Neutron star structure and evolution

Paweł Haensel

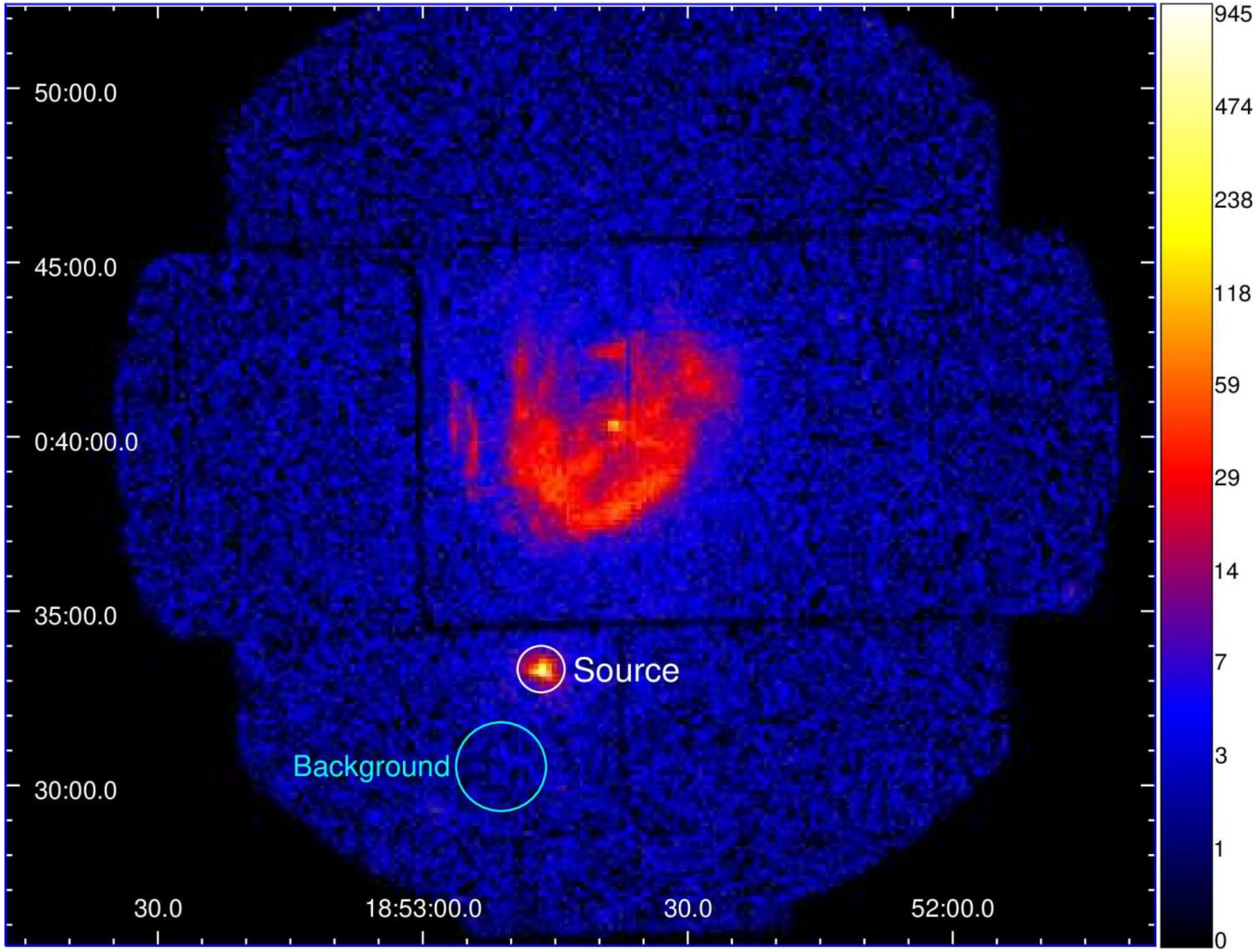
Projects completed in 2024

PROJECT 1 3XMM J185246.6 as a massive magnetar with low **B**

PROJECT 2 : Electron captures in transiently accreting neutron stars

3XMM J185246.6 as a massive magnetar with a low **B**

R.de Lima, J.P.Pereira, J.G.Coelho,R.C.Nunes,P.E.Stecchini,M.Castro,
R.R.da Silva, J.C.N. de Araujo, M.Bejger, P.Haensel,J.L.Zdunik



Solitary X-ray pulsar P=11.6 s

$dP/dt < 1.4 \times 10^{-13}$ s/s ====> $B < 4.1 \times 10^{13}$ G

Bright state observations in 2008

$L_X \gg dE_{rot}/dt$ ====> transient **magnetar** with low **B**

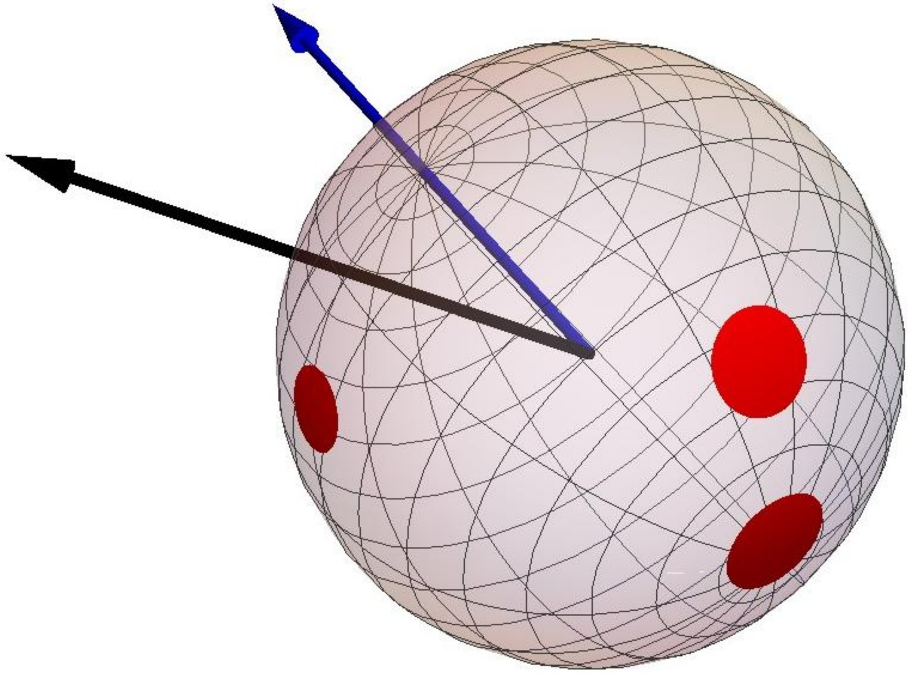
Our main result: determination of M, R, B, from the modeling via **ray-tracing** method of fitting of time dependent X-spectra and luminosity.

Best fitting model has 3 hot spots, carbon atmosphere. It yields neutron star parameters
(68 percent confidence level)

$M=2.09(+0.16,-0.09)\ M_{Sun}$

$R=12.02(+0.72,-0.35)$ km

$\log_{10}(B/G)=11.89(+0.19,-0.93)$
consistent with slow-down constraint
$B_{sd}<4.1*10^{13}$ G



Layers of electron captures in the crust of accreting neutron stars

L. Suleiman, J.L. Zdunik, P. Haensel

Using experimental nuclear data, we studied time evolution of nuclear abundances, matter heating, and neutrino energy loss associated with e-captures induced by accretion. We considered a smooth switch-on and switch-off of accretion, and compared results with those obtained using standard stationary approximation for the active (accretion) stage.

$$\mathbf{(Z_0,A) + e \rightarrow (Z_0-1,A) + Q\ ,\quad (Z_0-1,A) + e \rightarrow (Z_0-2,A) + Q^*}$$

<u>$A=56,\ Z_0=26,\ 24,\ 22,\ 20$</u> $\quad t_{active} = 4$ yr $\quad t_{quiet} = 40$ yr

$$t_{cycle} = t_{quiet} + t_{active}$$

10^{-8} M_{Sun}/yr X- abundance of parent nuclei 10^{-10} M_{Sun}/yr