Binaries (and pulsars) session highlights

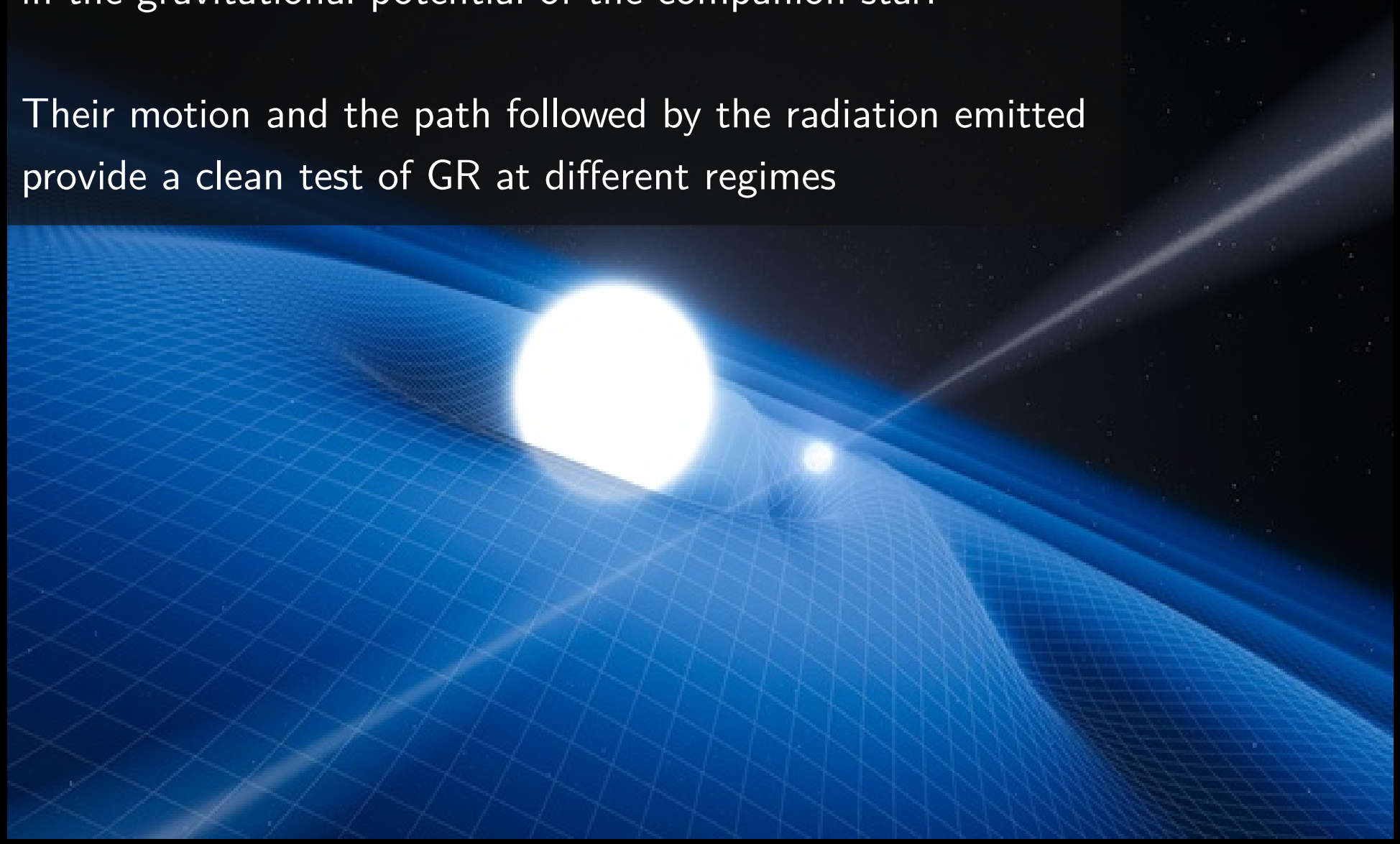
Alessandro Papitto
(ICE CSIC-IEEC Barcelona)

18.12.2015 – 28th Texas Symposium on Relativistic Astrophysics – Geneve (Switzerland)

Why pulsars? Why binaries?

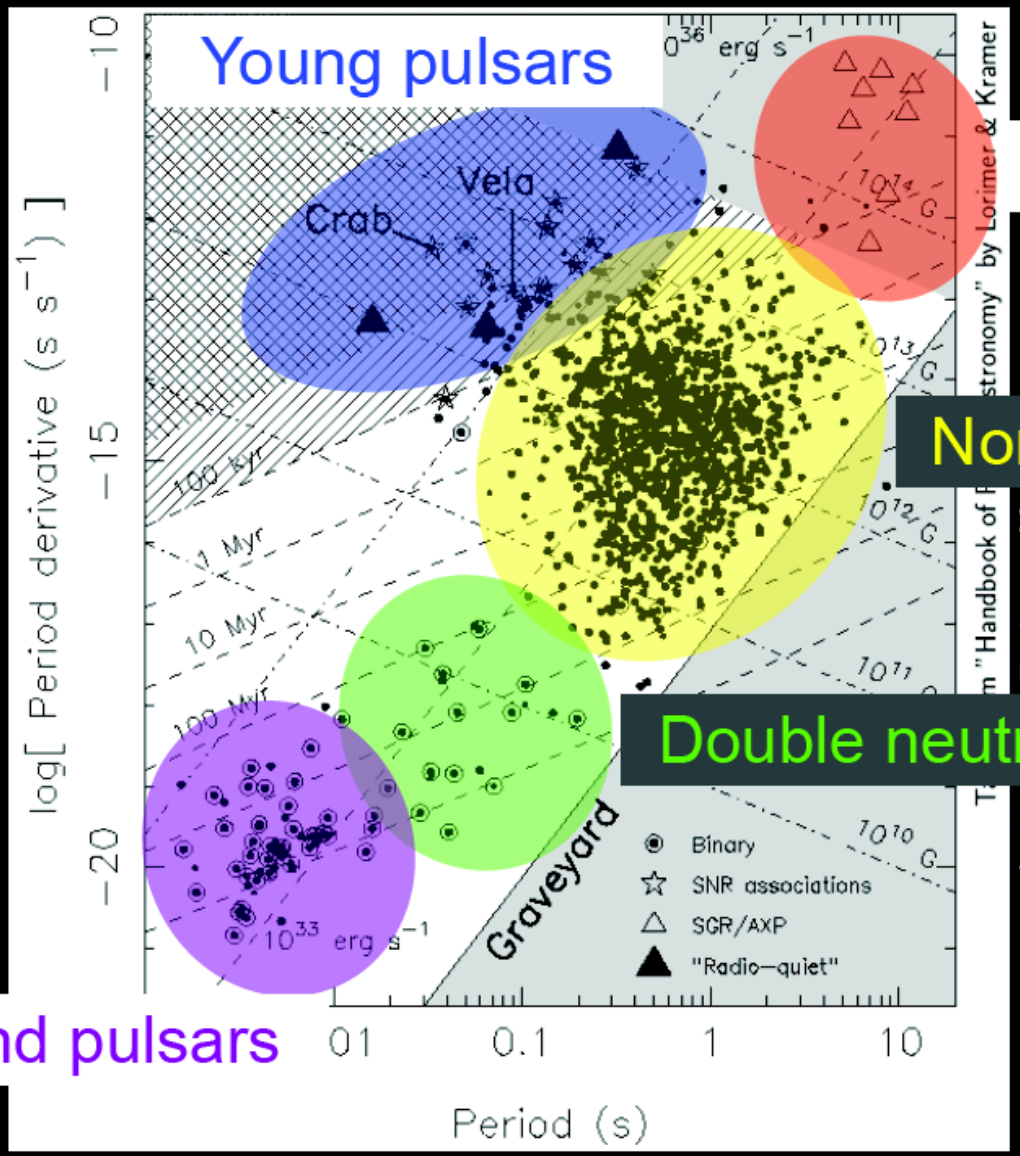
Pulsars in binary systems are clocks that are falling in the gravitational potential of the companion star.

Their motion and the path followed by the radiation emitted provide a clean test of GR at different regimes



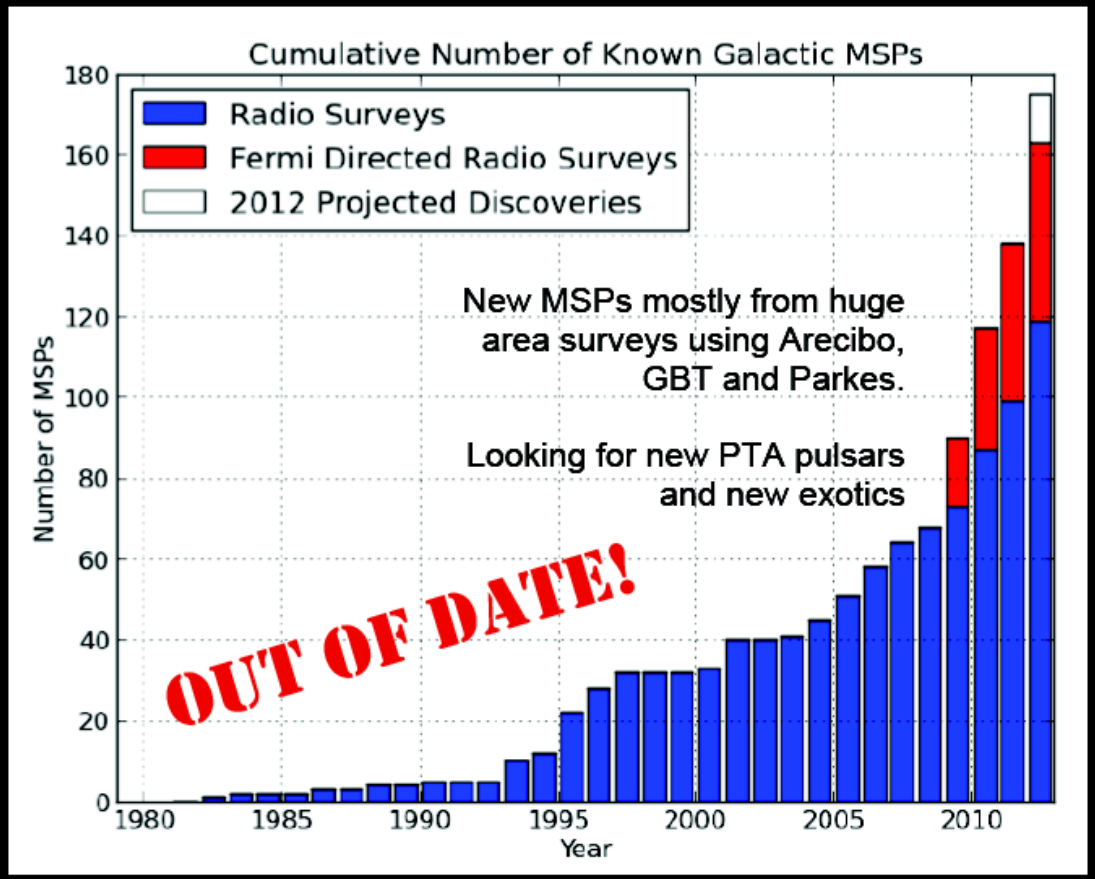
Why millisecond pulsars?

(J. Hessels, J. van Leeuwen, M. Berezina talks)



Why millisecond pulsars? (Jason Hessels talk)

Explosion in Discovery Rate



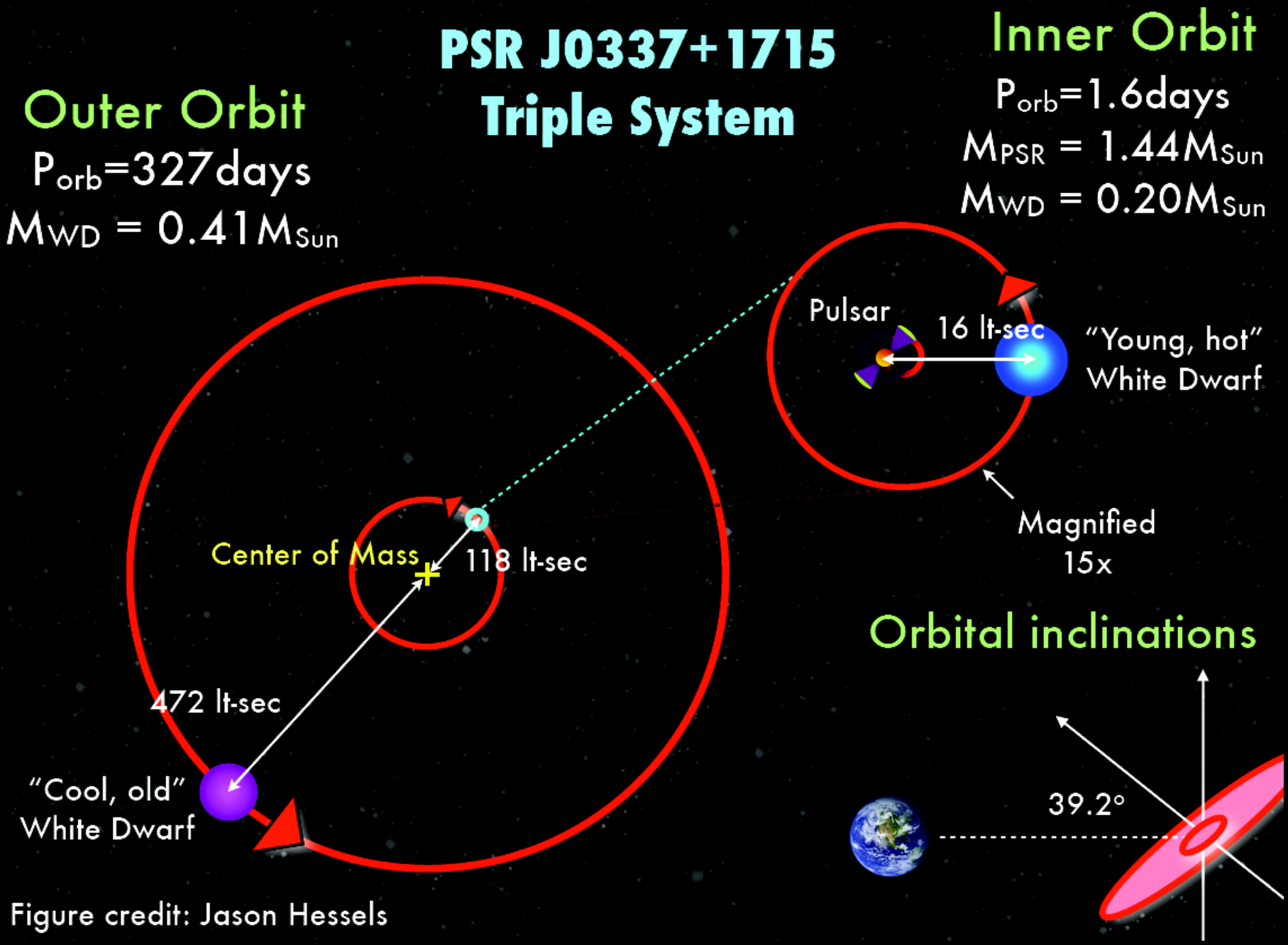
Ransom

43 Fermi targeted
27 HTRU (Parkes)
17 PALFA (Arecibo)
16 Drift/CC (GBT)

103 total
in 4 years

More Galactic MSPs than in GCs for the first time in a decade!

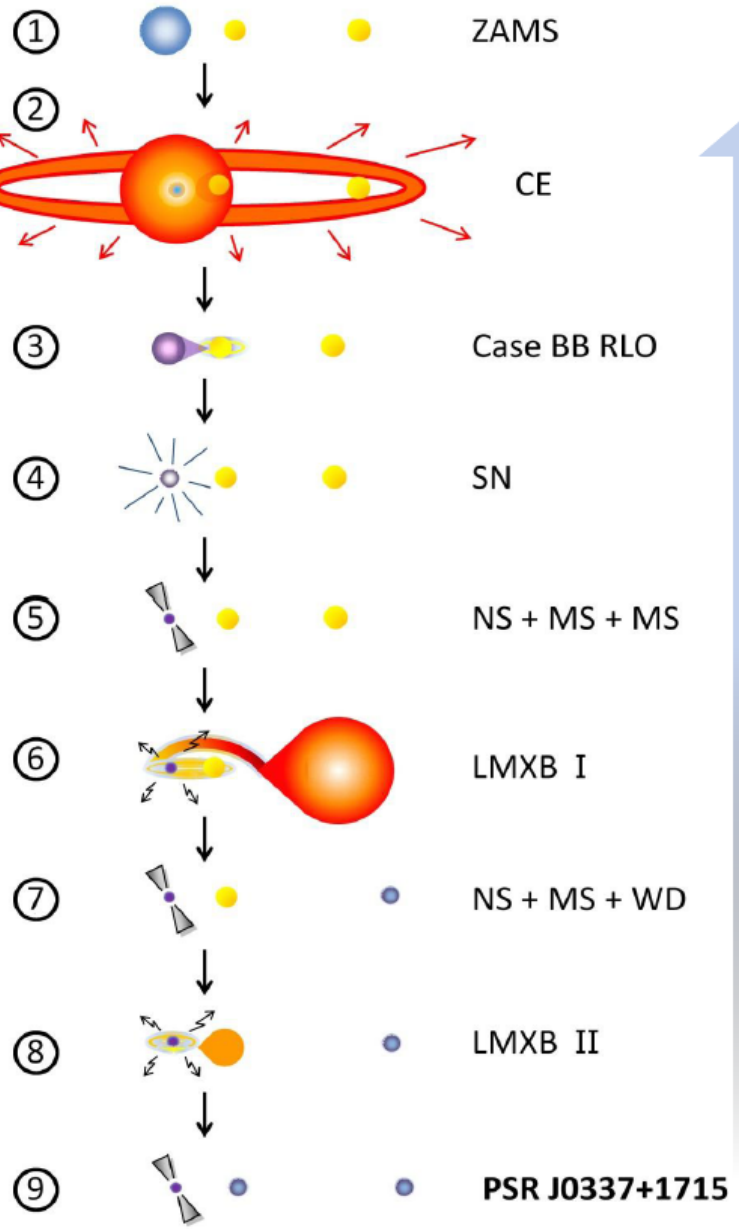
A ms pulsar in a triple system as a GR test? (Jason Hessels)



A ms pulsar in a triple system as a GR test? (Jason Hessels)

Strong Equivalence Principle

How exotic binaries form? (Thomas Tauris talk)



Stellar Forensics

Trace the evolution backwards

- Applying constraints from knowledge of stellar evolution and mass tranfer (RLO).
- Simulations of the dynamical effects of the supernova explosion.
- At all stages ensuring that the triple remains dynamically *stable* on a long timescale.

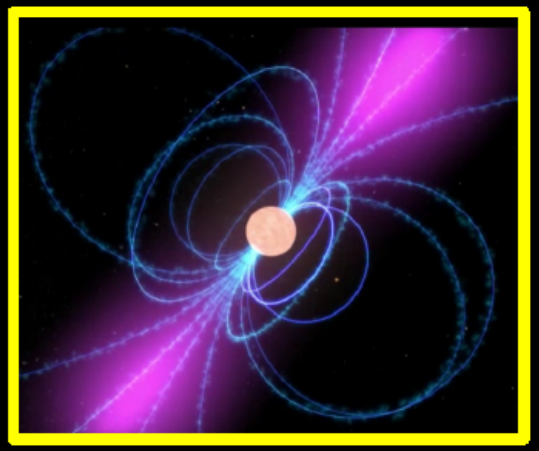
Millisecond pulsar mass:	$1.438\ M_\odot$
inner WD mass:	$0.197\ M_\odot$
inner WD temp:	$15\,800\ K$
inner P_{orb}:	1.63 days
inner ecc:	0.00069
outer WD mass:	$0.410\ M_\odot$
outer P_{orb}:	327 days
outer ecc:	0.035
angle between orb. planes:	0.01°

Ransom et al. (2014)

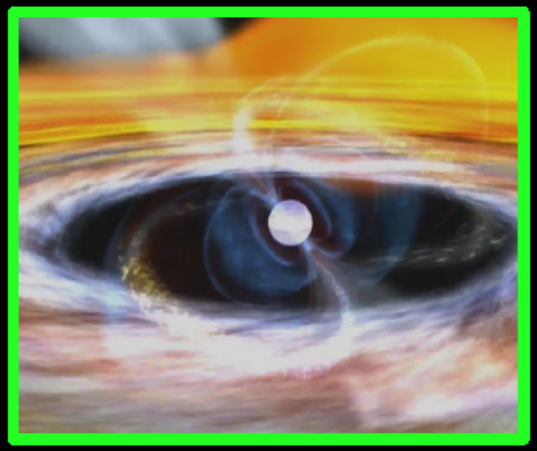
ms radio pulsars and X-ray binaries, mates but how close?

(Papitto, Ferrigno, Jaodand, Parfrey, Wadiasingh, Cruces talks)

Radio PSR (rotation power)



X-ray pulsar (accretion power)



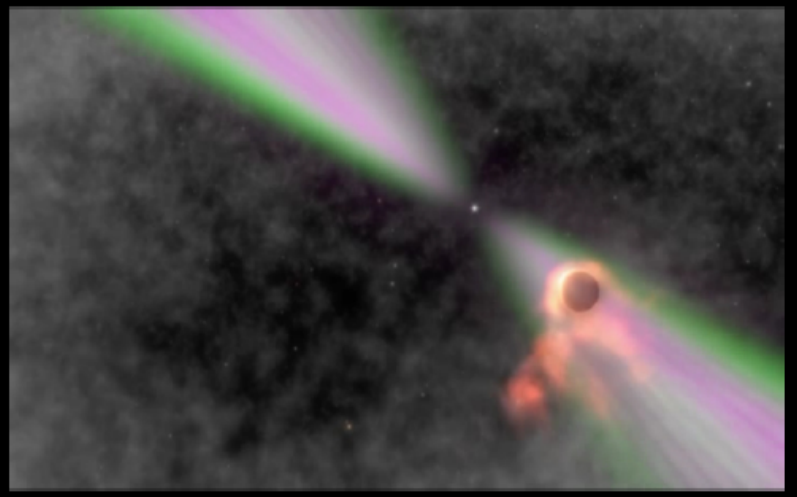
Parameter	IGR J18245–2452	PSR J1824–2452I
Right Ascension (J2000)	$18^h\ 24^m\ 32.53(4)^s$	
Declination (J2000)	$-24°\ 52'\ 08.6(6)''$	
Reference epoch (MJD)	56386.0	
Spin period (ms)	3.931852641(2)	3.93185(1)
Spin period derivative	$< 2 \times 10^{-17}$	
RMS of pulse time delays (ms)	0.1	
Orbital period (hr)	11.025781(2)	11.0258(2)
Projected semi-major axis (lt-s)	0.76591(1)	0.7658(1)
Epoch of zero mean anomaly (MJD)	56395.216889(5)	

Papitto et al. 2013, Nature, 501, 517

The discovery of transitional millisecond pulsars

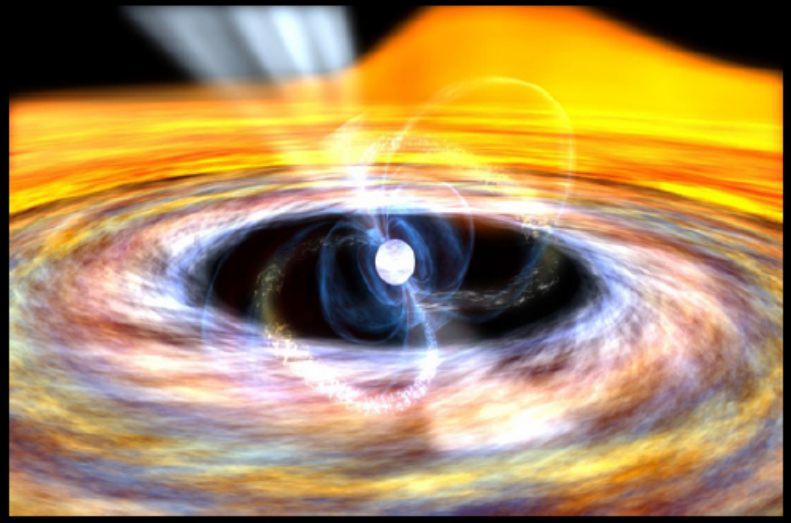
(Papitto, Ferrigno, Jaodand, Parfrey, Wadiasingh, Cruces talks)

Low Mass in-flow rate:
Magnetic field dominates
$\rightarrow$ rotation powered **Radio PSR**



High Mass in-flow rate:
Gravity dominates
$\rightarrow$ accretion powered **X-ray PSR**

[Stella+ 1994; Campana+ 1998; Burderi+ 2001]



Credits: NASA's Goddard Space Flight Center

How do radio pulsars actually work? (Wim Hermsen talk)

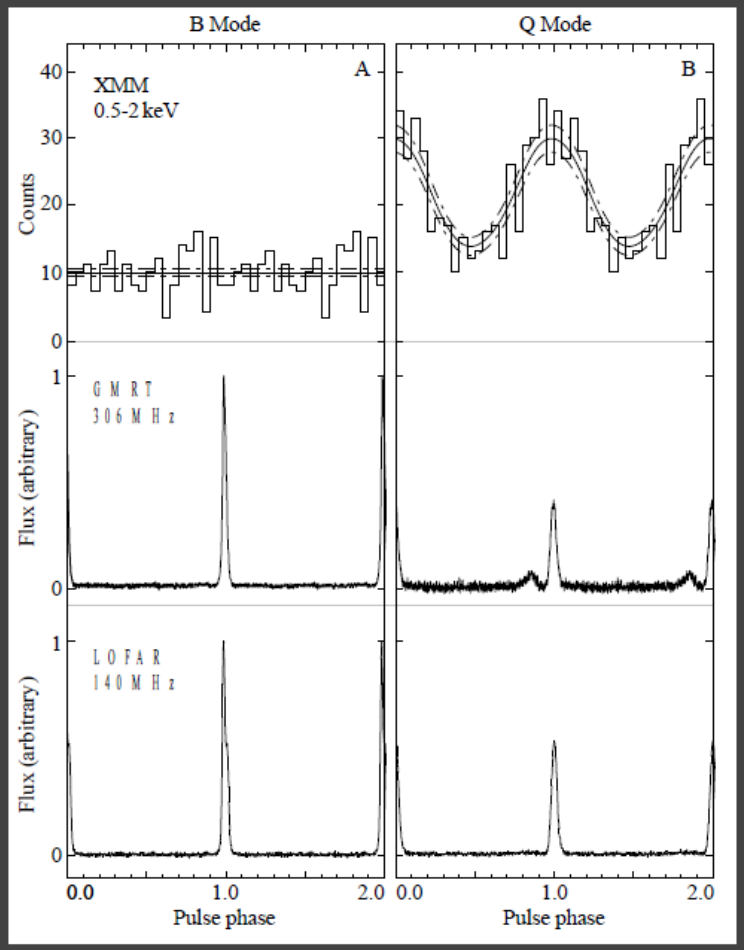
Discovery of Synchronous X-ray and Radio Mode Switches

XMM-Newton
EPIC PN + MOS-1 & MOS-2

Detection of pulsed X-ray emission in radio Q mode

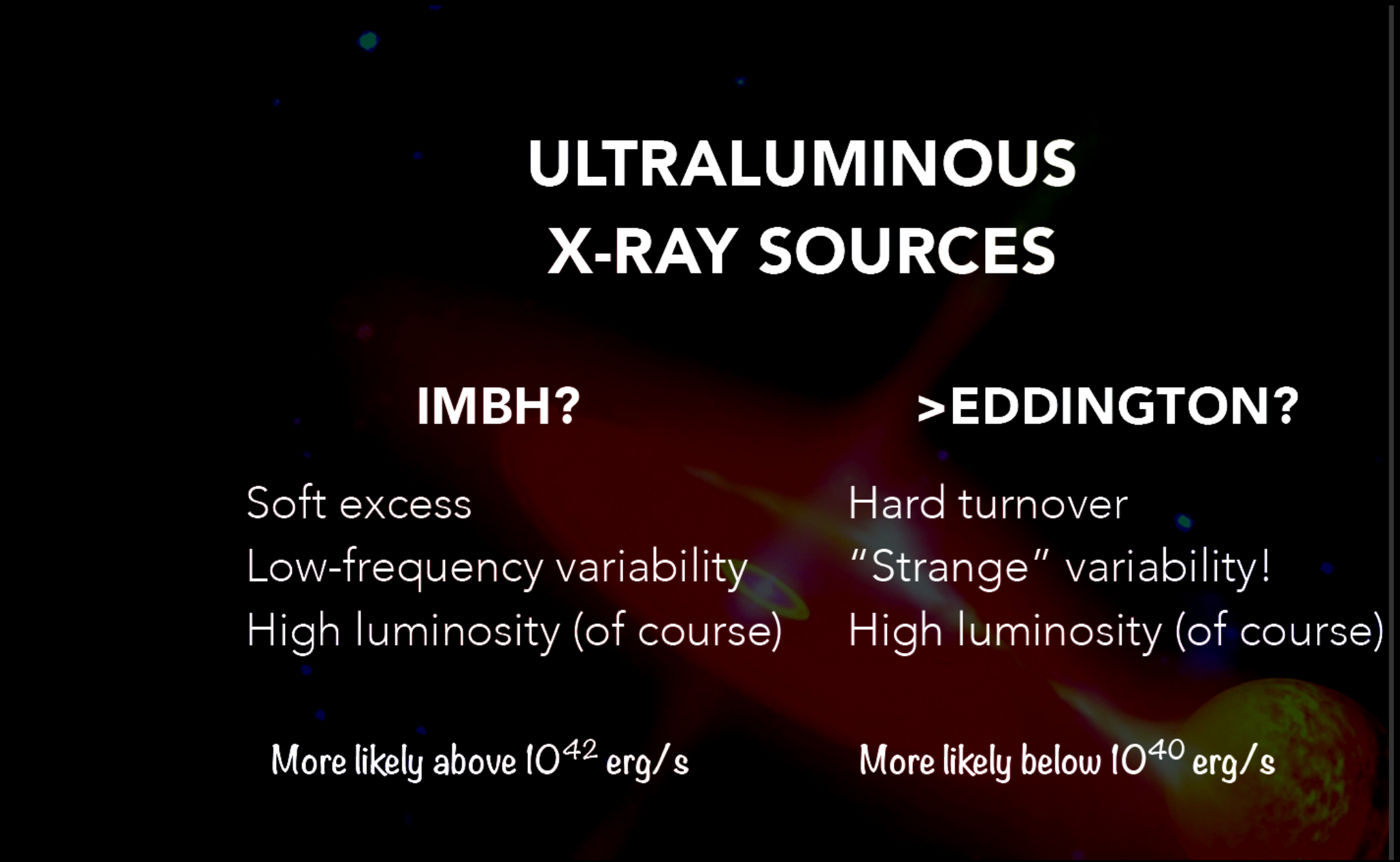
Difference between X-ray emissions in radio B and Q mode is addition of pulsed X-ray emission in Q mode !

X-ray pulse is aligned with radio main pulse with precursor

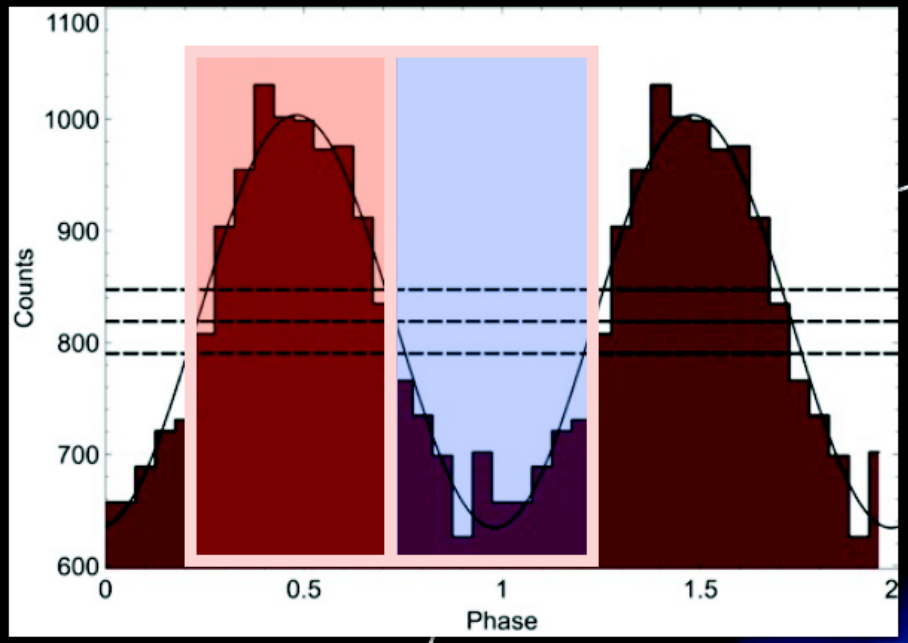


What is the nature of ultraluminous X-ray sources?

(M. Bachetti, A. Sutton talks)



A 1.3 s ultraluminous X-ray pulsar in M82 (M. Bachetti talk)

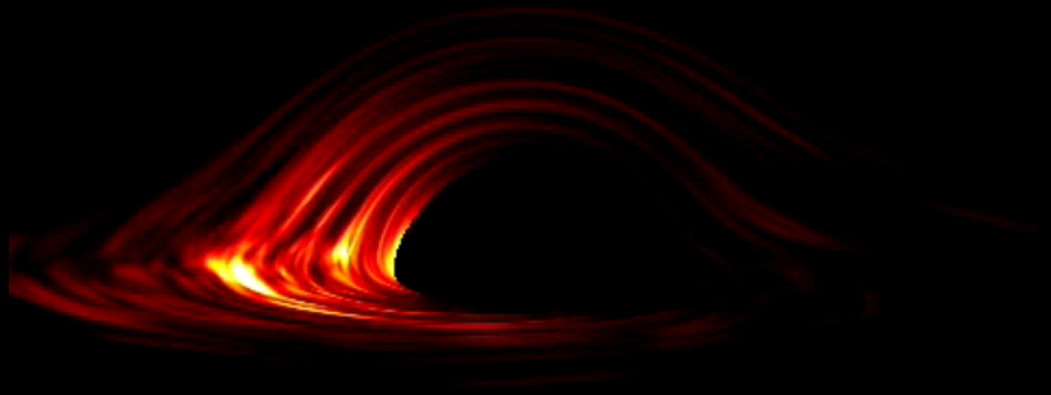


Magenta:

pulse-on - pulse off

NuSTAR image

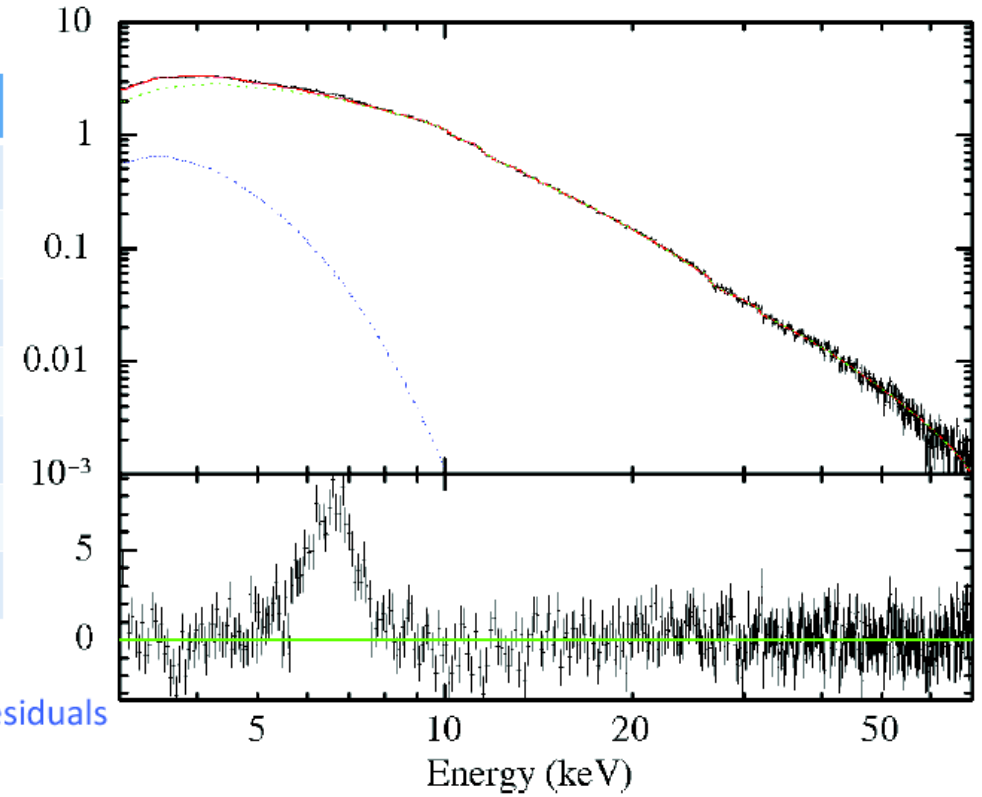
A few gravitational radii from a ms pulsar surface (T.Di Salvo talk)



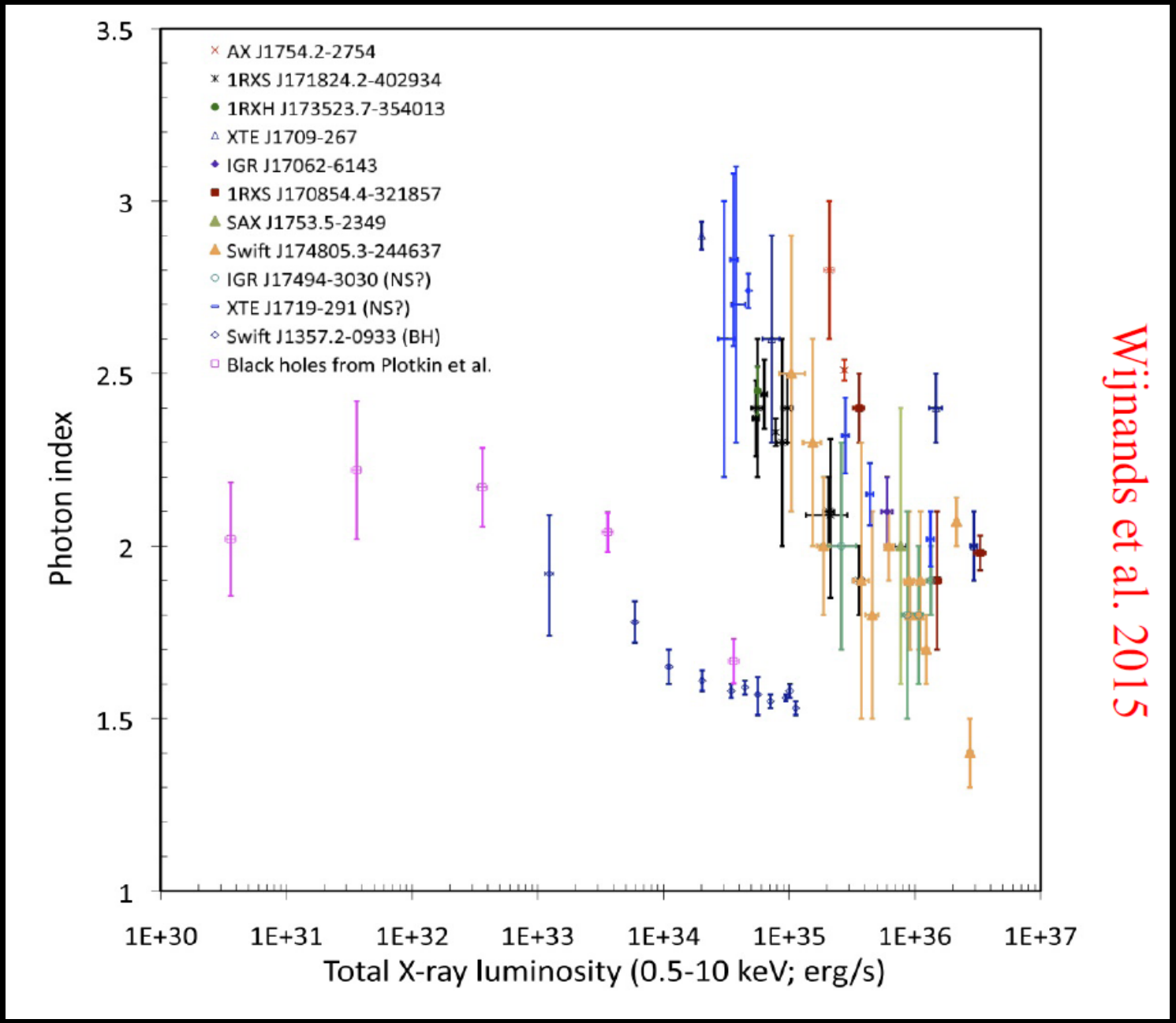
Results of the fitting with a diskline

Parameter	Value
E (keV)	6.47 ± 0.06
Betor	-2.2 ± 0.3
Rin (Rg)	< 10
Rout (Rg)	240 ÷ 1800
Incl (deg)	50 (fixed)
Eqw (eV)	100 ± 10
χ2	1676/1663

The broad Fe line is visible in the residuals
Gaussian sigma would be ≈ 0.7 keV



X-ray binaries at low luminosity (R. Wijnands talk)



So many kinds of binaries

High mass X-ray binaries with gamma-ray emission

- Labs to study interbinary shocks 'close' to the pulsar light cylinder

(D. Torres, G. Dubus, P. Munar Adrover talks)

Transient high mass X-ray binaries (P. Romano, A. Lutovinov)

Modelling of the high energy emission in individual sources

- Low Mass companions

(N. Schulz, F. Koliopanos, R. Iaria, F. Capitanio, L. Ducci, A. Fragkos, T.İÇLİ)

- High Mass companions

(A. Manousakis, P. Pradhan, N. Islam, C. Maitra, I. El Mellah)

3 sessions, 34 contributions, a lot of young people

Stay tuned for more!!!