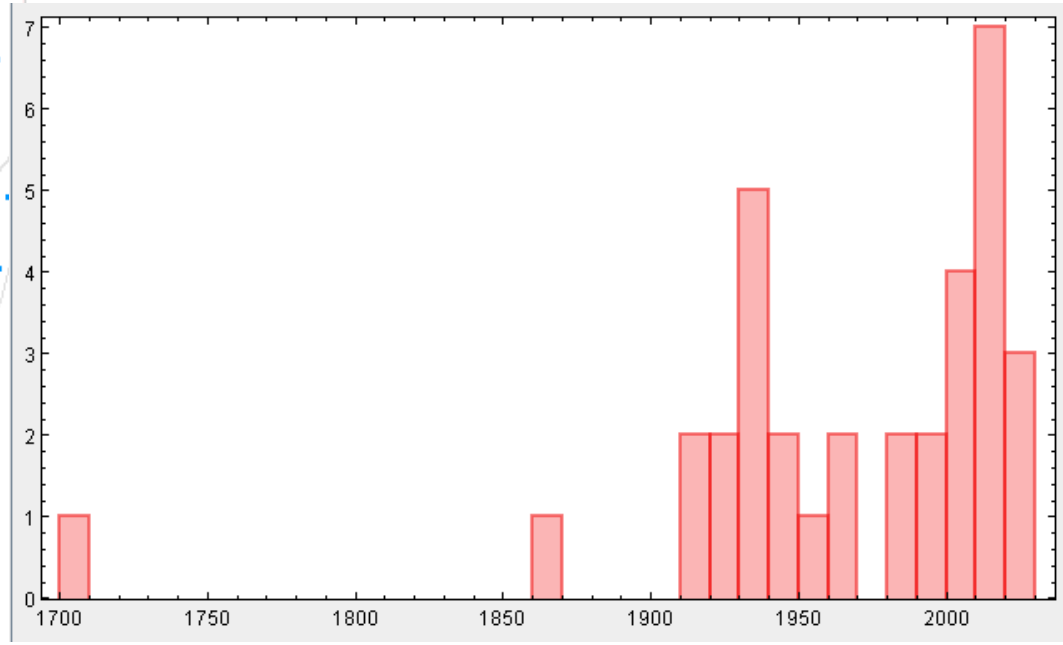
Nova	d (kpc)	$L_x \times 10^{32}$ erg s^{-1}	V	L_x/L_{opt} $\times 10^{-2}$	l.t.	orb.
V603 Aql	0.43	2	11.7	1.4	x	n
GK Per	0.6	3.5	13.0	2.8	x	
CP Pup	0.7	0.59–5.9	15.0	4.8		?
V841 Oph	1.0	0.3	13.4	1.6	?	
CP Lac	1.15	3.8	16.6	1.1	?	
T Sco	9.1	33	22.2	4.8		
DQ Her	0.33	0.03	14.5	0.005		
RS Oph	1.2	0.28–1.64	12.5	0.2	x	
RR Pic	0.26	0.02	12.2	0.06	x	n
V446 Her	1	0.72	18.0	3.3	x	
QU Vul	2.6	0.18	19.0	1.7		

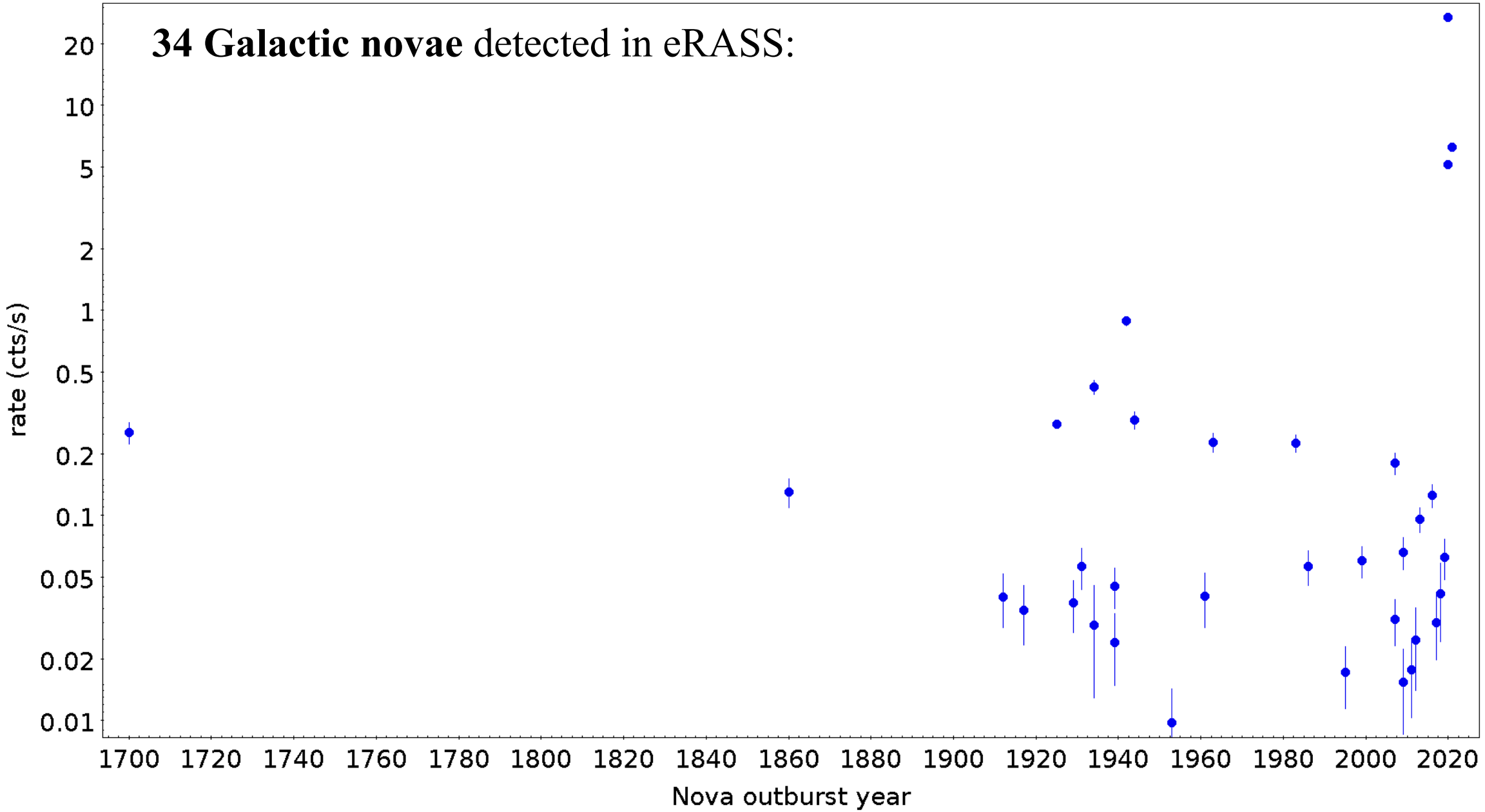
accretion. However, only 11 out of 81 quiescent Galactic novae observed in the pointed observations were detected.

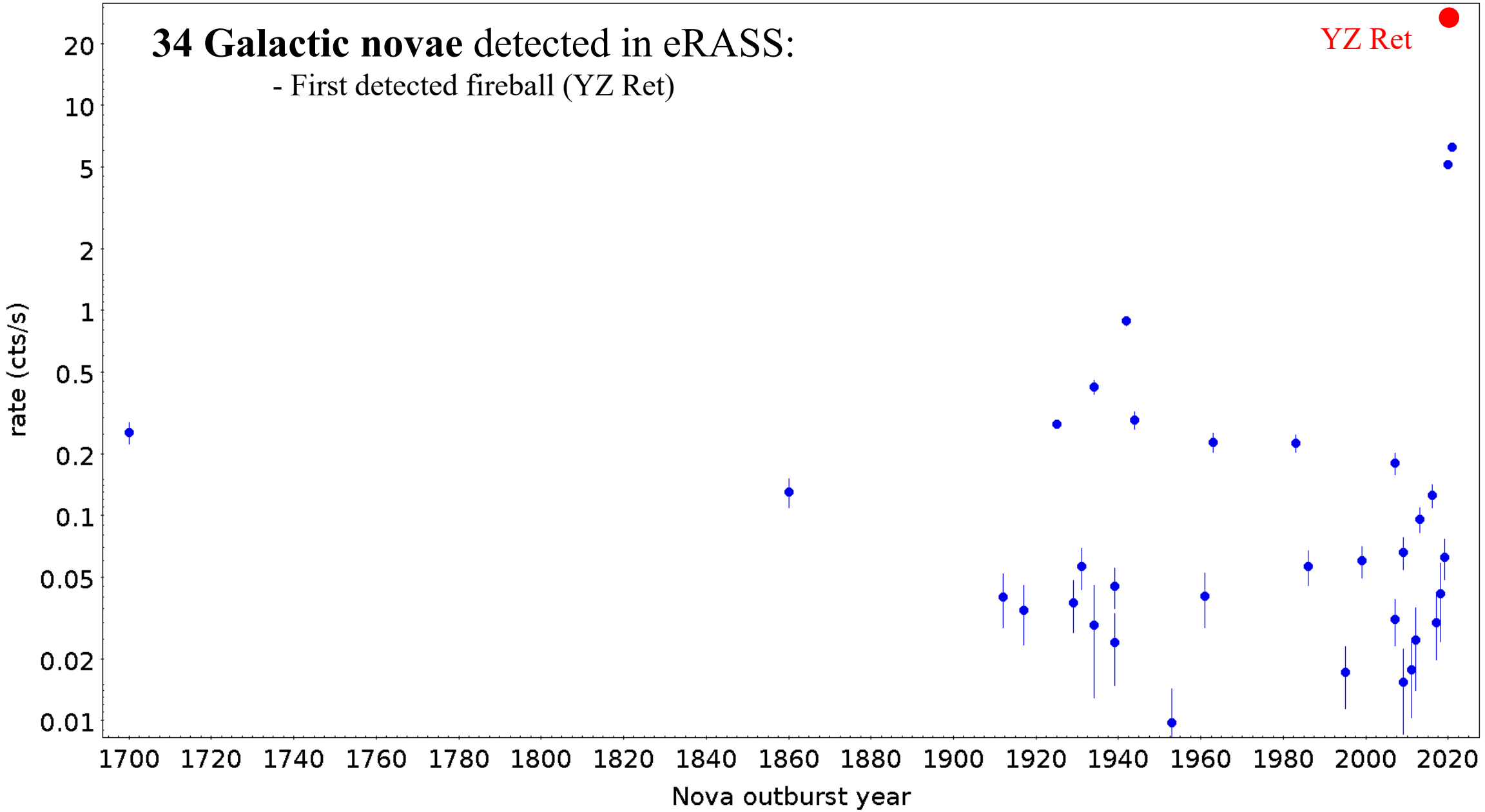


Galactic Novae
Detected in eRASS1:5
Previously known in X-ray

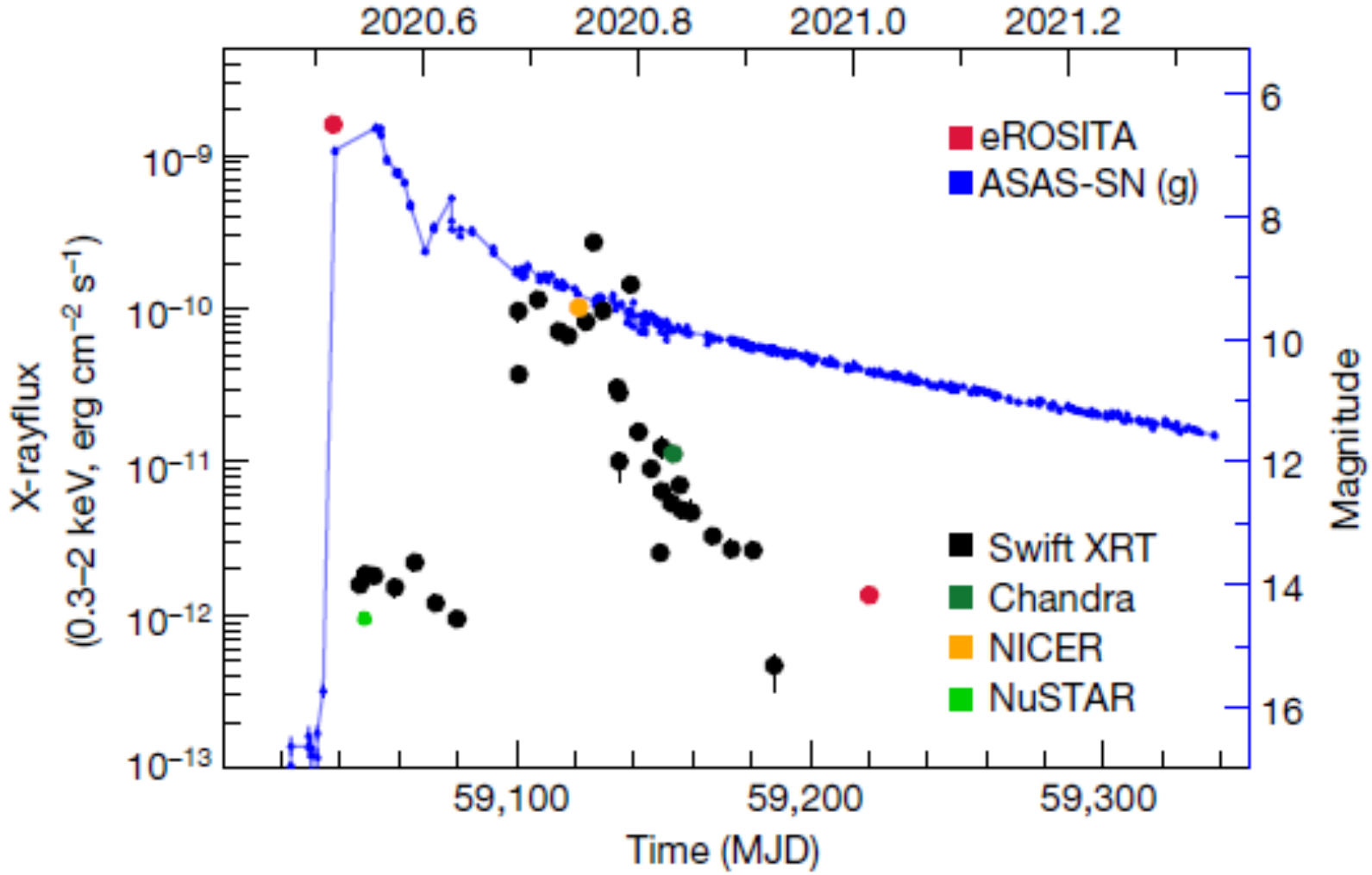
34 Galactic novae
detected in eRASS:4




34 Galactic novae detected in eRASS:
rate (cts/s)
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
1700
1720
1740
1760
1780
1800
1820
1840
1860
1880
1900
1920
1940
1960
1980
2000
2020
Nova outburst year

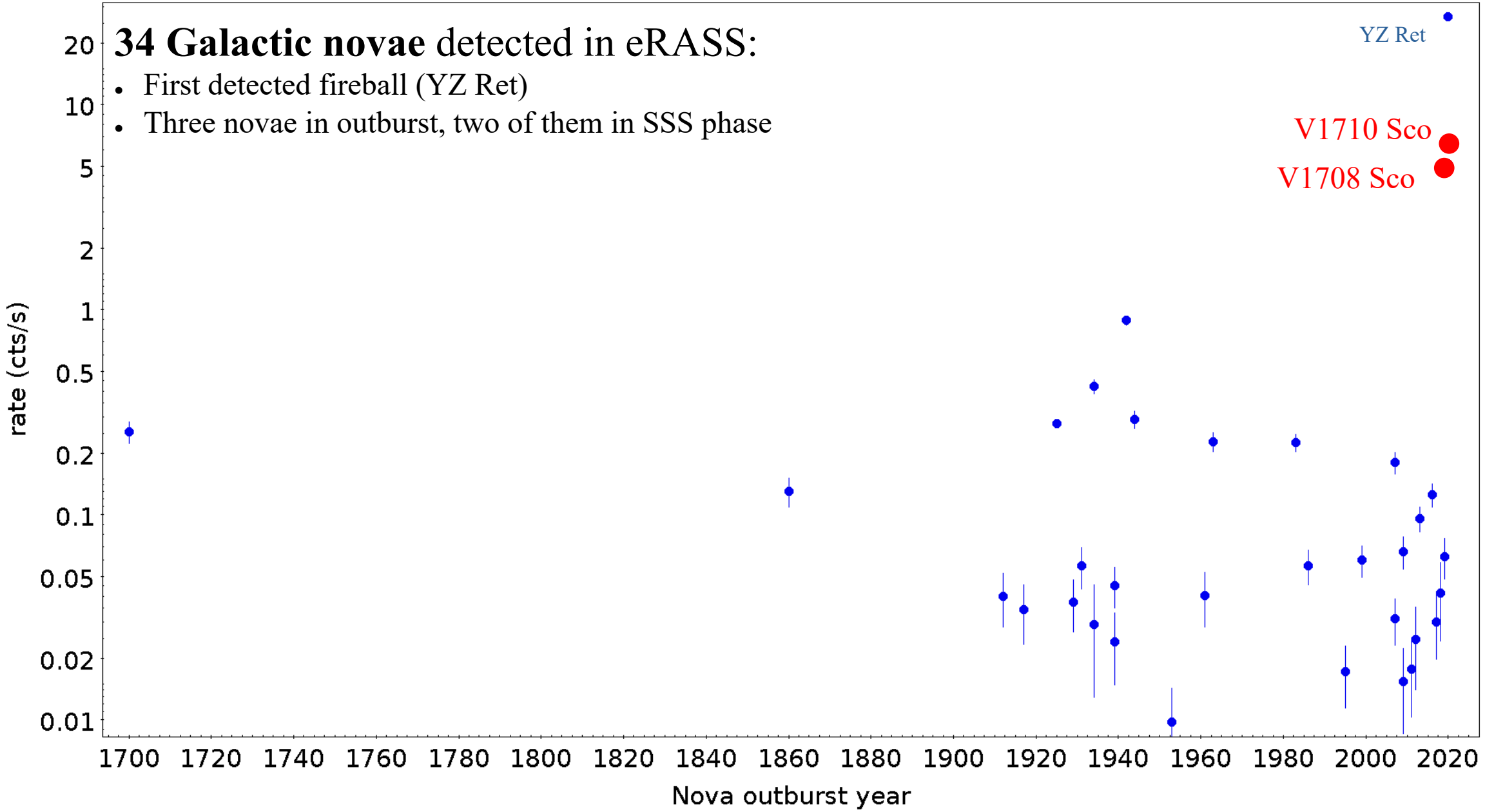

34 Galactic novae detected in eRASS:
- First detected fireball (YZ Ret)
YZ Ret
rate (cts/s)
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
1700
1720
1740
1760
1780
1800
1820
1840
1860
1880
1900
1920
1940
1960
1980
2000
2020
Nova outburst year

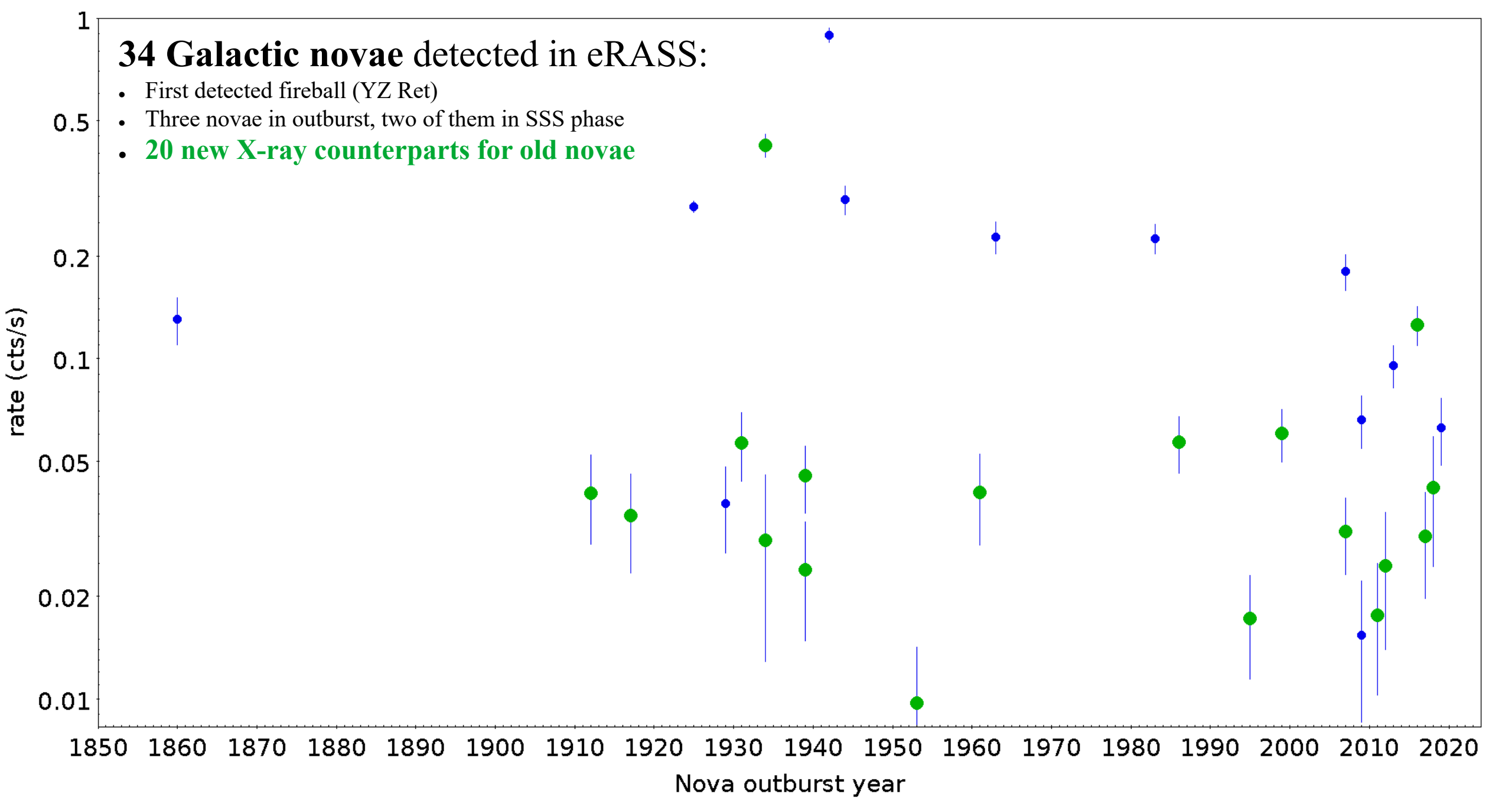
X-ray detection of a nova in the fireball phase

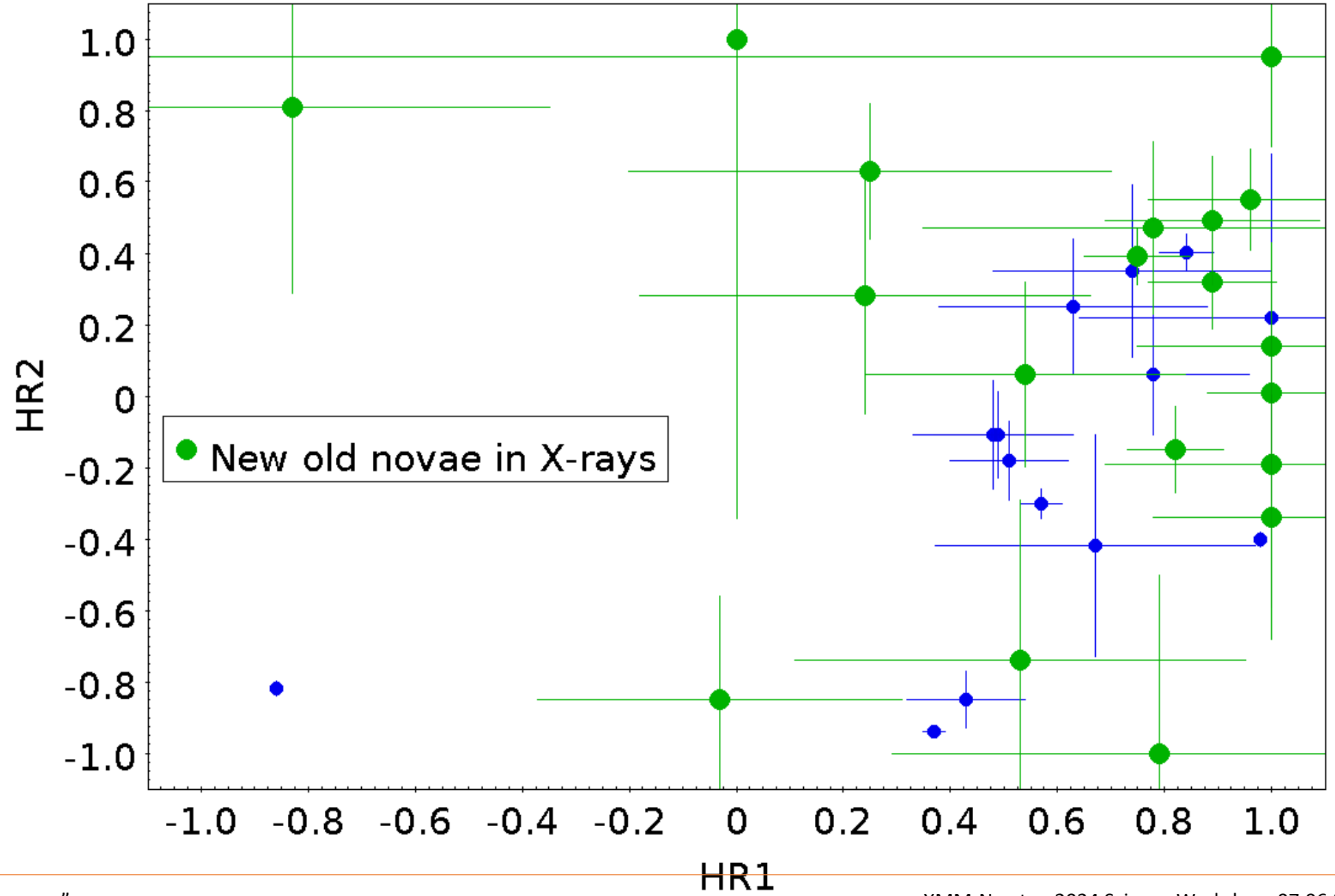


34 Galactic novae detected in eRASS:

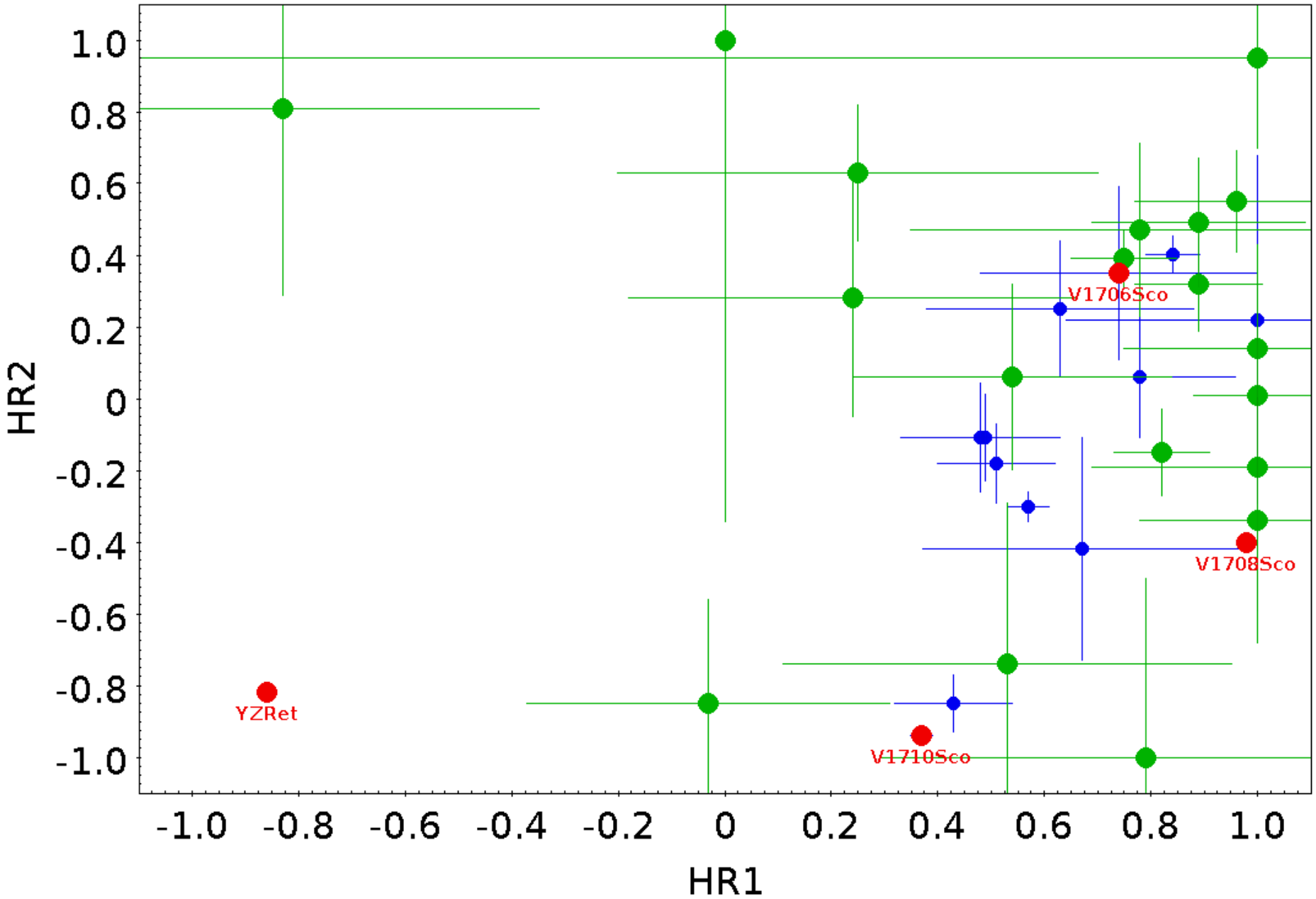
- First detected fireball (YZ Ret)
- Three novae in outburst, two of them in SSS phase



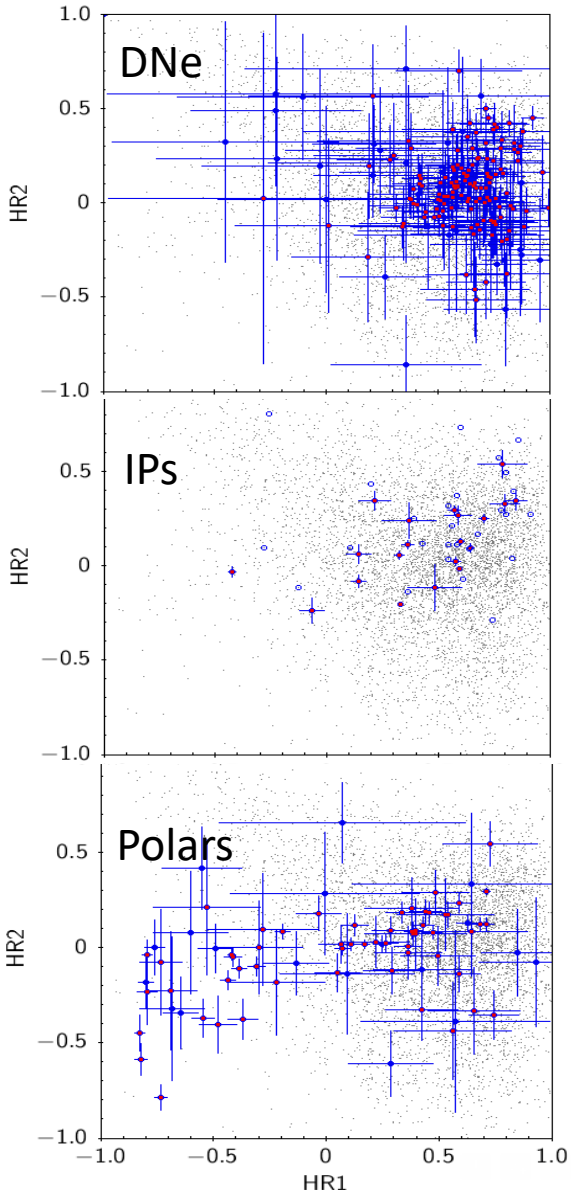

34 Galactic novae detected in eRASS:
First detected fireball (YZ Ret)
Three novae in outburst, two of them in SSS phase
20 new X-ray counterparts for old novae
rate (cts/s)
1
0.5
0.2
0.1
0.05
0.02
0.01
1850
1860
1870
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
Nova outburst year



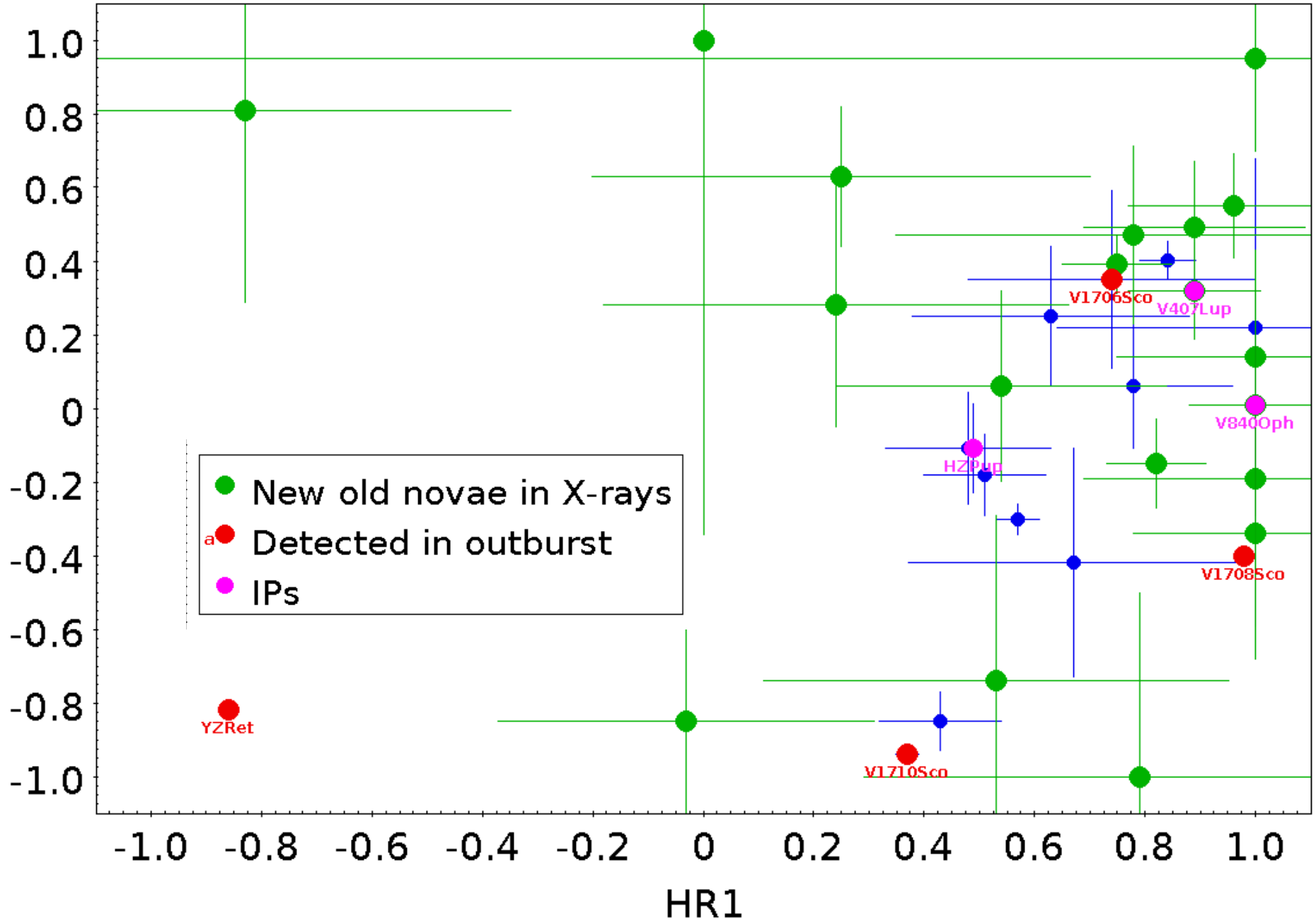
P1: 0.2-0.5 keV
P2: 0.5-1.0 keV
P3: 1.0-2.0 keV



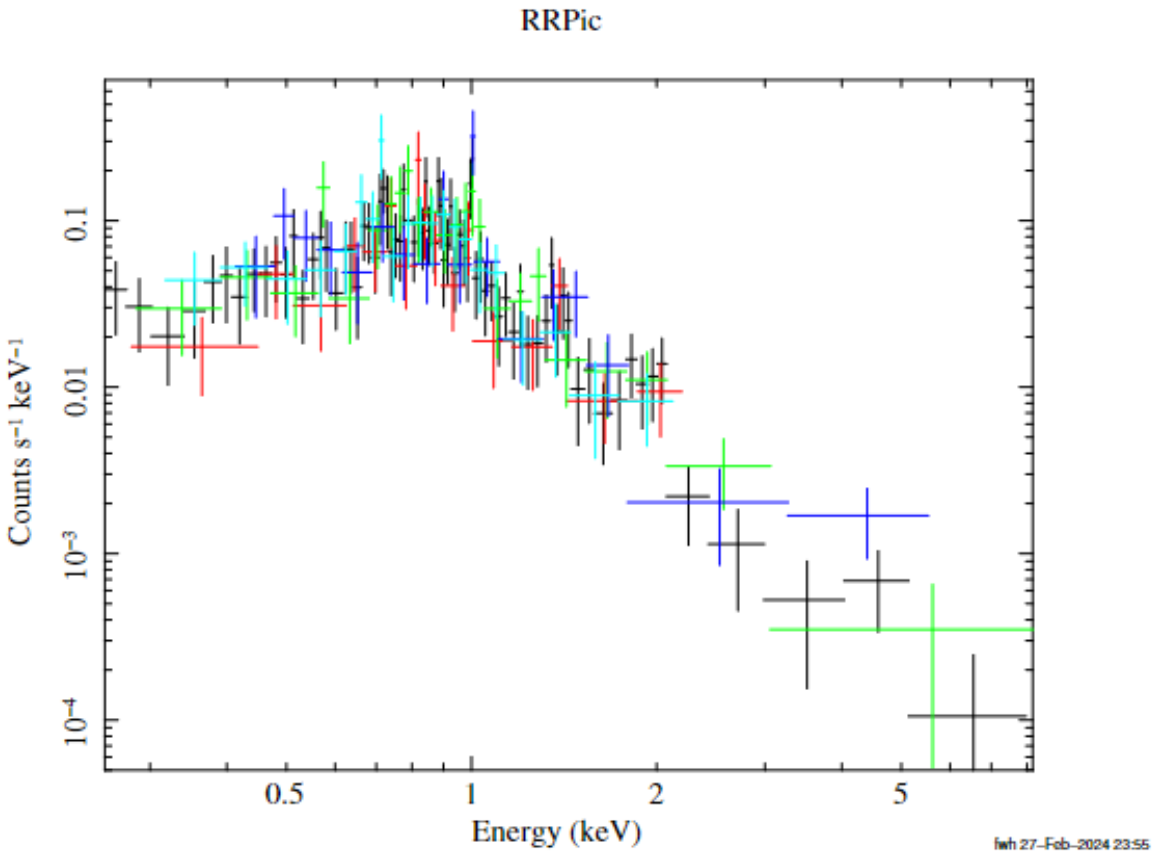
P1: 0.2-0.5 keV
P2: 0.5-1.0 keV
P3: 1.0-2.0 keV

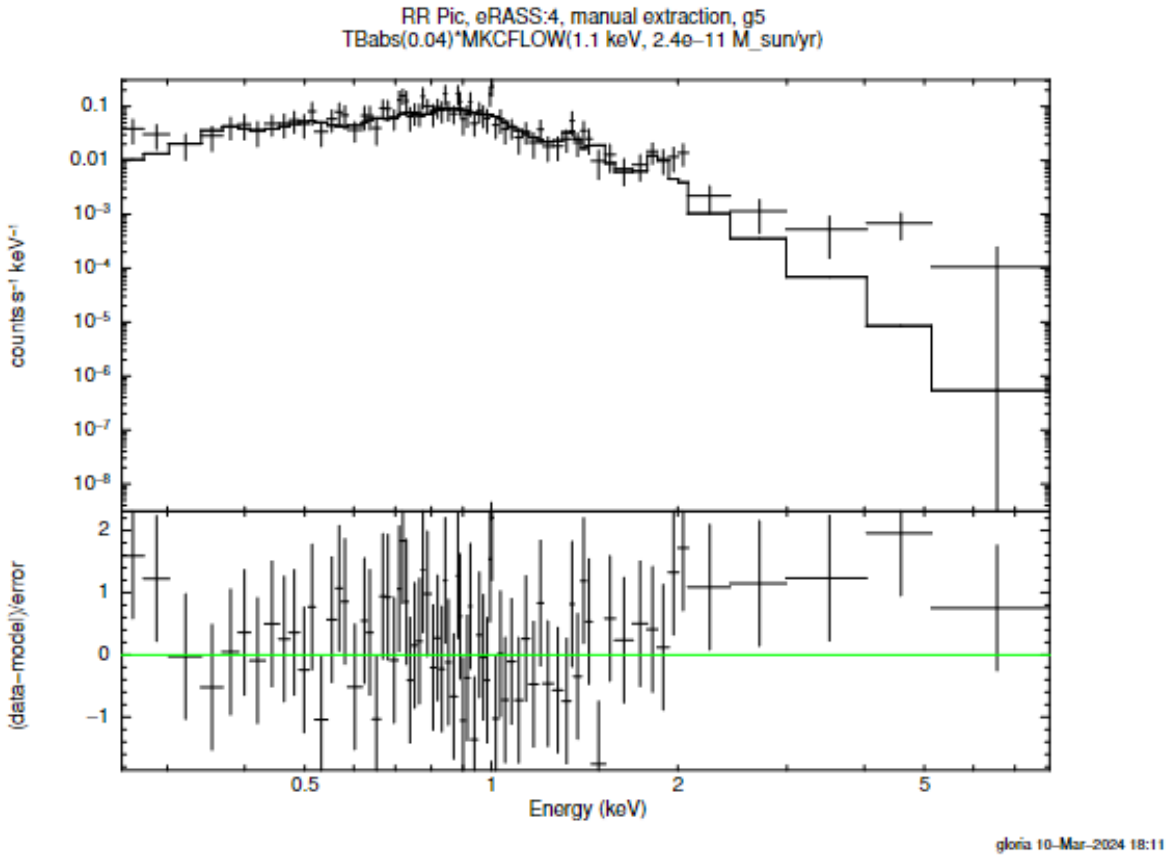


All CVs in eRASS
(courtesy of A. Schwope)



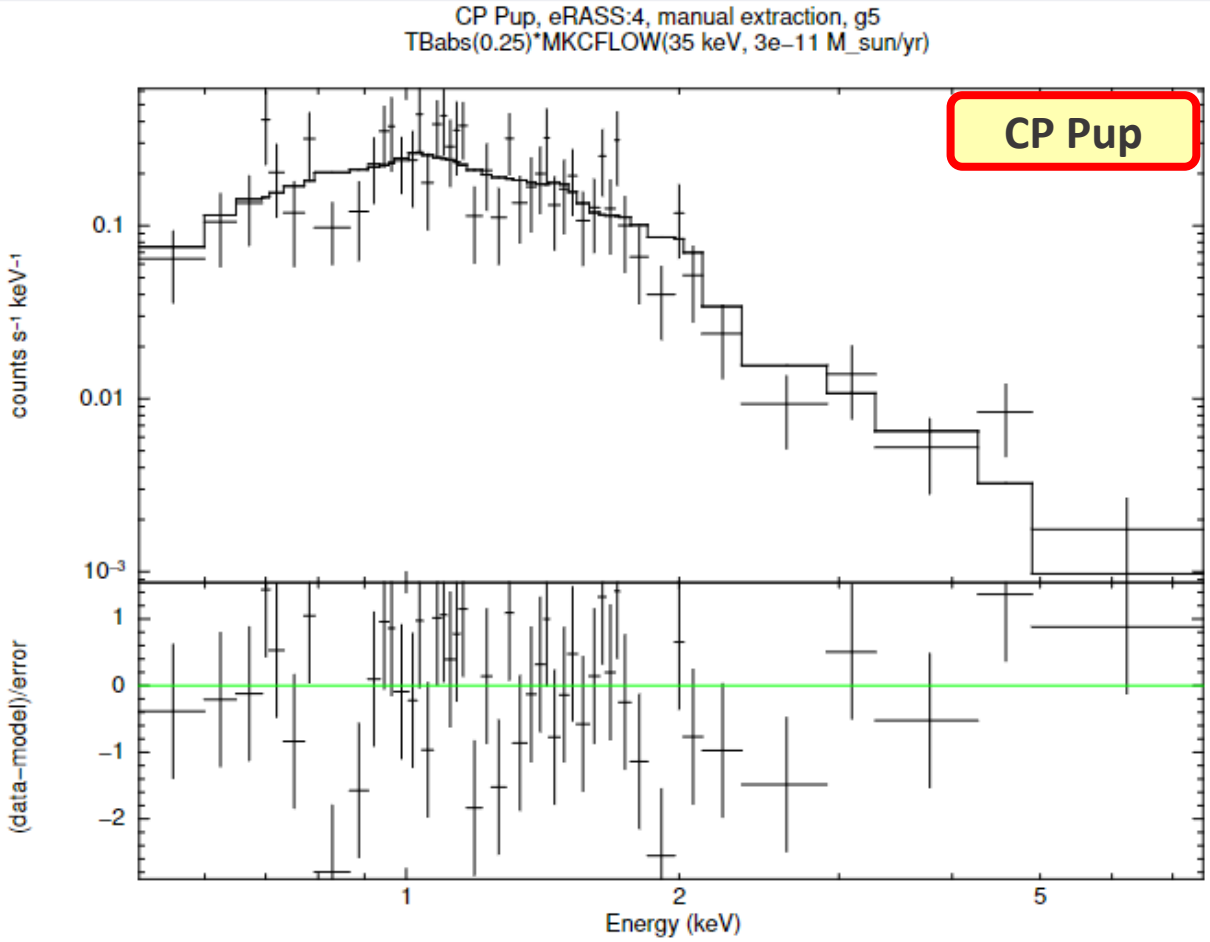
Non-magnetic CVs previously known in X-rays: RR Pic (Nova Pic 1925)



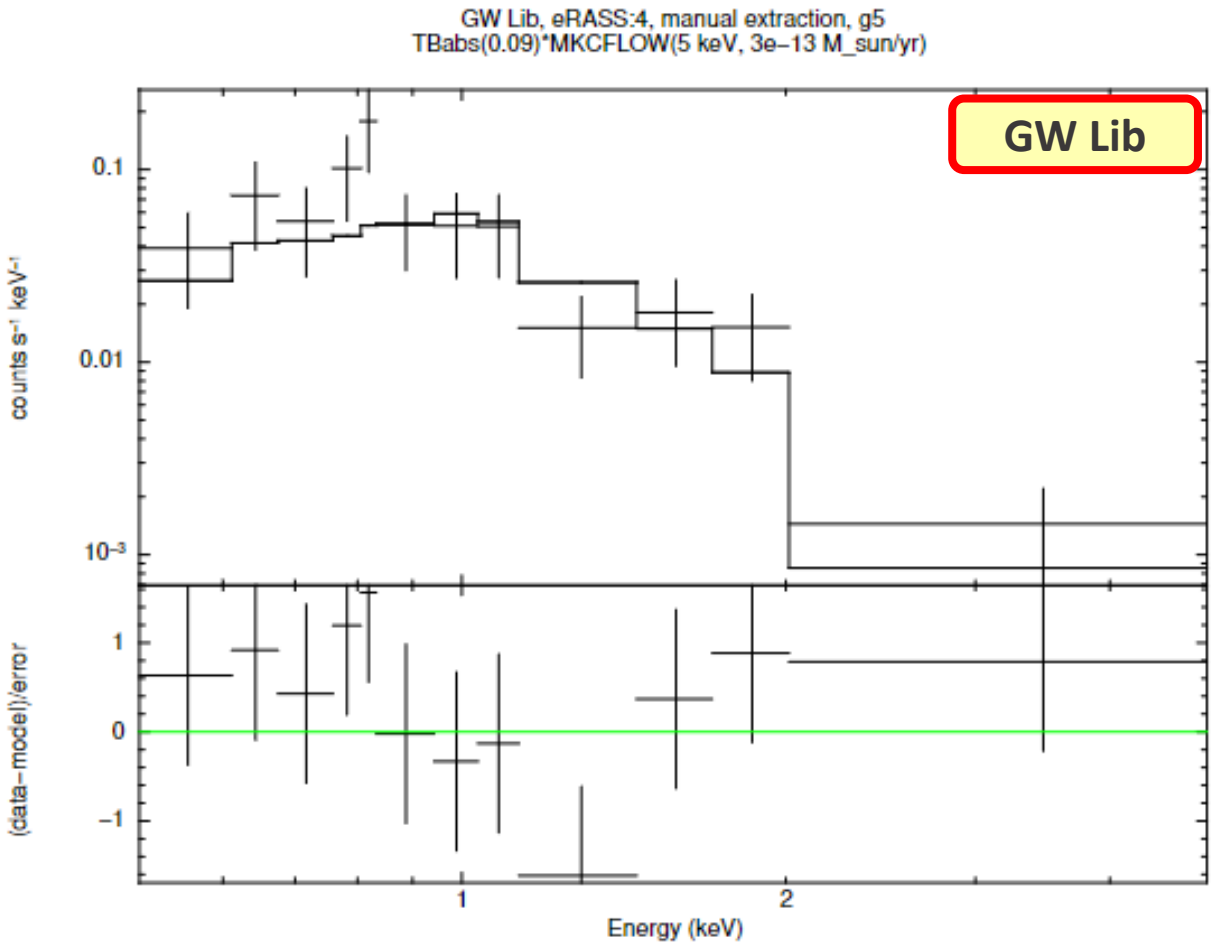


Spectral parameters and flux compatible with results from Chandra (Pekön & Balman 2008)

CVs previously known in X-rays: CP Pup (1942) and GW Lib (1983)



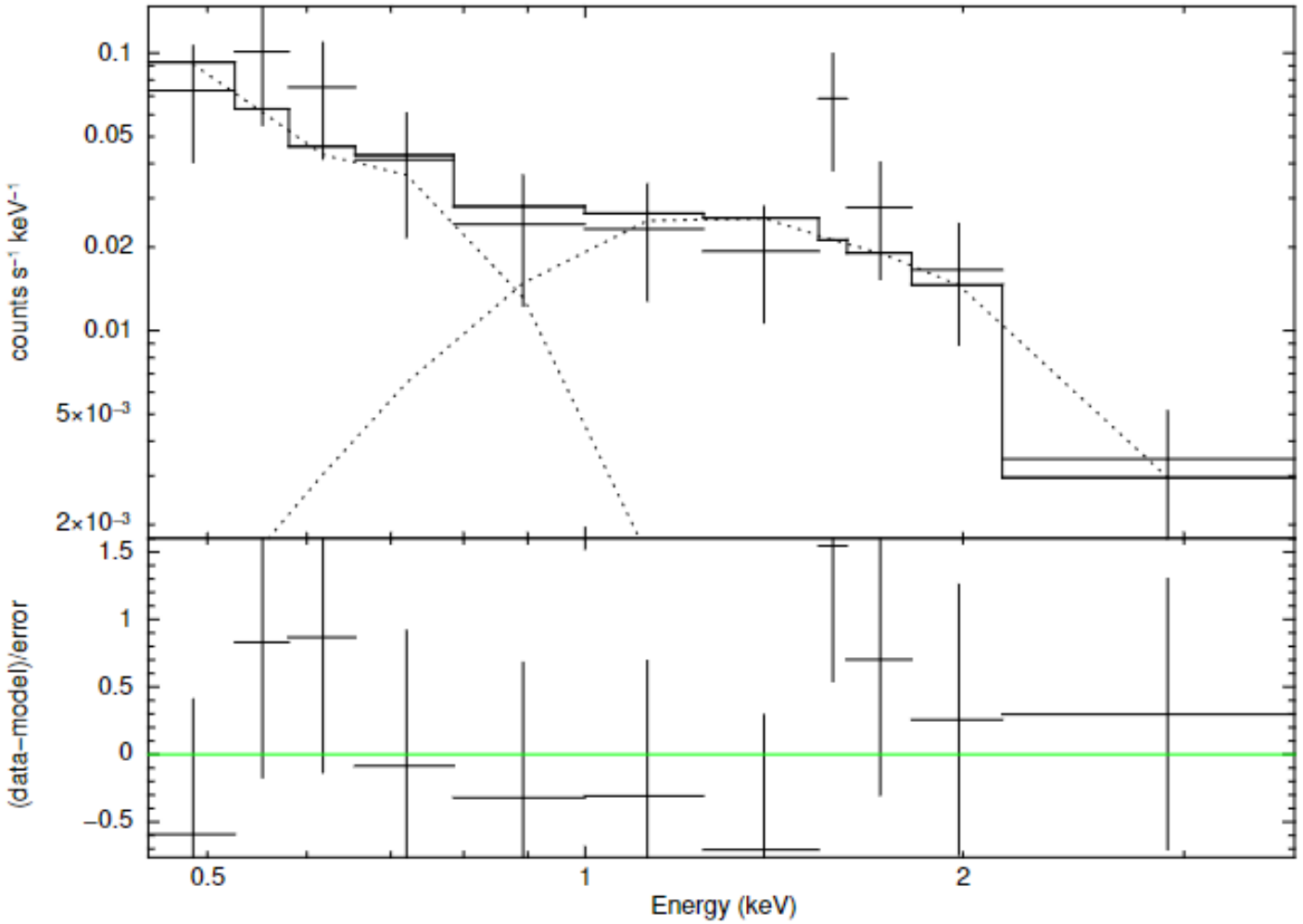
Spectra and flux compatible XMM-Newton obs. in 2005 (Orio et al 2009), and with ASCA (1998), ROSAT (1990s) and Einstein (1980s) observations.



Spectra and flux compatible XMM-Newton obs. in 2005 (Hilton et al. 2007)

mCVs previously known in X-rays: HZ Pup (Nova Pup 1963)

IP candidate: Porb~5h, Pspin~20 min (Abbott & Shafter 1997),



IP with soft excess

mkcflow model:

Low kT: 200 eV
High kT: 80 keV

Acc. Rate : $5\times10^{-11}\mathrm{M}_{\odot}\mathrm{yr}^{-1}$

bbody model

kT_{eff}: 60 eV
L_{bol}: (2-10) x 10^{34} erg/s

X-ray luminosity (0.2-10 keV):

$2 \times 10^{32}\mathrm{erg/s}$

Previously known in X-rays: HZ Pup as seen by XMM

HZ Pup	0804110501	2018-04-21	XMM	42.8 ks

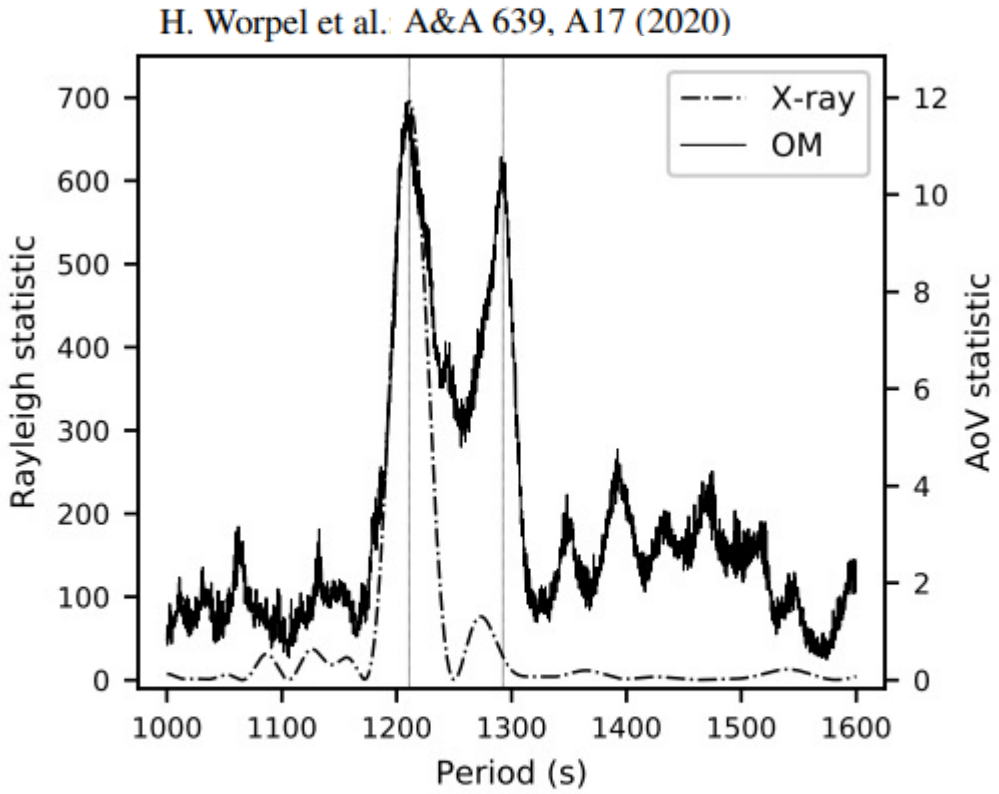
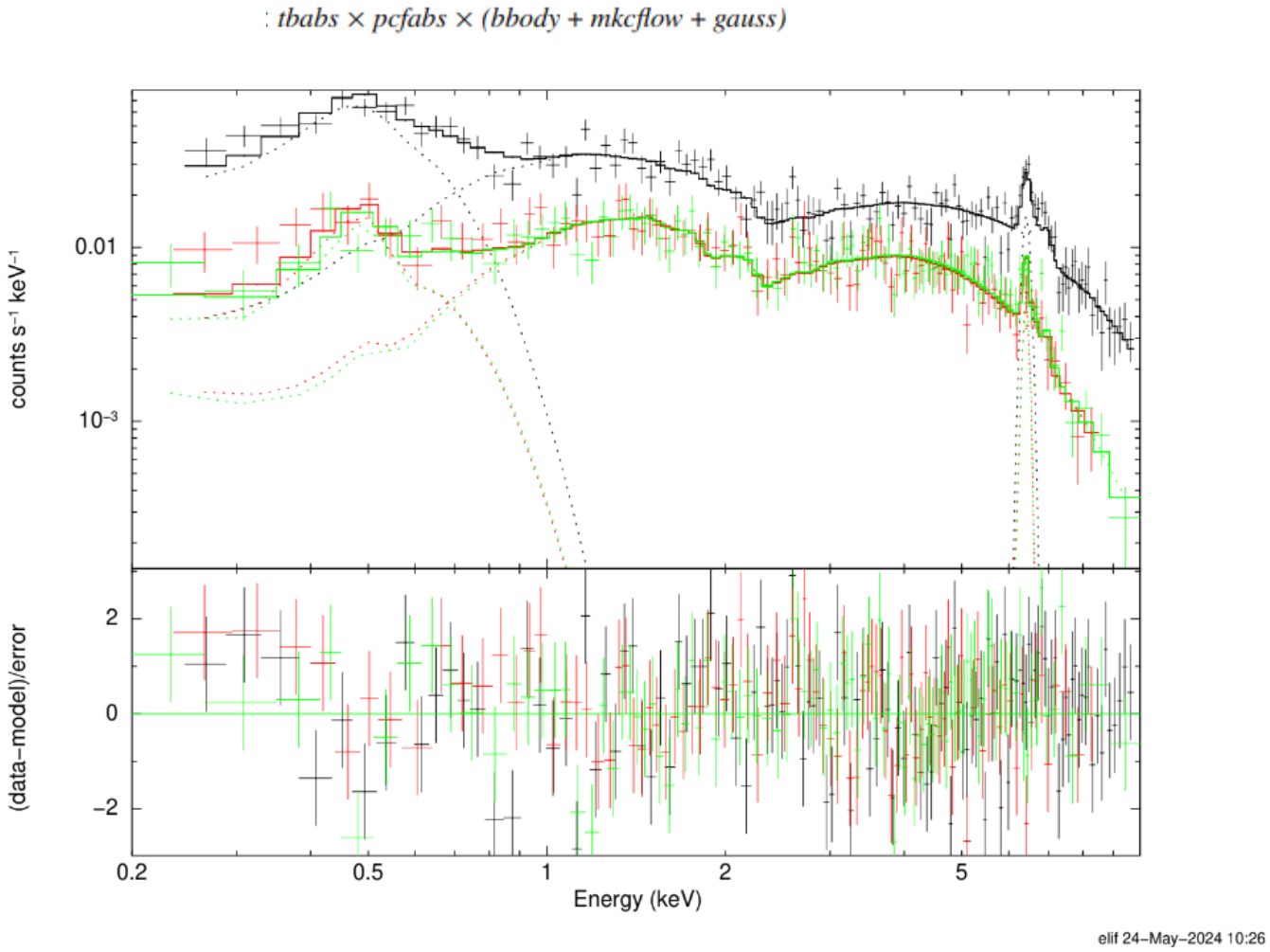
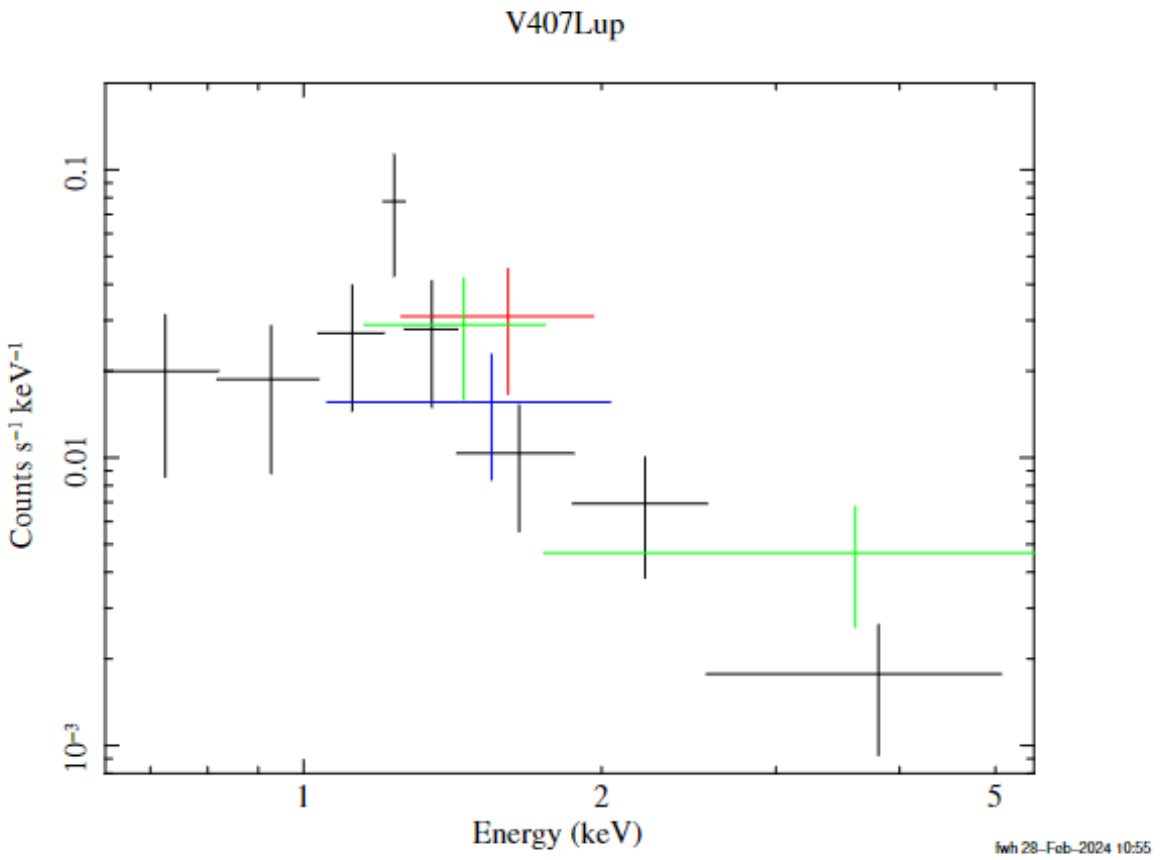
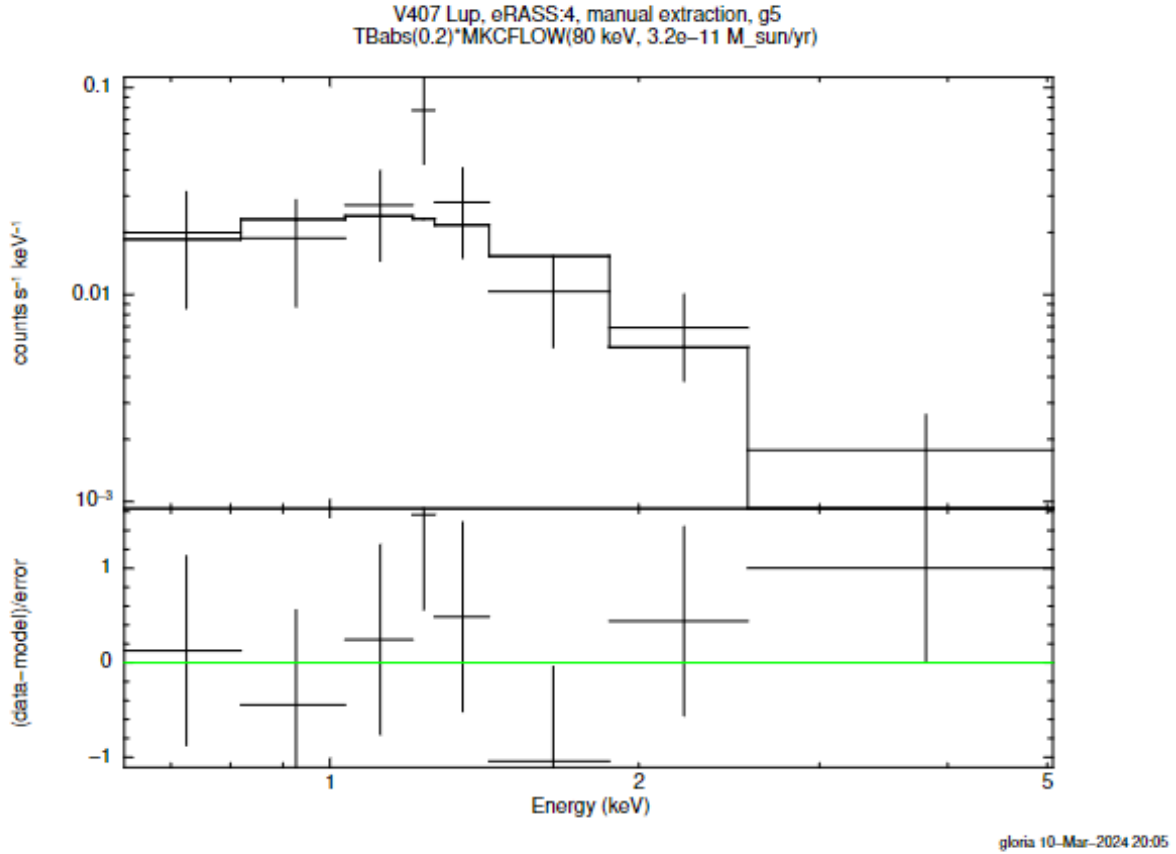


Fig. 2. Periodicities for HZ Pup in X-rays (dashed curve, H-statistic) and UVW1 (solid curve, AoV statistic). Vertical dotted lines indicate the 1210.9 s spin period and the likely 1292.6 s $\omega - \Omega$ beat frequency.



A not so old nova… V407 Lup (2016) now in quiescence



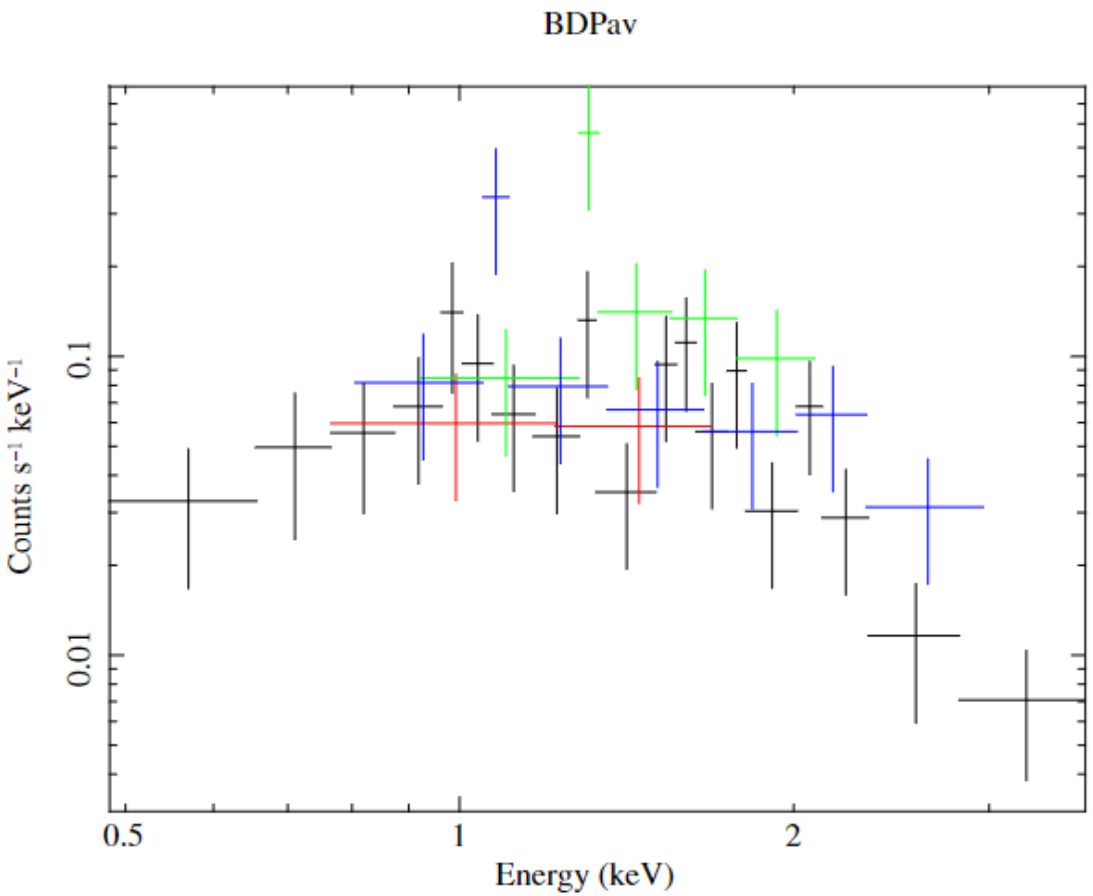


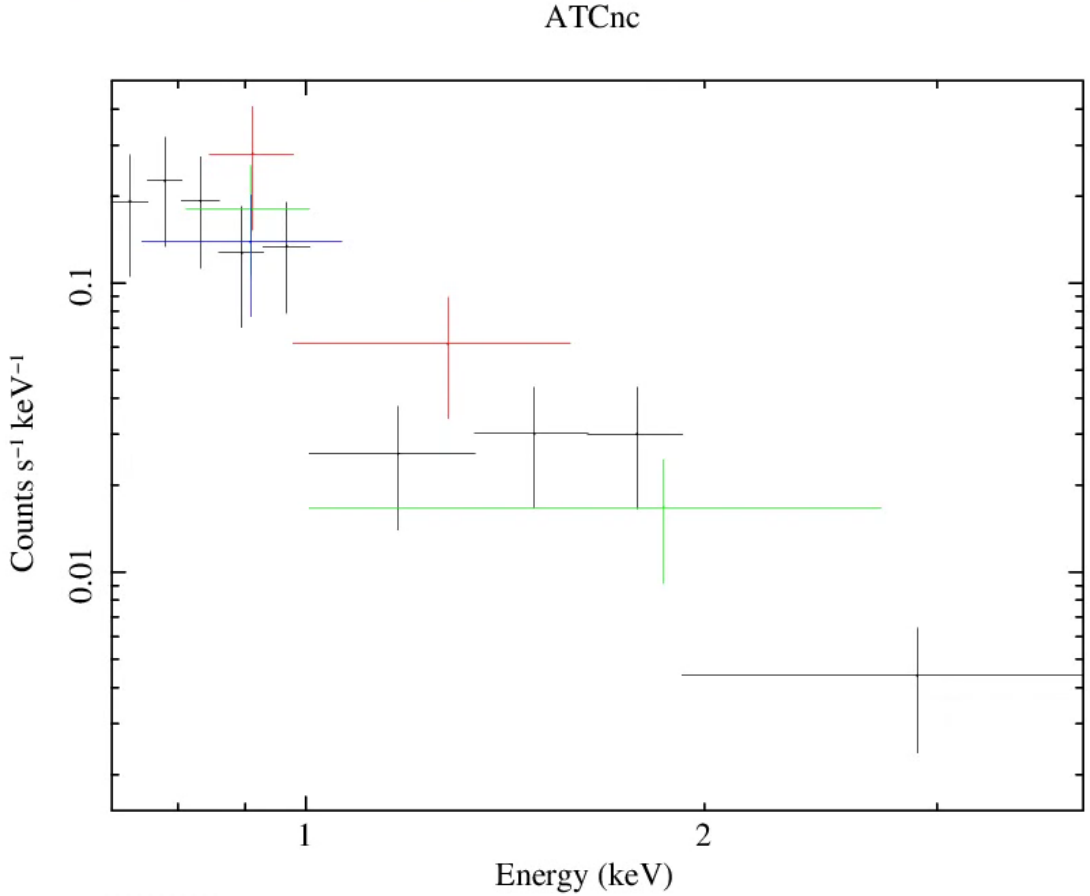
Low kT: 200 eV

High kT: 80 keV

Acc. Rate : $3\times10^{-11}\mathrm{M}_{\odot}/\mathrm{yr}$

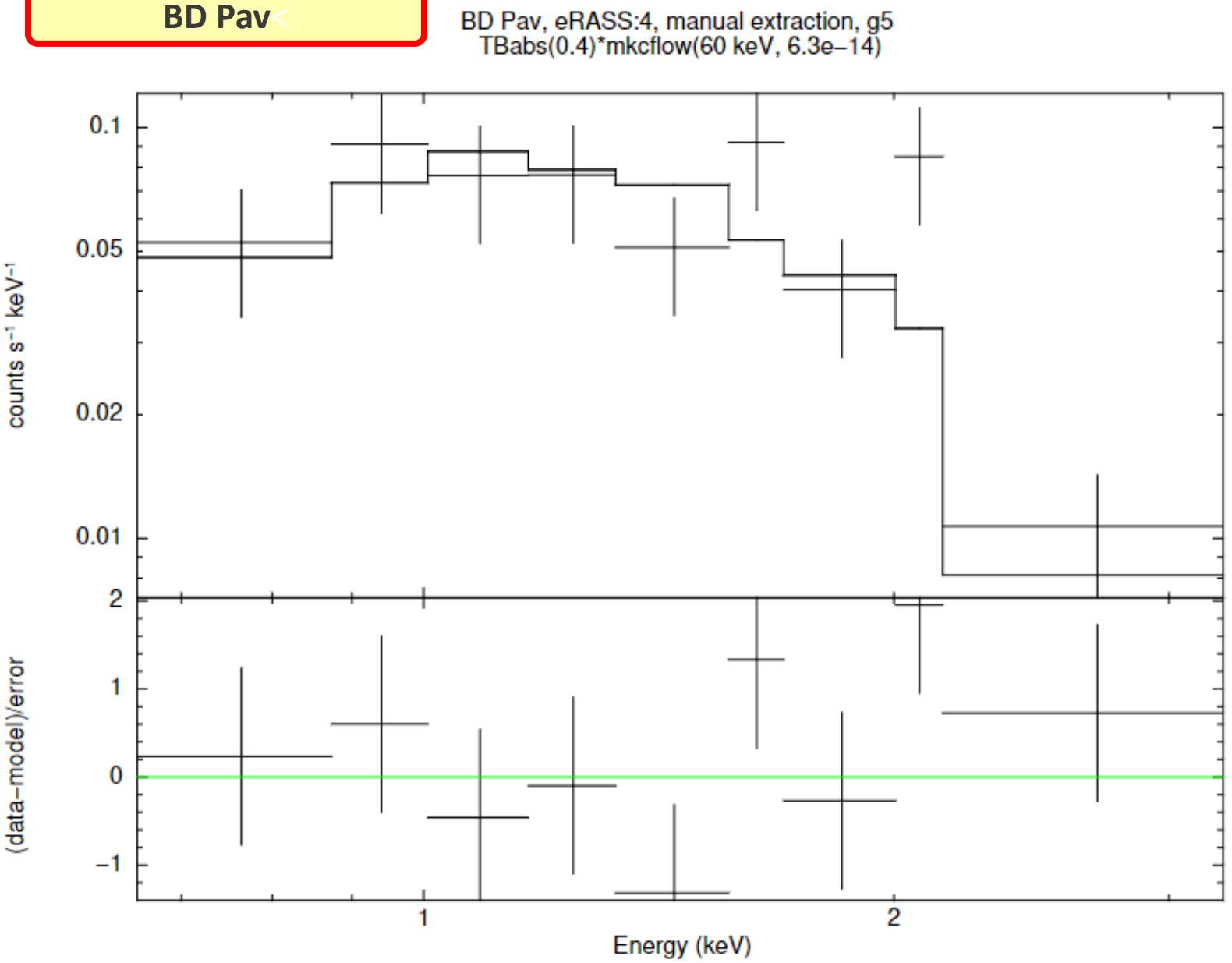
New X-ray counterparts of old novae in quiescence: AT Cnc and BD Pav





CV Name	Nova	CV type	orb.(h)	SpType
AT Cnc	1700	DN, ZC	4.8	K7-M0/5
BD Pav	1934	DN, UG	4.32	M5-8/5

BD Pav<



BD Pav (nova 1934)

Accretion onto non-magnetic WD

⇒ cooling flow

mkcflow model:

Low kT: 200 eV
High kT: 60 keV

Acc. Rate :

$$6(^{+10}_{-3}) \times 10^{-14} \mathrm{M_{\odot} yr^{-1}}$$

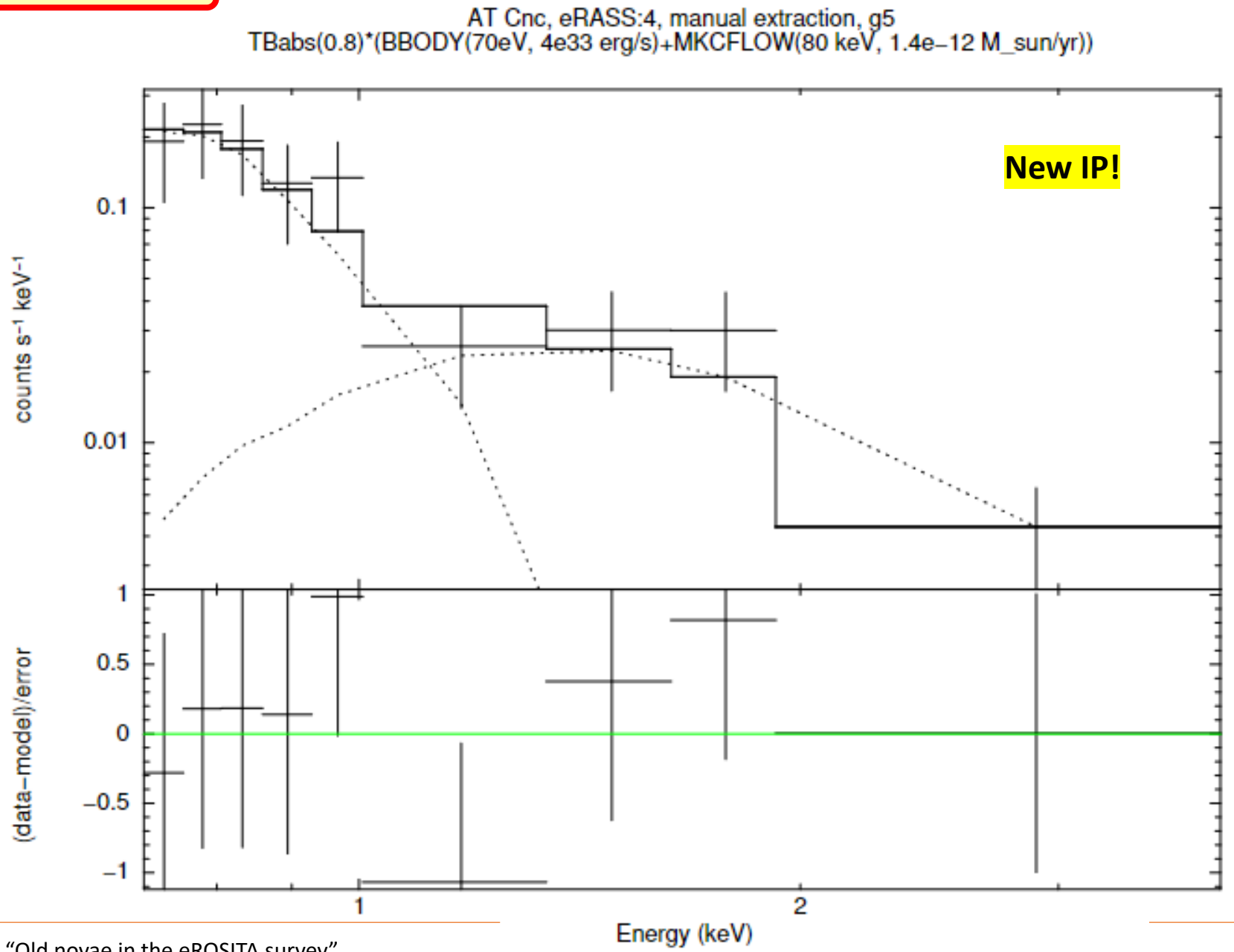
Total X-ray luminosity:

$$4(\pm 2) \times 10^{30} \mathrm{erg/s}$$

X-ray flux:

$$4(\pm 2) \times 10^{-13} erg\ s^{-1} cm^{-2}$$

AT Cnc



- Nova shell from 1700
  (Shara et al 2012)
- Two periodicities
  (Bruch et al. 2019)

mkcflow model:

Low kT: 200 eV
High kT: 80 keV

Acc. Rate :

$$1.4 \times 10^{-12} \mathrm{M}_{\odot}/\mathrm{yr}$$

bbody model:

kT_{eff}: 70 eV
L_{bol}: 4×10^{33} erg/s

Total X-ray luminosity:

$$7 \times 10^{30} \mathrm{erg/s}.$$

Summary

- **In total 34** novae detected in eRASS-DE
- **4** in outburst (2 SSS, one fireball)
- **NEW 20** host systems of old, quiescent novae detected in X-ray for the first time

- **8** sources with >50 counts in merged spectra
  - *6 non-magnetic*: *RR Pic, CP Pup, GW Lib* and the new counterparts
  - **BD Pav** and **V407 Lup**, are consistent with dwarf novae (non-magnetic white dwarf); bright *CP Pup* constant since the 80s!!
  - 2 magnetic candidates with soft excess:
    - **AT Cnc** and *HZ Pup*