

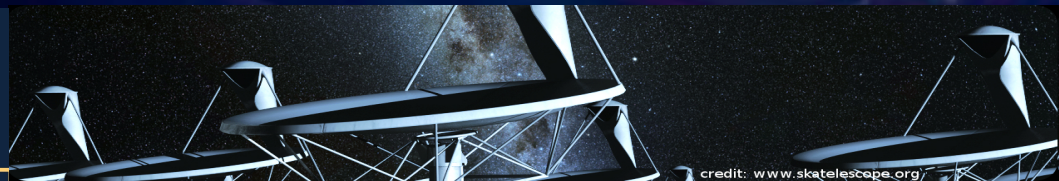


# The free precessing or glitching neutron star RX J0720 and other rare objects



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Credit: Ralph Schoofs



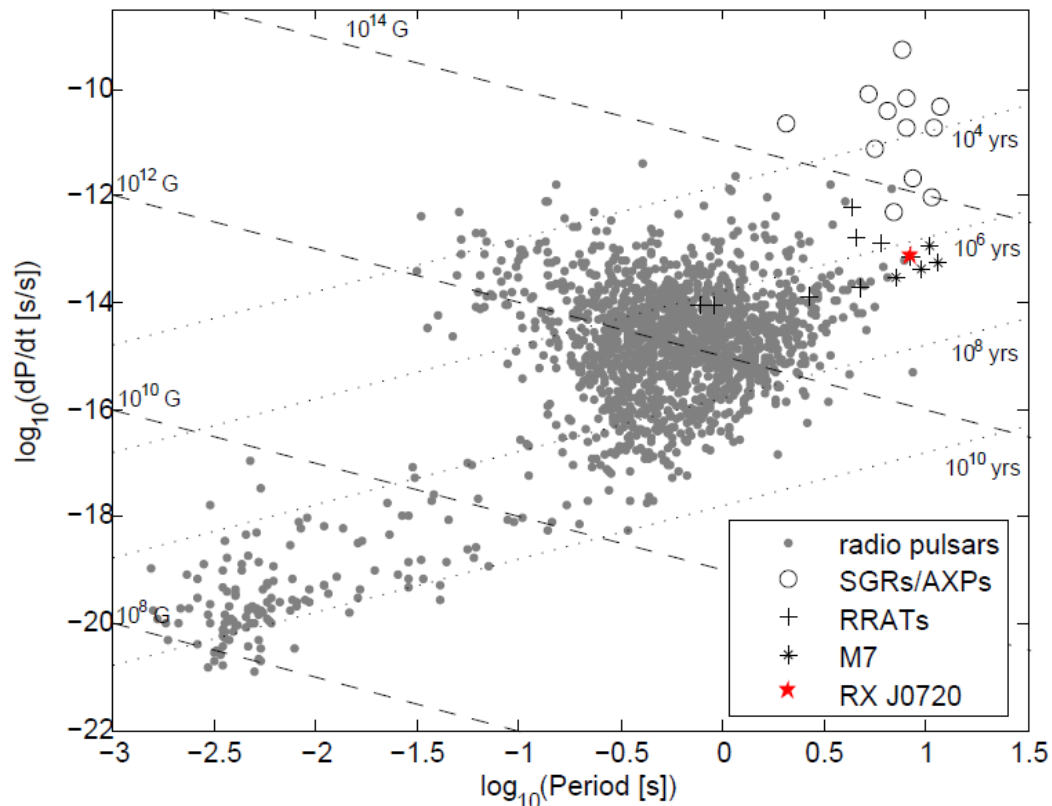
credit: www.skatelescope.org

# current status:

## 1978 NSs (ATNF)

- 9 double NS
- 38 isolated NS, X-ray
  - 11 CCOs
  - 11 AXPs + 7 SGRs
  - 7 (+2) “Magnificent Seven”
  - “Three Musketeers” (see later)

no known radio pulsar is so dim @1400MHz (0.1mJy kpc<sup>2</sup>)

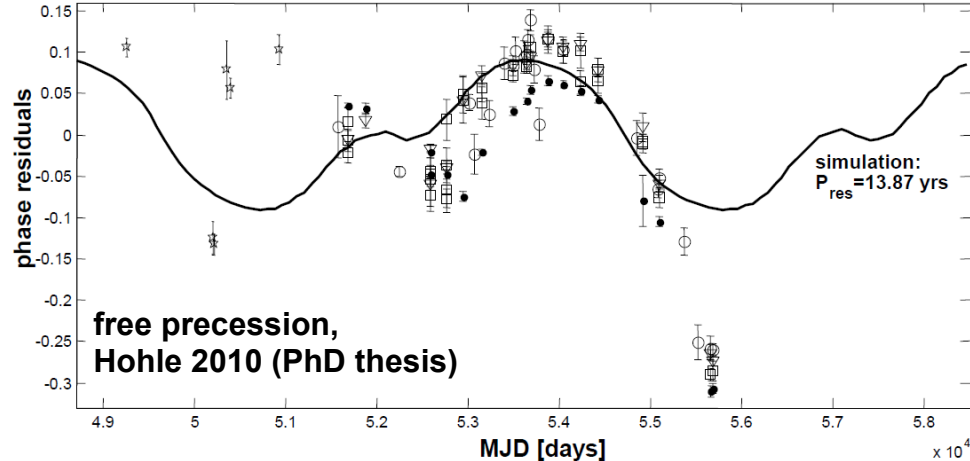
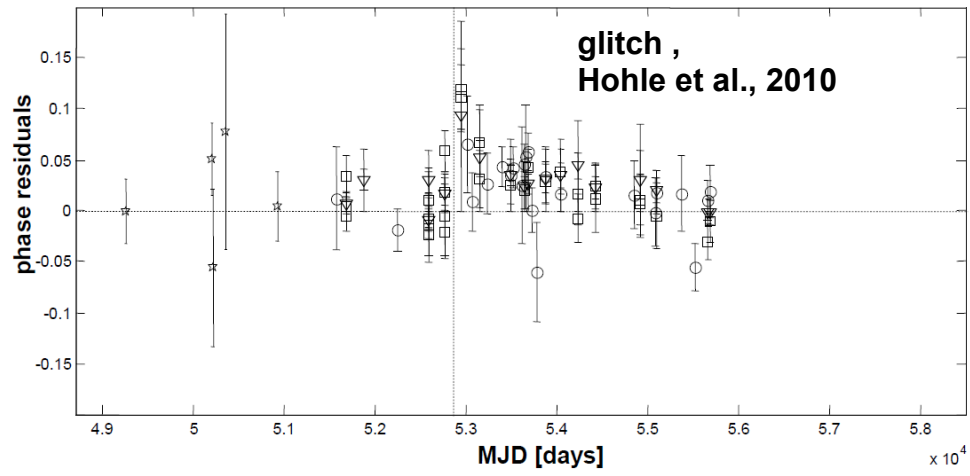
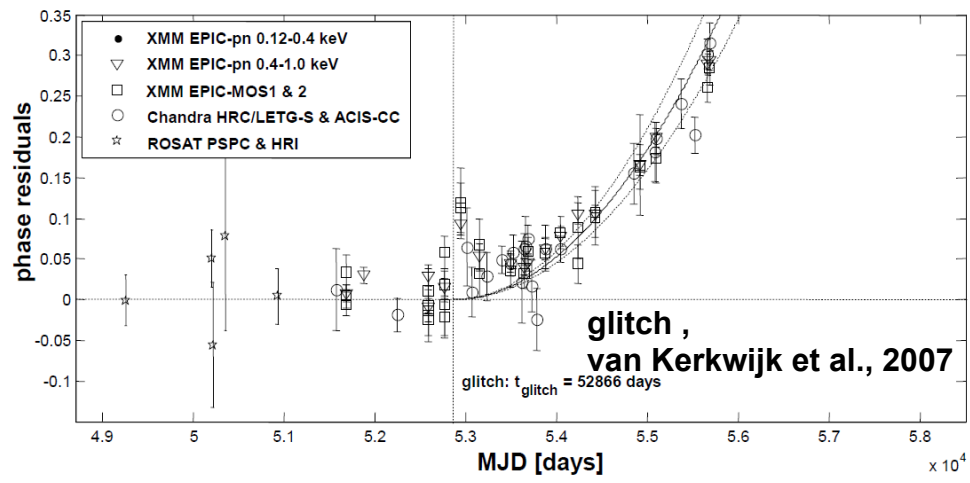
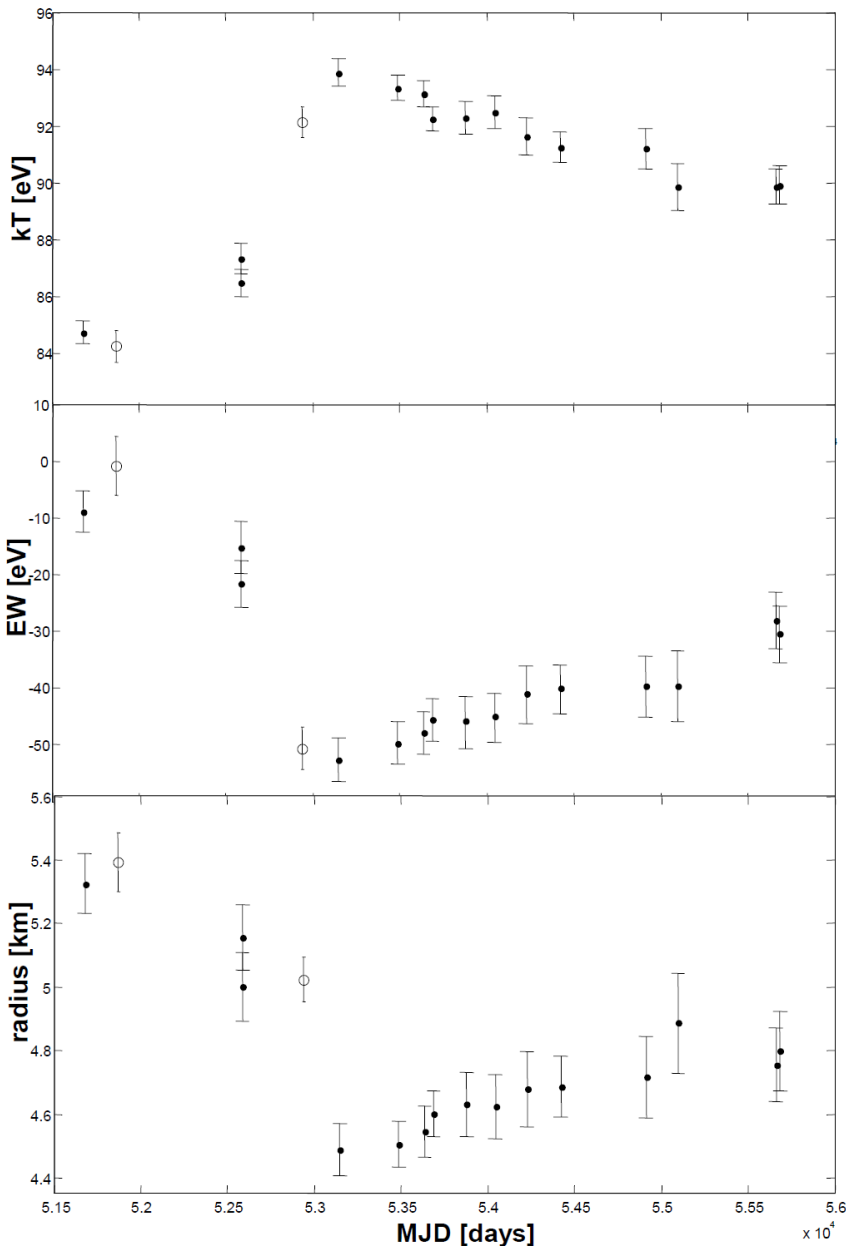


- young: 0.5-5 Myrs
- nearby: <500pc
- B~10<sup>13</sup> G
- kT<sub>eff</sub>~40-120eV
- P~3-12sec
- BB like X-ray emission
- radio quiet

XDINS	Pulsed Emission		
	<i>S</i> <sub>1400</sub> (μJy)	<i>L</i> <sub>1400</sub> <sup>p,max</sup> (mJy kpc <sup>2</sup> )	<i>L</i> <sub>820</sub> <sup>p,max</sup> (mJy kpc <sup>2</sup> )
RX J0720.4–3125	8	4 × 10 <sup>-4</sup>	10 <sup>-3</sup>
RX J0806.4–4123	10	4 × 10 <sup>-3</sup>	10 <sup>-2</sup>
RX J1308.6+2127	10	4 × 10 <sup>-3</sup>	10 <sup>-2</sup>
RX J1605.3+3249	8	3 × 10 <sup>-3</sup>	8 × 10 <sup>-3</sup>
RX J1856.5–3754	14	1.4 × 10 <sup>-4</sup>	3.6 × 10 <sup>-4</sup>
RX J2143.0+0654	13	5 × 10 <sup>-3</sup>	1.3 × 10 <sup>-2</sup>

# RX J0720

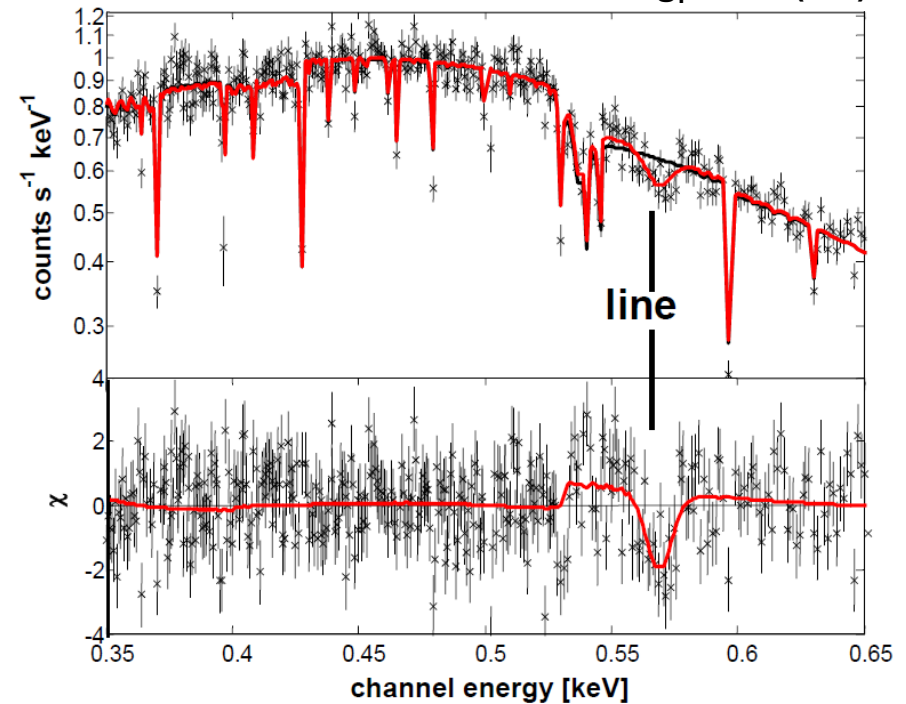
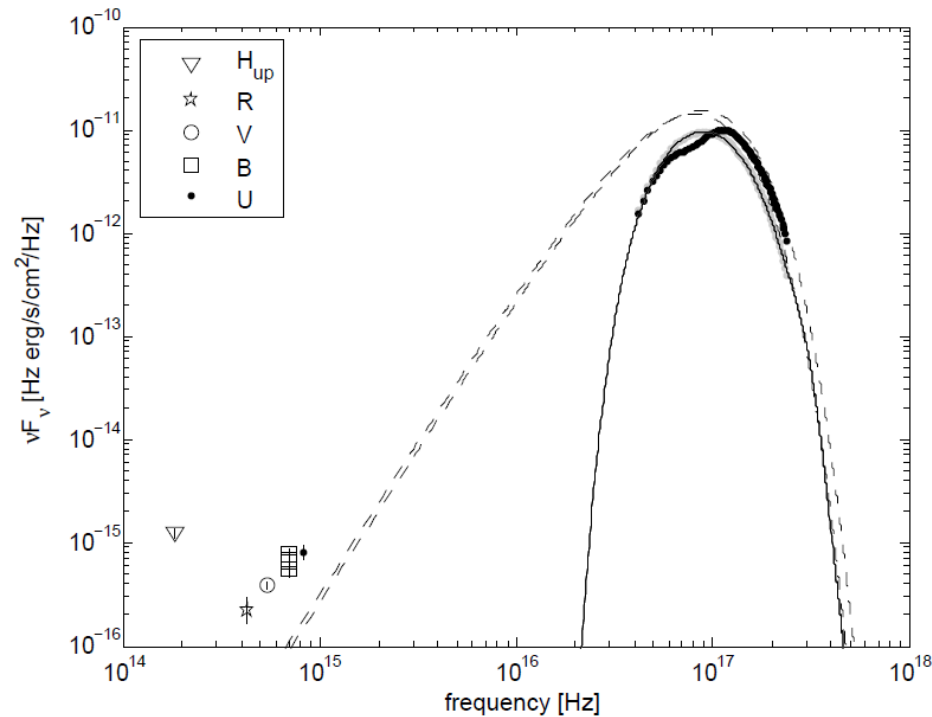
## spectral and temporal variations



# RX J0720

optical excess and an absorption feature at 0.57 keV

OVII K $\alpha$  at rest (ISM, disk)  
or OVIII K $\alpha$  with  $g_r=1.17$  (NS)



van Kerkwijk et al., 2007: glitch  $\rightarrow$  change in period  $\rightarrow$  mass of an asteroid  
Hambaryan et al., 2009: disk  $\rightarrow$  may explain PL in optical excess + absorption feature

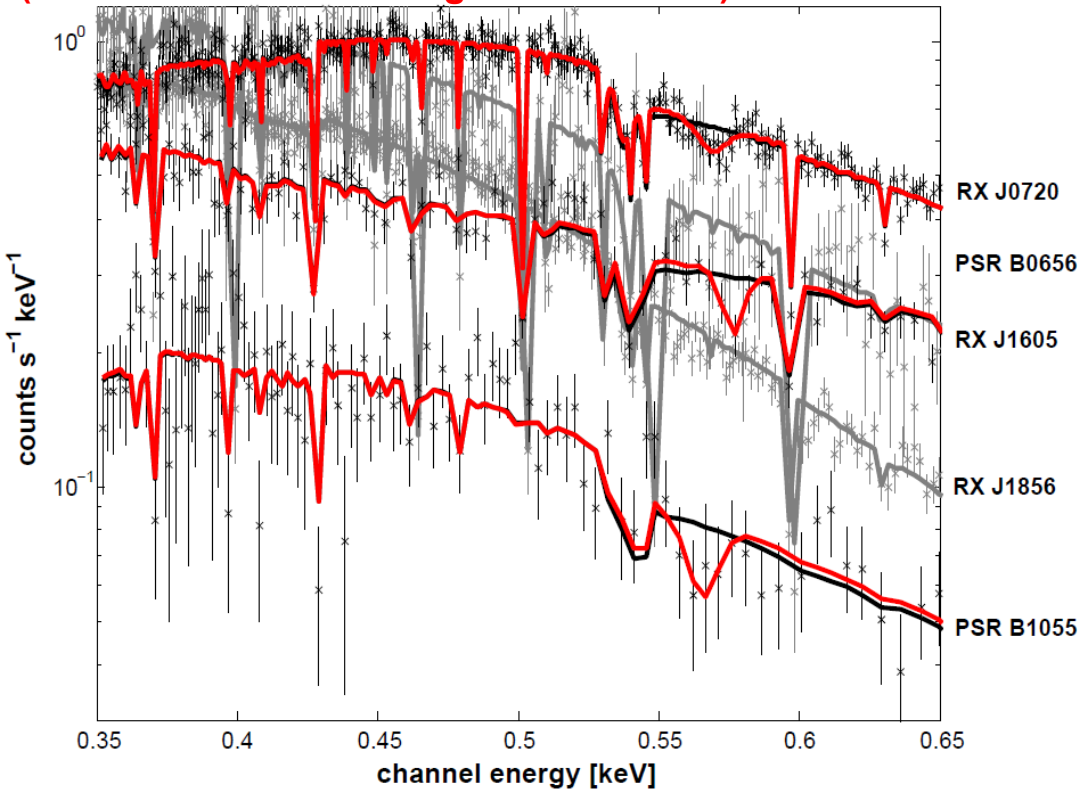
Does RXJ0720 host a disk?  $\rightarrow$  **radio observations: high resolution + high sensitivity**

Are these lines from ISM (no: too much material), disk (maybe) or NS atmosphere (unlikely, **but would offer a lot of new insights**)

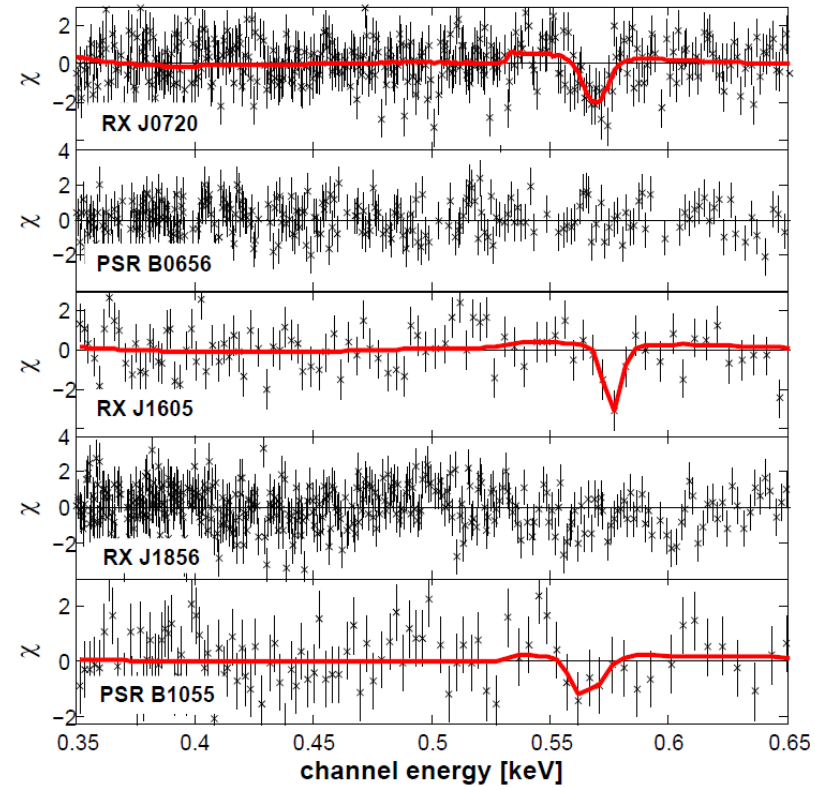
Hohle et al., MNRAS, in press

# More absorption features:

(Three Musketeers + Magnificent Seven)



Hohle et al., MNRAS, in press



	line EW [eV]	significance [σ]
RX J0720	$-1.89^{+0.57}_{-0.62}$	5.6
RX J1605	$-3.2^{+1.5}_{-1.8}$	3.5
PSR B1055	$-5.7^{+4.6}_{-9.2}$	2.1

three of seven sources exhibit  
a line at 0.57 keV

do these three NSs host a disk?

→ **radio observations**

# More absorption features (some estimates):

Yao & Wang, 2005:  $n_{\text{OVII}}(\text{ISM})=(1.35\text{-}2.84)\times 10^{-6}/\text{cm}^3$

$d_{\text{RXJ0720}}=195\text{-}530$  pc (Kaplan et al., 2007)  $\rightarrow N_{\text{OVII}}=1.2\times 10^{14} \dots 4.1\times 10^{15}/\text{cm}^2$

$d_{\text{RXJ1605}}=325\text{-}390$  pc (Posselt et al., 2007)  $\rightarrow N_{\text{OVII}}=1.2\times 10^{14} \dots 4.1\times 10^{15}/\text{cm}^2$

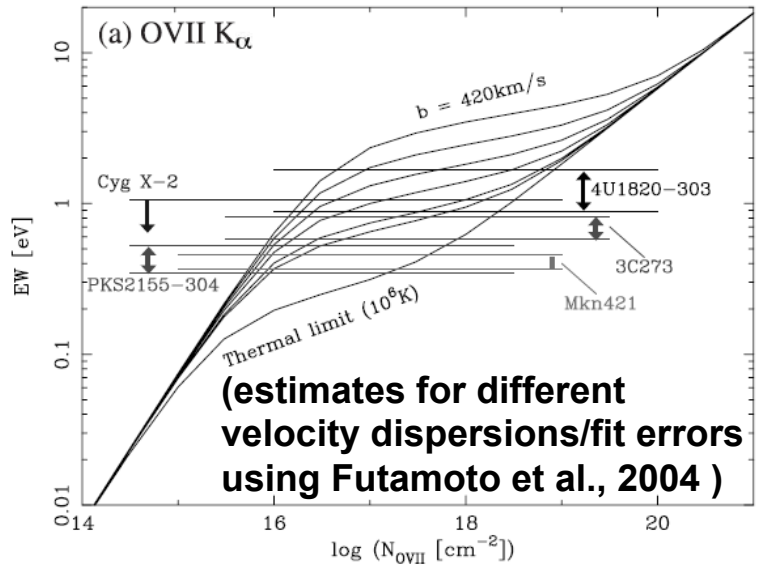
$d_{\text{PSRB1055}}=750$  pc (Kramer et al., 2003)  $\rightarrow N_{\text{OVII}}=3.0\times 10^{14} \dots 6.4\times 10^{15}/\text{cm}^2$

in all three cases the X-ray fit yields  $N_{\text{H}} = 10^{20}/\text{cm}^2$

Anders & Grevesse, 1989:  $n_{\text{O}}/n_{\text{H}}=4\times 10^{-4} \rightarrow$  if all oxygen would be ionised:  $N_{\text{OVII}}=10^{16}/\text{cm}^2$

	line EW [eV]	$N_{\text{OVII}}$ [ $\text{cm}^{-2}$ ]
RX J0720	$-1.89^{+0.57}_{-0.62}$	$3\times 10^{16}\text{-}10^{19}$
RX J1605	$-3.2^{+1.5}_{-1.8}$	$3\times 10^{16}\text{-}10^{20}$
PSR B1055	$-5.7^{+4.6}_{-9.2}$	$>10^{16}$

Hohle et al., MNRAS, in press



example for RX J0720: ATCA, H168  $\rightarrow 1\text{mJy}@30\text{K} \sim 30M_{\text{earth}}$  (tot. exp.=44hrs)  
**but: dust/gas ratio is unknown  $\rightarrow$  ALMA**  
**as lower are the upper limits  $\rightarrow$  NS-atmosphere**

# Summary

strong absorption features at 0.57 keV in three of six!! objects  
(RX J0720, RX J1605, PSR B1055)

+ power law in optical excess (RX J0720)

+ radio quiet (RX J0720 and RX J1605)

→disk → mm observations (ATCA/**ALMA**)

→no disk → **from NS atmosphere!**

Thank you!

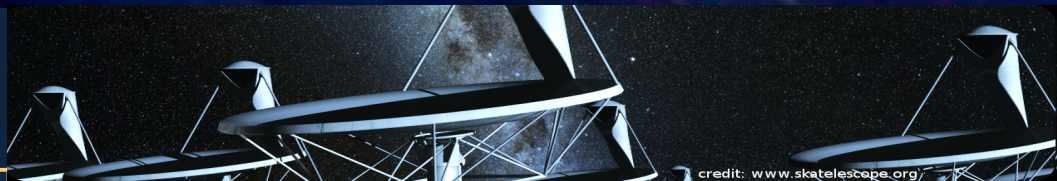
[SPACE]

Credit: Ralph Schoofs

ANNUAL MEETING OF THE  
ASTRONOMISCHE GESELLSCHAFT



HEIDELBERG  
**2011**  
SEPT. 19-23



credit: www.skatelescope.org