RRAT J1819-1458
and its extended X-ray emission

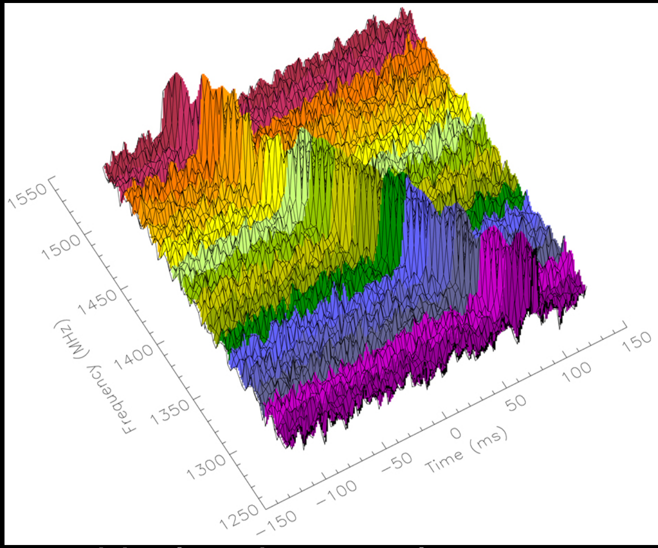
A. Camero-Arranz (CSIC/IEEC),
N.Rea (CSIC/IEEC), M. A. McLaughlin (West Virginia Univ.), N. Bucciantini (INAF), M. Burgay (INAF), F.Camilo (Univ. Columbia), S.Chatterjee (Cornell Univ.), B. Gaensler (Univ. Sydney), G.L. Israel (INAF), M. Kramer (MPI), A. Lyne (Univ. Manchester), E. de Oña (CSIC/IEEC), D.T orres (CSIC/IEEC), A. Possenti (INAF), L. Stella (INAF)

IEEC

CSIC
Consejo Superior de Investigaciones Científicas

Rotating Radio Transients

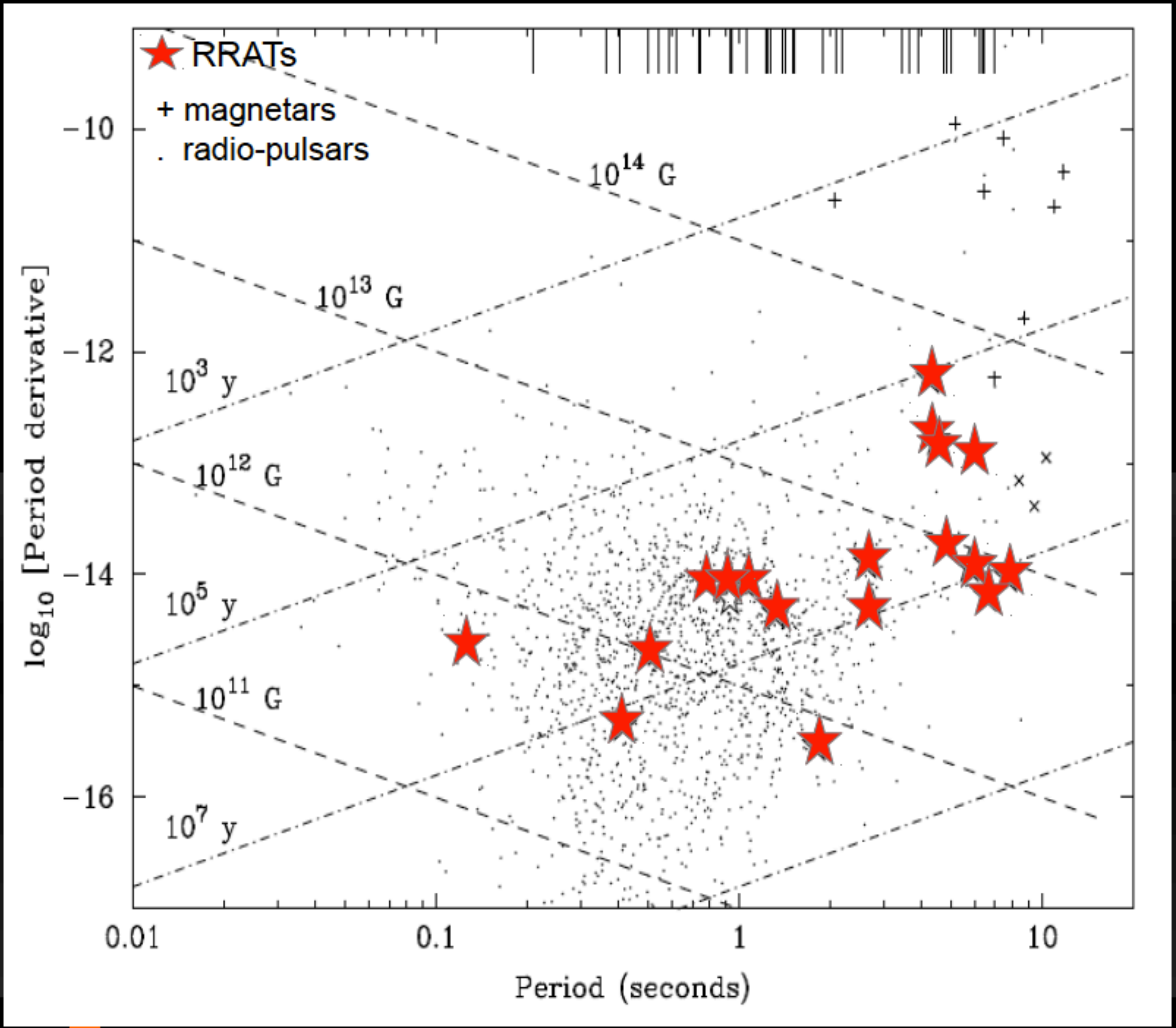
- In 2006, a new class of neutron stars, the “Rotating RAdio Transients” (RRATs), is reported (McLaughlin et al. 2006).
- Characterized by repeated dispersed radio bursts
- Flashes are very short and rare: one hundredth of a second long
- The total time a RRAT is visible is only about 1/10th of a second per day.
- Periods ranging from 0.7 to 7 seconds
- Located in the Galactic plane at 2 – 7 kpc distances



- About ~70 RRATs found over the past several years in archival and new pulsar surveys (McLaughlin et al. 2009; Keane et al. 2011;Boyles et al 2011)
- The spin-down parameters with a tendency towards longer periods
- High magnetic fields ($2x10^{12}$ – $5x10^{13}$G) and ages from 0.1 to 4 Myr
- X-ray detections: only for RRAT J1819-1458.

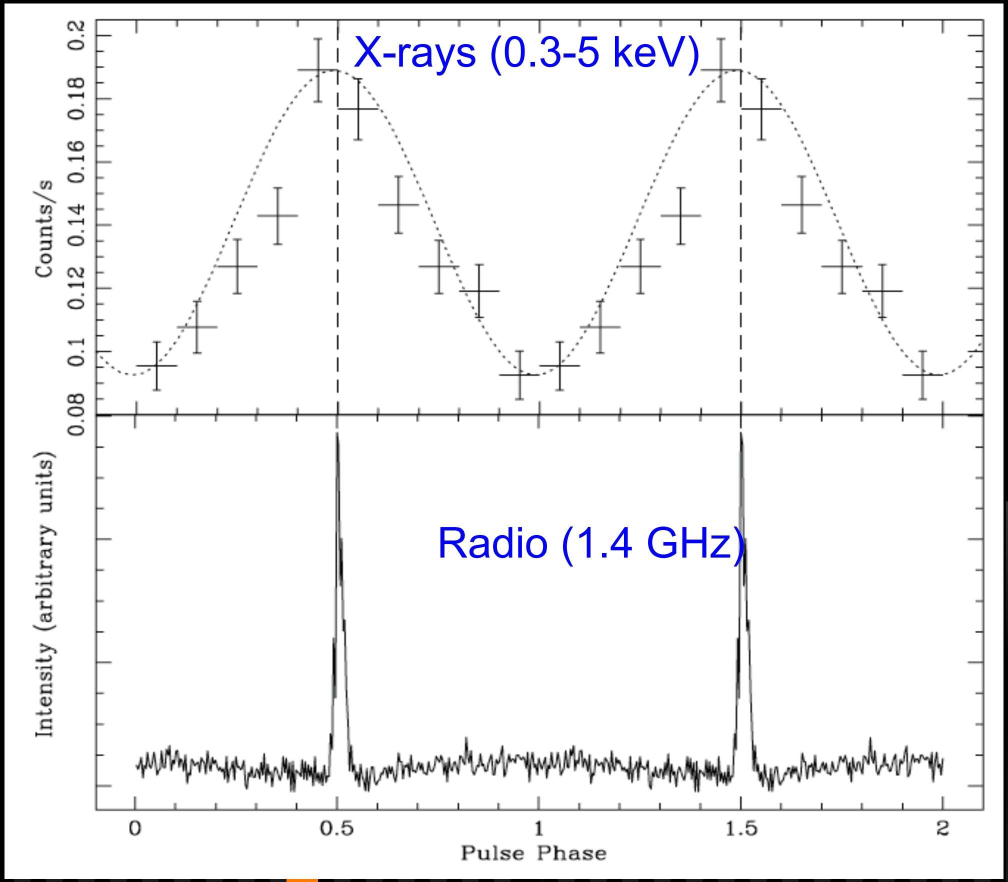
Rotating Radio Transients

19 sources (red stars) with known P-derivative



RRAT J1819-1458

XMM-Newton McLaughlin et al. (2007)



-Only RRAT with detected X-ray counterpart (Reynolds et al. 2006)

-Radio bursts detected every ~3 minutes
2 glitches observed (Lyne et al. 2009)

- Anomalous glitch recovery, with net decrease in Pdot, suggesting a magnetar origin (Lyne et al. 2009).

P_{spin}~4.3 s spin period, age of ~117 kyr and at distance of ~3.6 kpc

B ~ 5×10^{13} G (≈> Bcrit = 4 .4$\times10^{13}$G)

$\dot{E}$rot ~3×10^{32} erg s^{-1}

-No optical counterpart detected, possible IR candidate (Rea et al. 2010)

RRAT J1819-1458

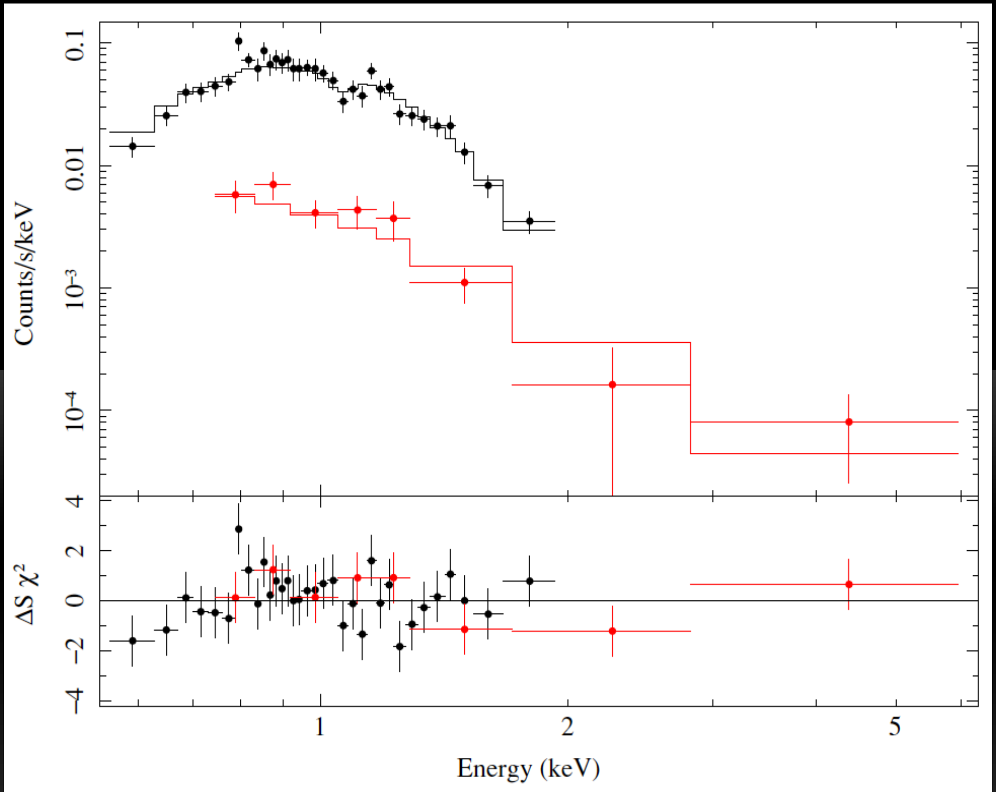
Spectrum

(Black points) absorbed blackbody
N_H=6(2)x10^{21} cm^{-2}
kT=0.12(2) keV

plus

1 keV absorption line (McLaughlin et al 2007, Miller et al. 2013) :
- resonant cyclotron line
- due to NS atmosphere
- overabundance of Ne along the line of sight

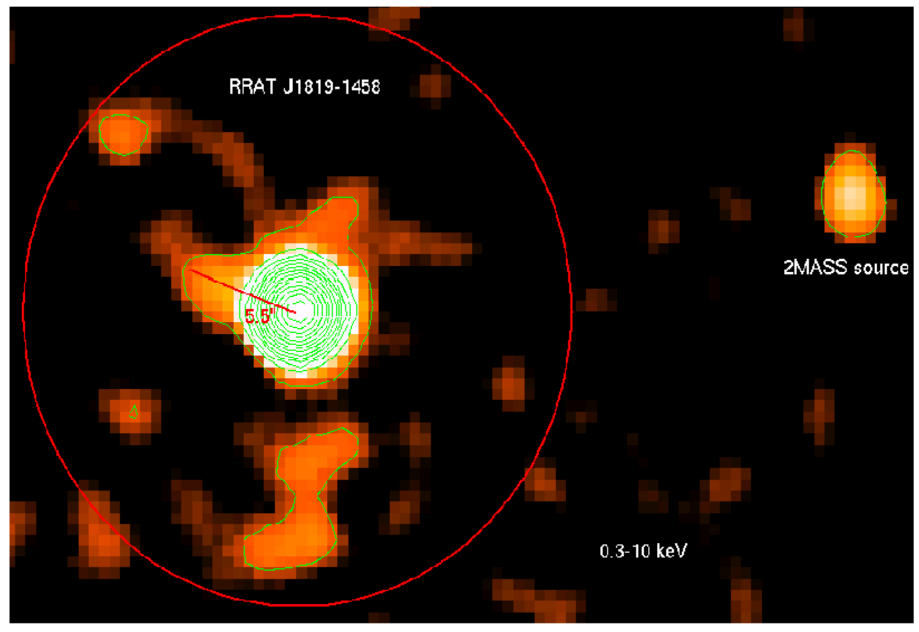
Chandra ACIS-S ~27 ks obs. Rea et al. (2009)



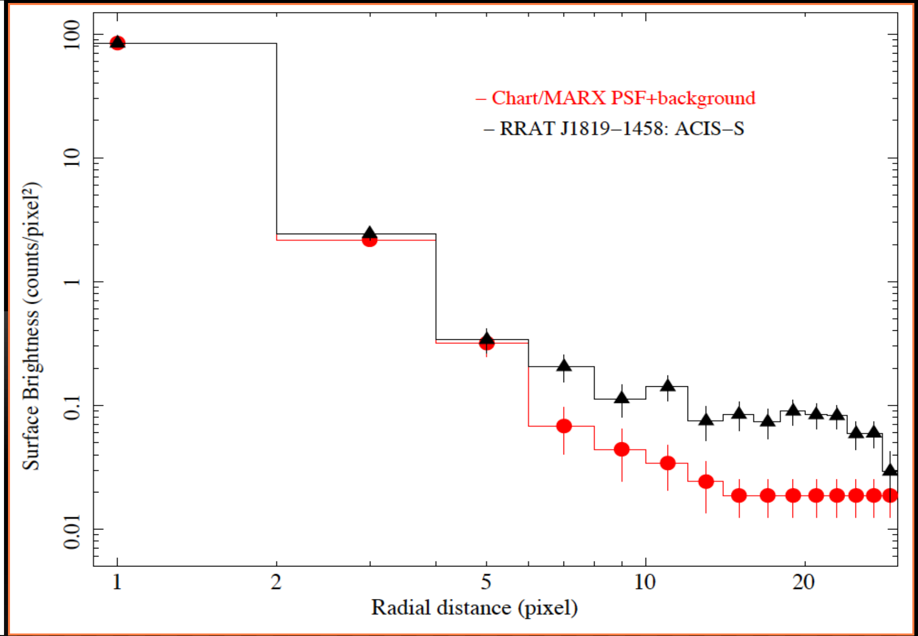
RRAT J1819-1458's Nebula

Discovery of extended X-ray emission around this source (Rea et al. 2009)

0.3-10 keV image + annular region of 13″



Surface Brightness Radial Profile



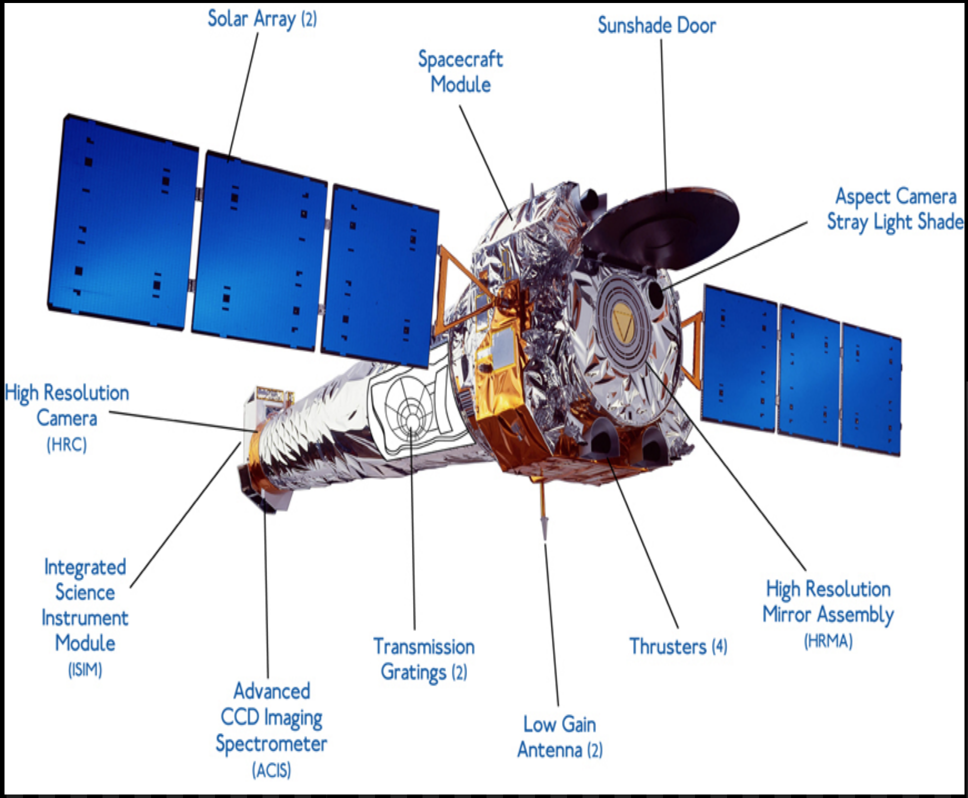
RRAT J1819-1458 *Chandra* Observations

- ObsID 7645, 2008 May 31 for 30 ks

- ObsID 12670, 2011 May 28 for 90 ks

with the Advanced CCD Imaging Spectrometer (ACIS-S)
1/8 subarray S3

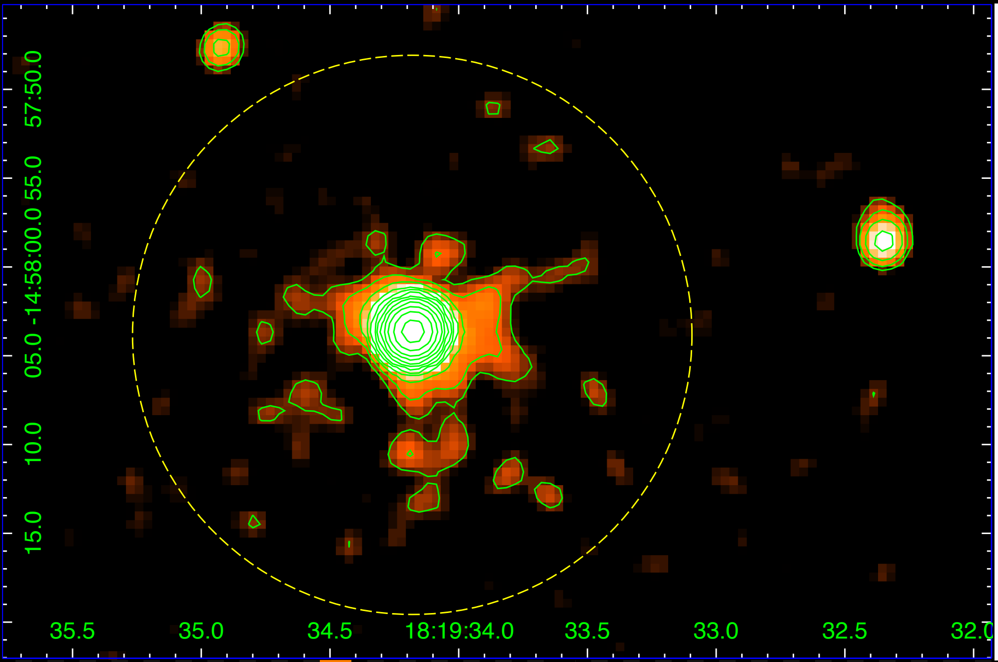
Time resolution ~0.4 s



Imaging

Combined Image 0.3-10 keV:

central source ~2.5” + extended emission ~20”



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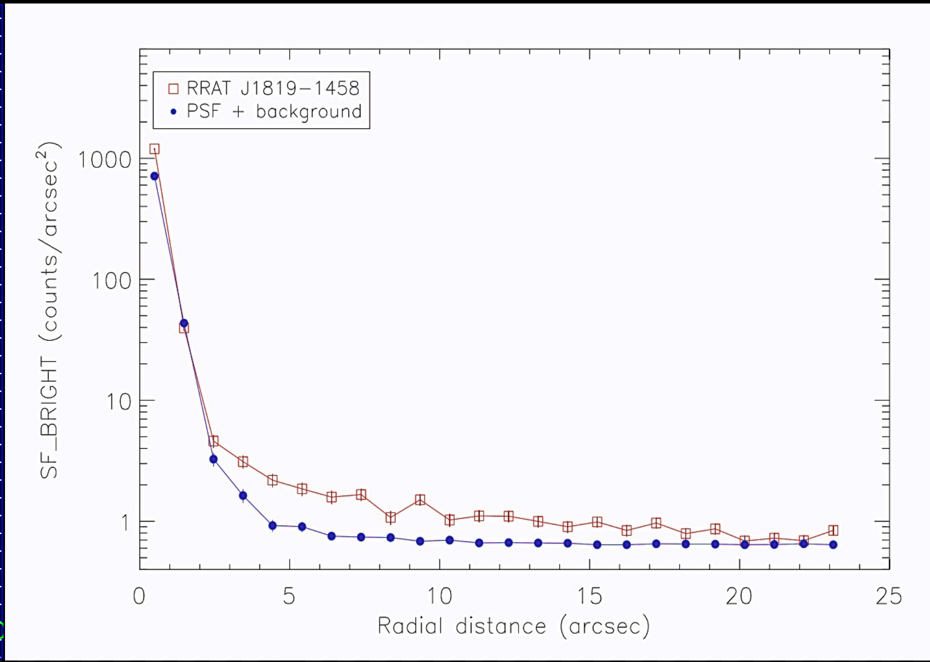
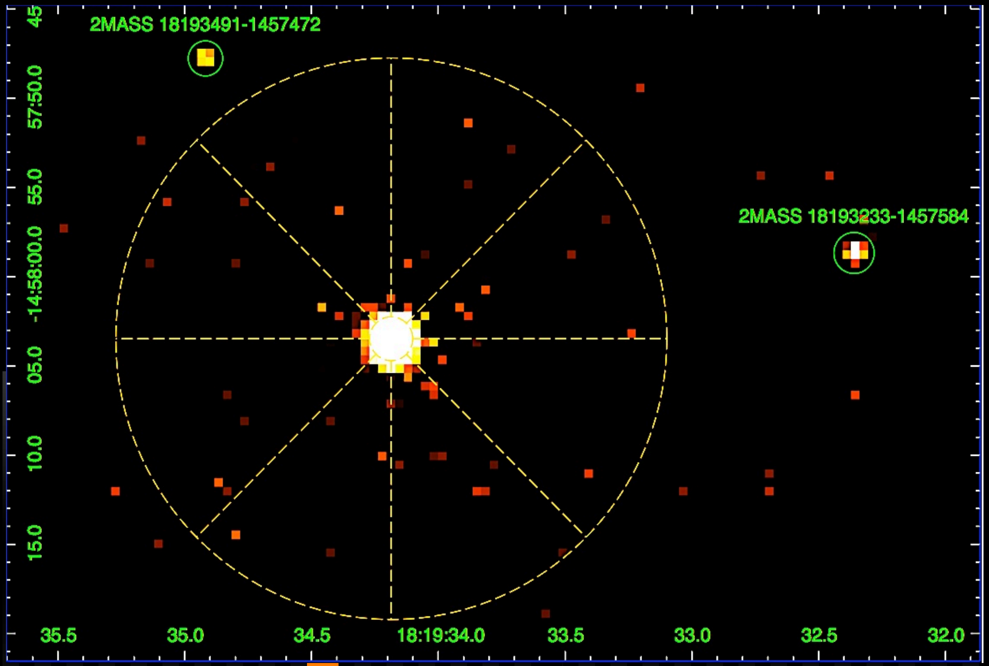
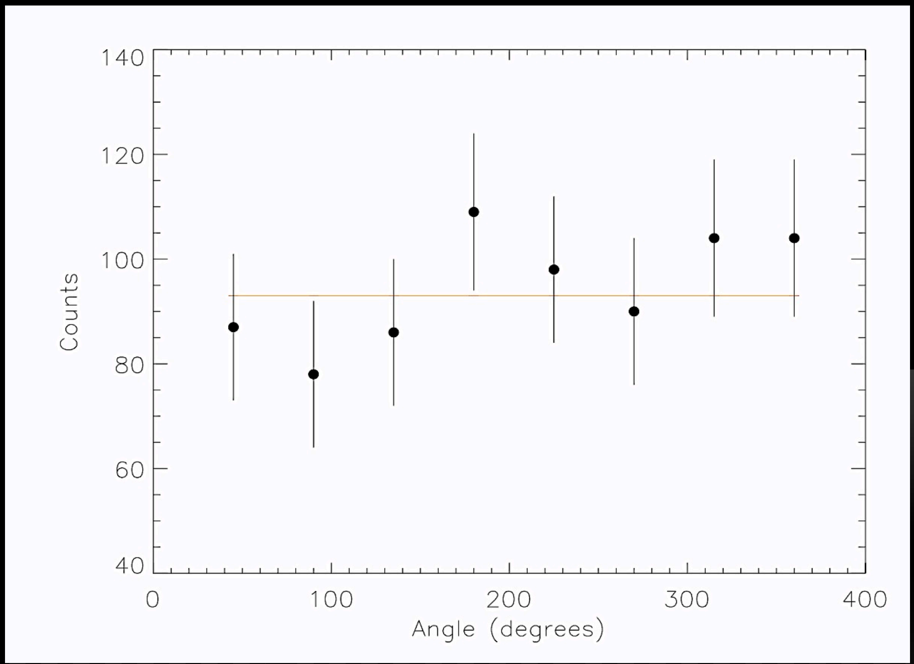


Imaging

Nebula's variability?

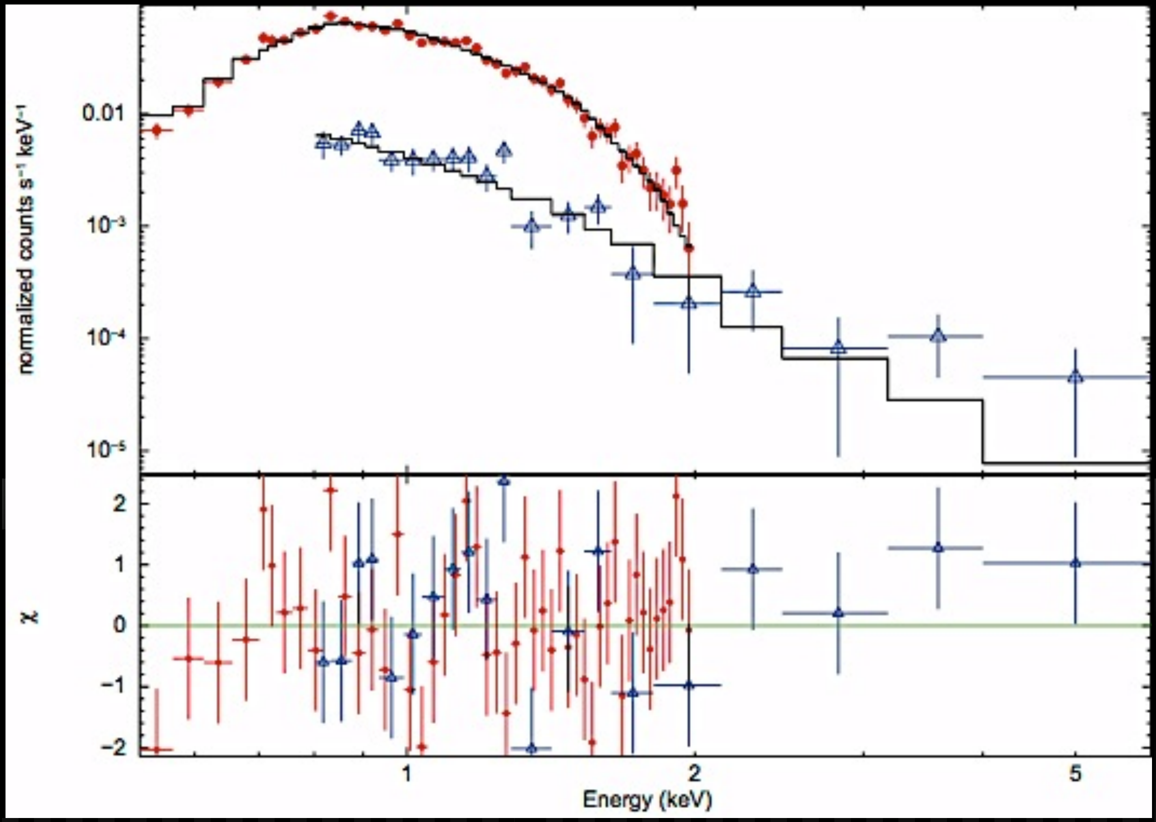




Spectroscopy

RRAT J1819-1458

N_H=6x10^{21} cm^{-2}
T_{BB} =0.130(2) keV
E_{Gauss}=1.16(3) keV and
σ = 0.17(3) keV
Flux(0.3-5 keV)=1.35(2) erg cm^{-2} s^{-1}
reduced χ2 =1.10 (44 dof)



NEBULA

N_H<7x10^{21} cm^{-2}
Γ= 3.7(6)
Flux(0.3-5 keV)=0.23(2) erg cm^{-2} s^{-1}
reduced χ2 =1.26 (19 dof)

Timing

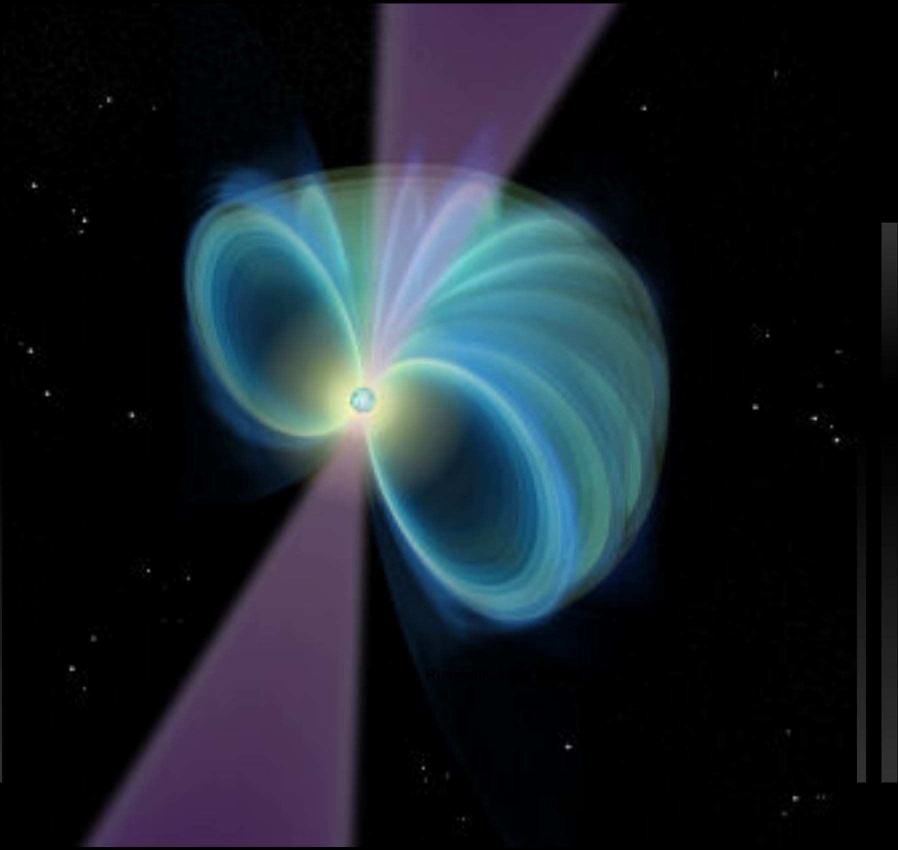
-New *Chandra* X-ray observation folded using the radio ephemeris (Lyne et al. 2009).

-Confirming the sinusoidal X-ray modulation seen by *XMM-Newton* and *Chandra* *(McLaughlin et al. 2007, Rea et al. 2009).*

-Pulse Fraction:

XMM- Newton 2006 --> 34(6)%
Chandra 2008 --> 37(3)%
Chandra 2011 --> 31(4)%

-No long-term timing variability observed



Observational Summary

-Extended X-ray emission from 2.5 - 20 arcsec

-RRAT J1819-1458's spectrum:
abs. BB (kT=0.130(2) keV) + 1 keV line

-Nebula spectrum: power law (Γ=3.7(6))

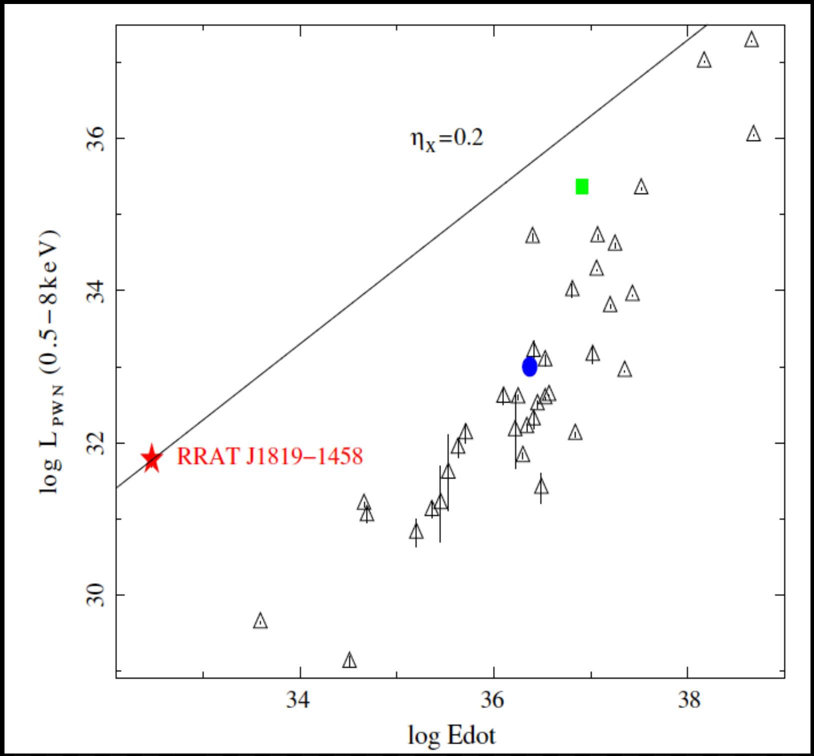
-Pulsed emission at ~35%

-No spectral and timing long-term variability observed

-$\eta_X \equiv L_{pwn}$(0.5−8 keV) / $\dot{E}_{spin\text{-}down}$ ~ 0. 2 (high)

-$L_X > L_{spin\text{-}down}$

- Need of an additional source of energy



Possible Interpretations for the extended X-ray emission

a) Scattering halo

b) PWN

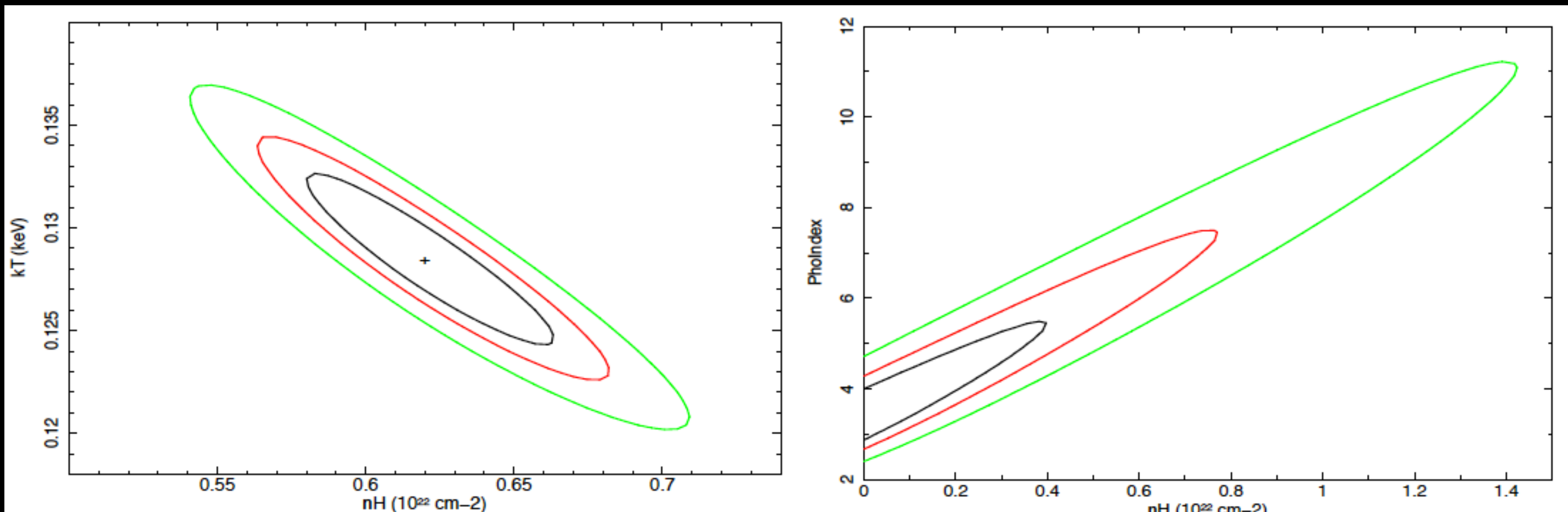
c) Magnetic Nebula?
Examples: . 1E 1547-5408 (Sholtz & Kaspi, 2011)
. Swift J1834.9-0846 (Younes et al. 2012; Esposito et al. 2012)

For RRAT J1819 : only in the case of a Compton nebula (not in the case of synchrotron emission)

(Camero-Arranz et al. 2013, MNRAS, 429, 2493)

THANKS!!

Spectroscopy



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