Compact Binary Millisecond Pulsars





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UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH Bahramian, Bogdanov, Casares, Heinke, Homan, Kachelriess, Miles-Paez, Palomo, Patruno, Rodriguez-Gil, Shahbaz, Wijnands

Compact binary millisecond pulsars



A Spider Revolution

A booming field thanks to Fermi-LAT driven discoveries



Compact binary MSPs: a growing, nearby (0.5-3.5 kpc, 1e21-1e22 cm) pulsar population

M. Linares, Hernanzfest, 2017-06-15

INCREASING X-RAY LUMINOSITY

Log(Lx;erg/s): 31-32 33-34





(Rotation-powered) PULSAR STATE (Rotation?/Accretion) DISK STATE (Accretion-powered) OUTBURST STATE

35-37

X-ray states of redbacks

Pulsar, disk(active/passive) and outburst states



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33:x



 5143^{-0} 900^{-0}

Chandra revealed $\stackrel{\leftarrow}{}$ striking variability from a redback in the disk state (M28-I): Fast (<500s) transitions between disk-active (L_x=3.9×10³³ erg/s) and disk-passive (L_x=5.6×10³² erg/s) states, both nonthermal (Γ =1.5)

Linares+ (2014, MNRAS, 438,251)

Disk state: mode switching (M28-I)

At the boundary between accretion and rotation power



Balance (tug-of-war) between accretion flow and pulsar wind? (Linares et al. 2014; see also Campana et al. 2016)

Light cylinder radius at **186 km**. For a 10⁸ G magnetic field:

- Active states ($L_{bol}=1.2\times10^{34}$ erg/s $\rightarrow R_m \sim 130$ km): magnetospheric accretion.
- Passive states ($L_{bol}=1.7\times10^{33}$ erg/s \rightarrow $R_m\sim230$ km): pulsar wind shock.

33:x

INCREASING X-RAY LUMINOSITY

Log(Lx;erg/s): 31-32 33-34 35-37



NS MASS! TeV?

ACCRETION vs. ROTATION

LMXB

(Rotation-powered) PULSAR STATE (Rotation?/Accretion) DISK STATE (Accretion-powered) OUTBURST STATE

The Future is Bright

Fermi-LAT: driving force and discovery space



More than a thousand unidentified GeV sources!



COBIPULSE: COmpact Blnary PULsar SEarch



Optical "hunt" for binary MSPs in Fermi-LAT un-identified sources Complementary to radio/gamma-ray pulsar searches (hampered by enshrouding and acceleration in unknown orbit)

→COBIPULSE:

Optical survey of 38 LAT-selected MSP candidates (21 North, 17 South)

COBIPULSE: COmpact Binary PULsar SEarch









Multi-band, wide-field, well-sampled optical photometry (robotic) COBIPULSE-N: Stella-1.2m Large Program, observed (220 hrs) COBIPULSE-S: LCOGT-1m Program, observed (80+100 hrs) 32:0

J0212: the brightest companion, in a 21hr orbit





A millisecond pulsar candidate in a 21-h orbit: 3FGL J0212.1+5320

Manuel Linares ख़, Paulo Miles-Páez, Pablo Rodríguez-Gil, Tariq Shahbaz, Jorge Casares, Cecilia Fariña, Raine Karjalainen

Mon Not R Astron Soc (2017) 465 (4): 4602-4610. **DOI:** https://doi.org/10.1093/mnras/stw3057 **Published:** 29 November 2016 Article history -

J0212: the brightest companion, in a 21hr orbit



Modelling jointly light and radial velocity curves:

 $M_1 = 1.75 + -0.25 Msun$ $M_2 = 0.48 + -0.20 Msun$ $i \approx 70^{\circ}$ (Shahbaz, Linares, Breton, submitted)

Current record at 2.01 Msun (Antoniadis+13), but evidence for Mmax > 2 Msun (EoS consequences)

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32:0



Summary



COBIPULSE

M1=1.75Msun, Porb=21hr

MODE SWITCHING!

WIND – FLOW TUG OF WAR?

MORE TO COME!

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