

A new nearby PWN overlapping the VelaJr SNR

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(1) LUPM, CNRS/Université Montpellier 2

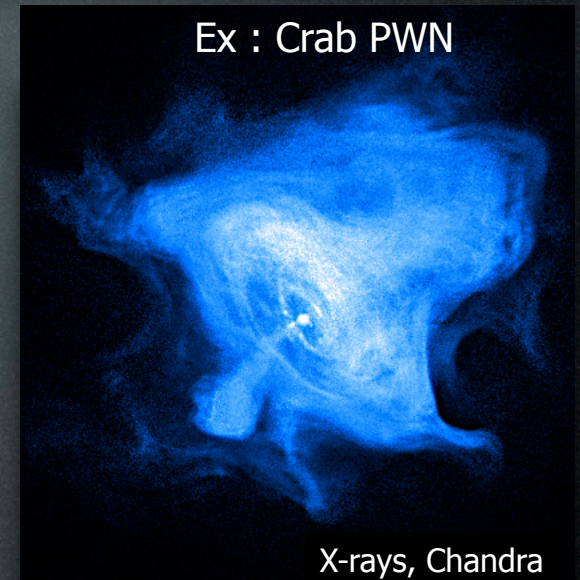
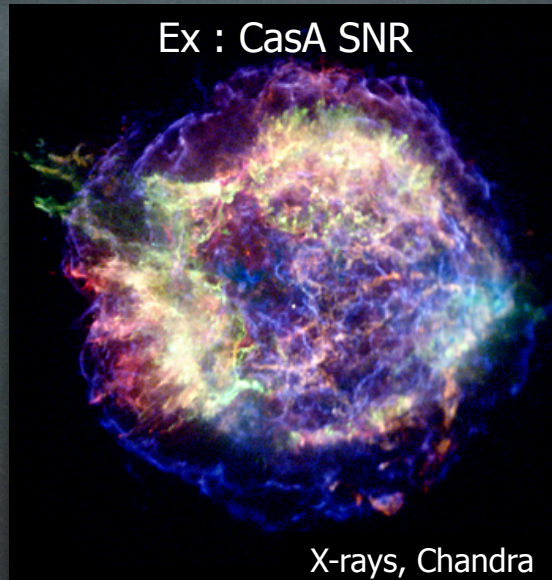
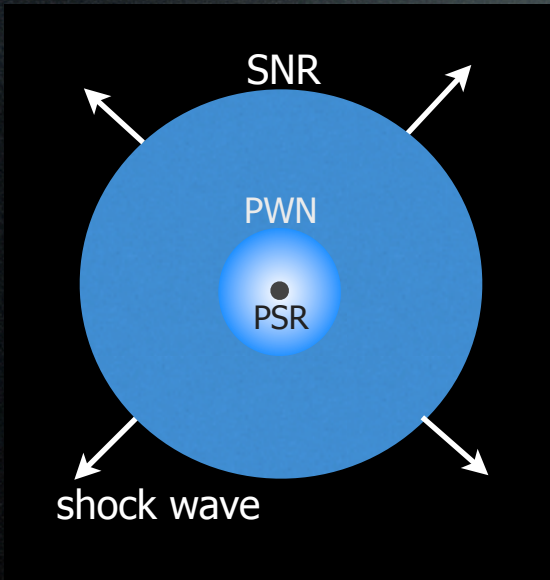
(2) APC, CNRS/Université Paris Diderot-Paris 7

(3) AIM, CEA/CNRS/Université Paris Diderot-Paris 7

CRISM meeting

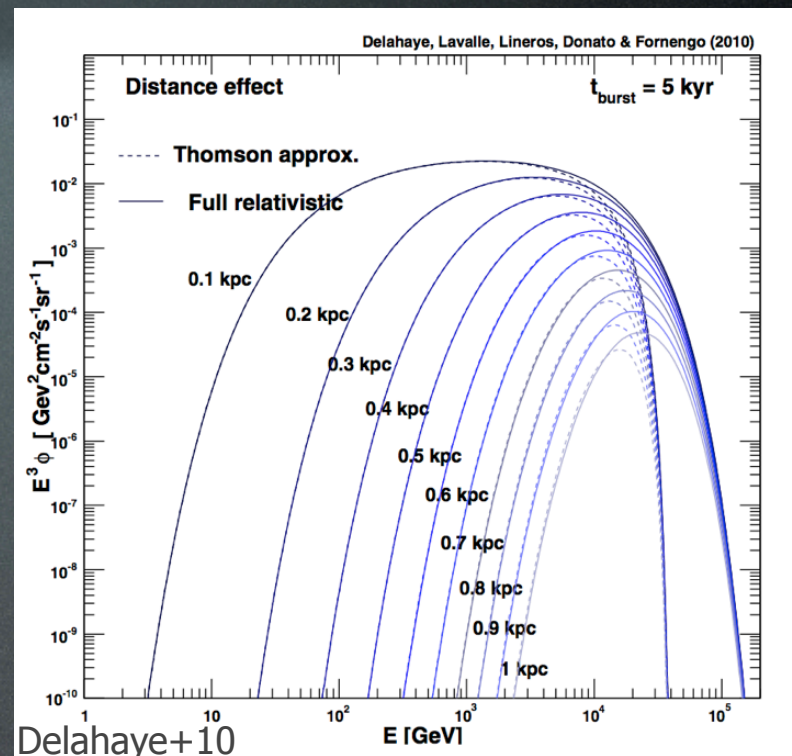
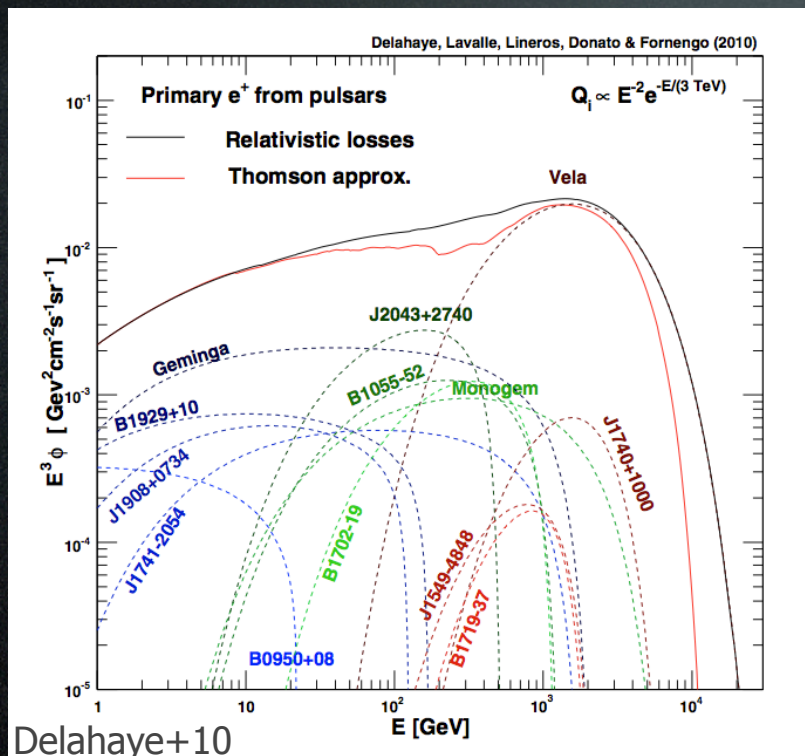


Cosmic rays accelerators



- Where are accelerated CRs (hadrons/leptons) ?
- SNRs are accelerating e^- and (we hope) hadrons
- PSR are the prime contributors of e^+

Contributors to the positron spectrum



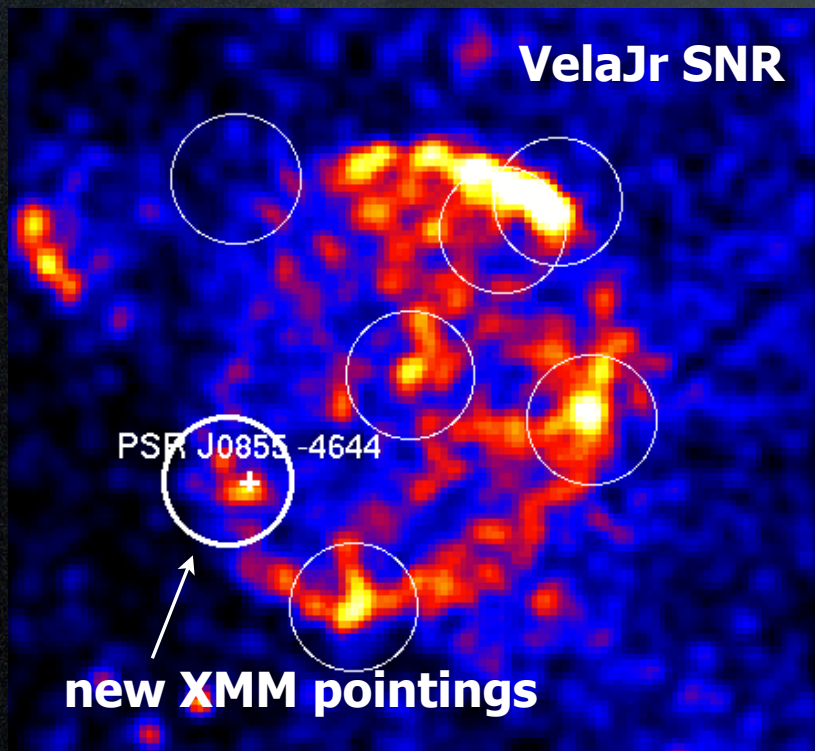
- Spectrum received at Earth = Sum(PSR * propagation)
- Propagation effects : diffusion + energy losses
(see J. Laval's talk)
- Nearby and energetic PSR are the prime contributors

Motivations to observe PSR J0855-4644

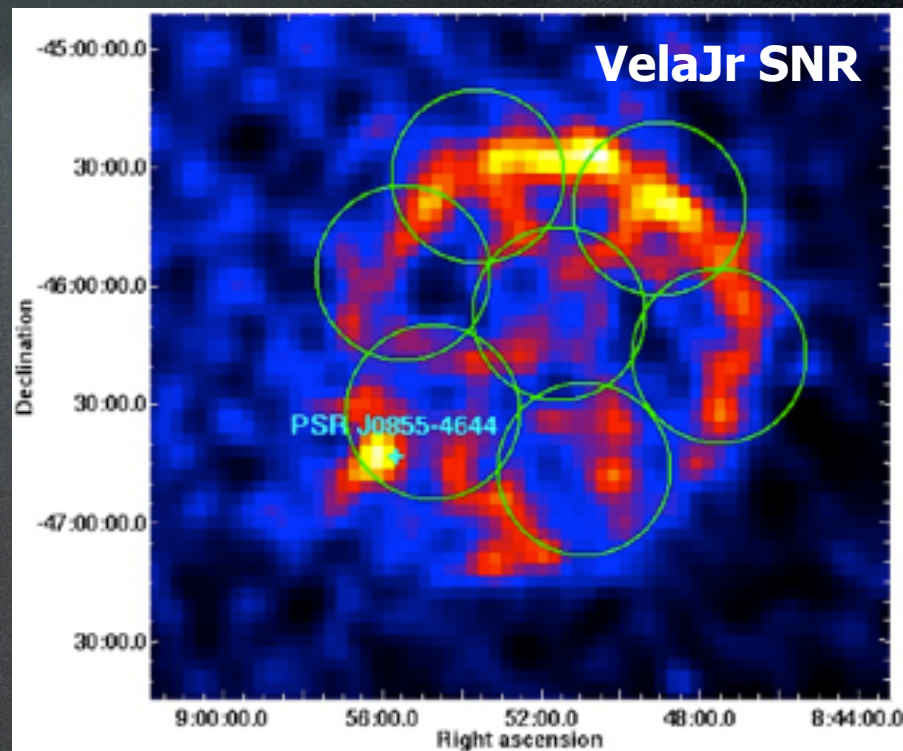
Pulsar parameters

$P = 64$ ms
 $\dot{E} = 1.1 \times 10^{36}$ ergs/s
 $d = 4$ kpc (from DM)
 $\tau_c = 140$ kyrs

Kramer+03,
Redman+05

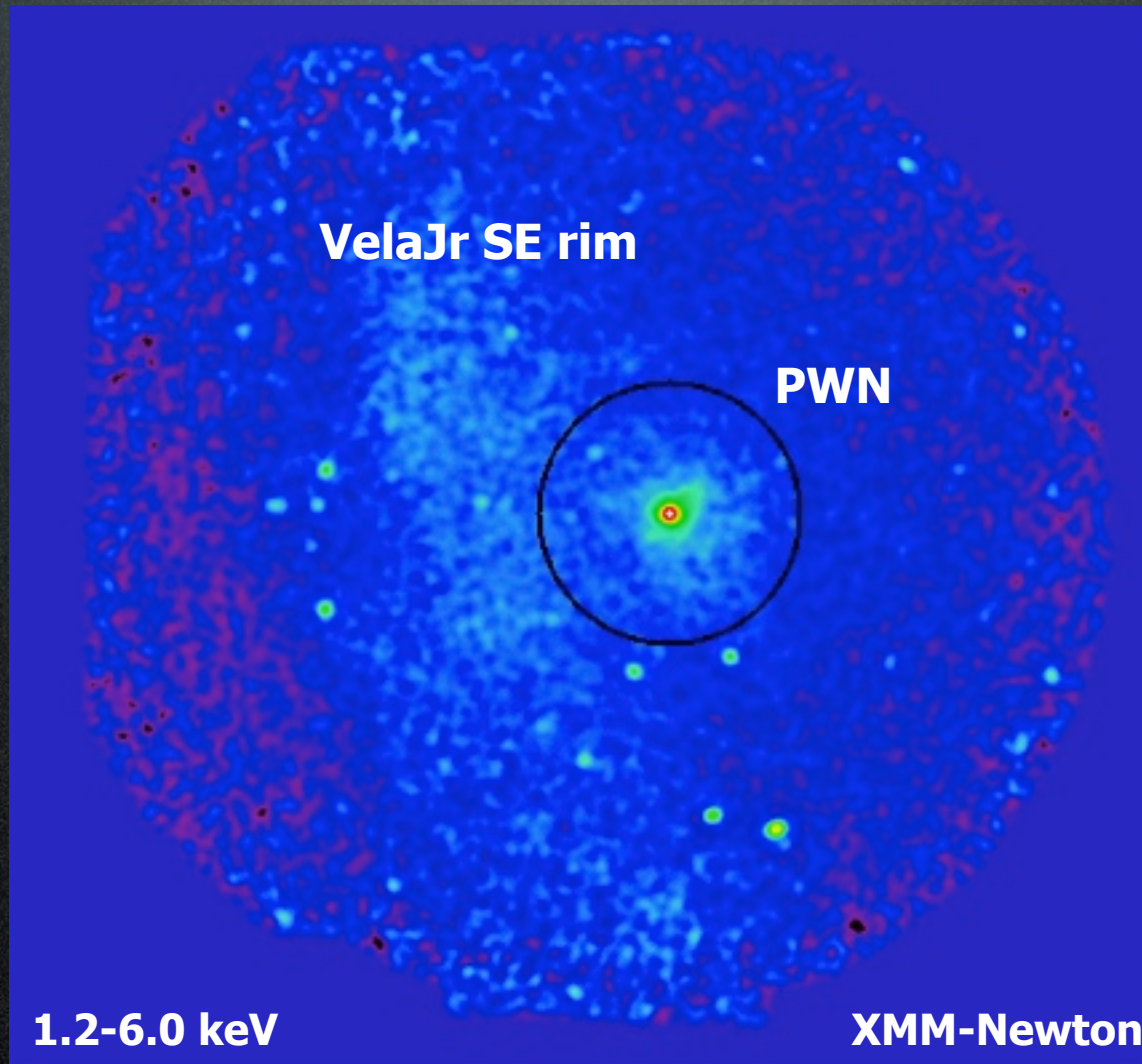


ROSAT > 1.3 keV



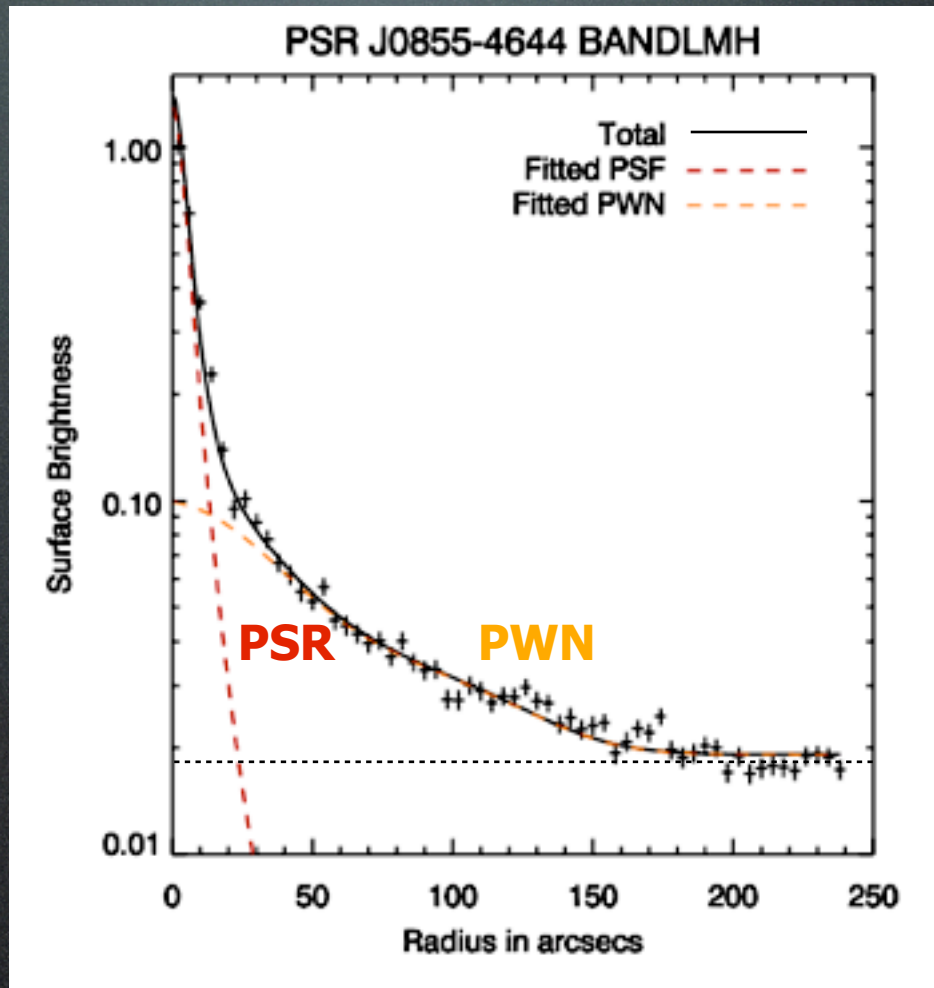
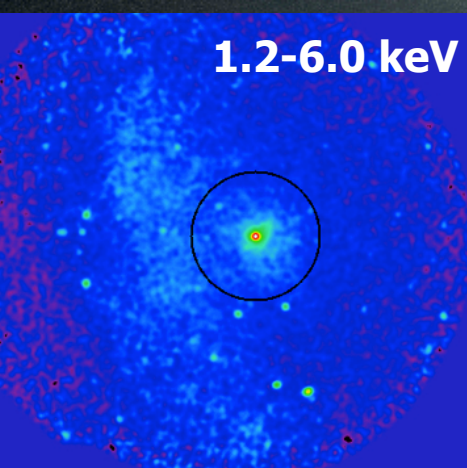
HESS excess map (Aharonian+07)

Discovery of a new PWN in the VelaJr region



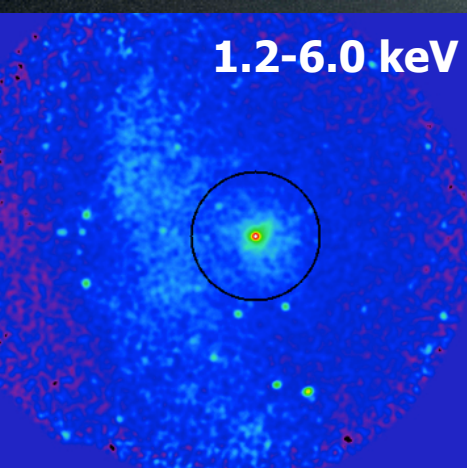
1.2-6.0 keV

PWN radial profile



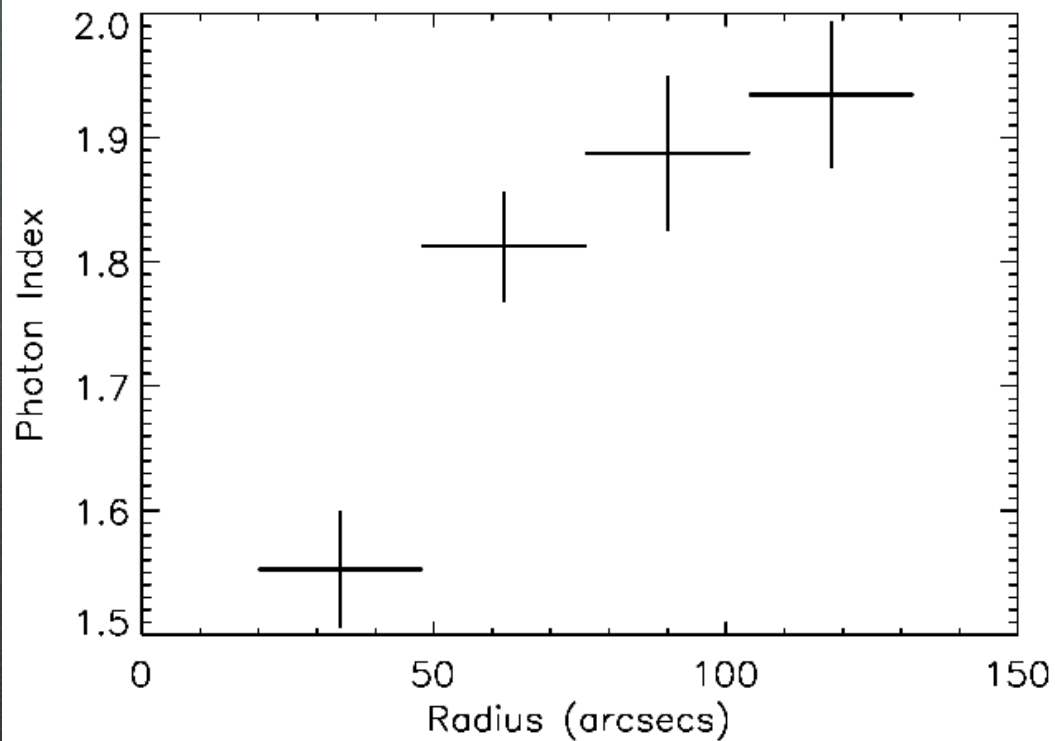
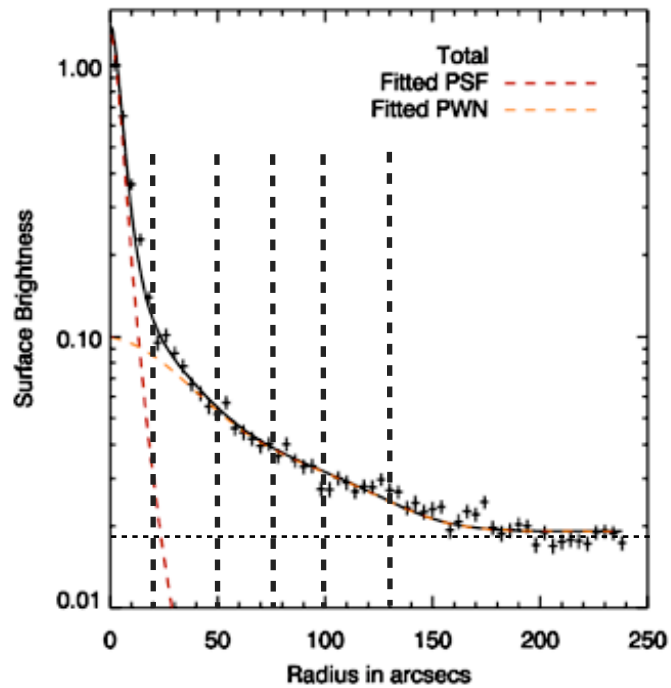
point source subtracted

1.2-6.0 keV

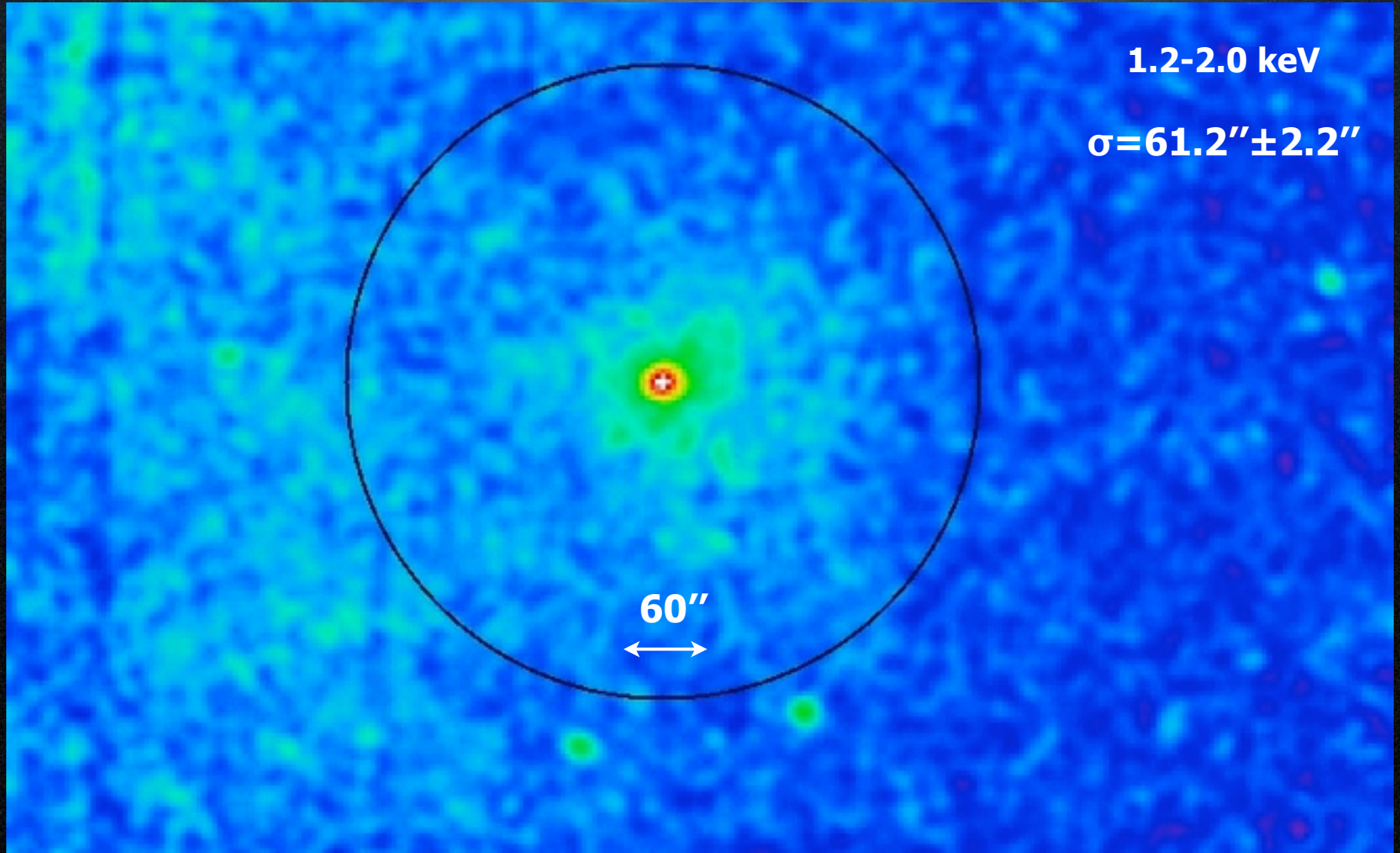


Cooling of the e^-

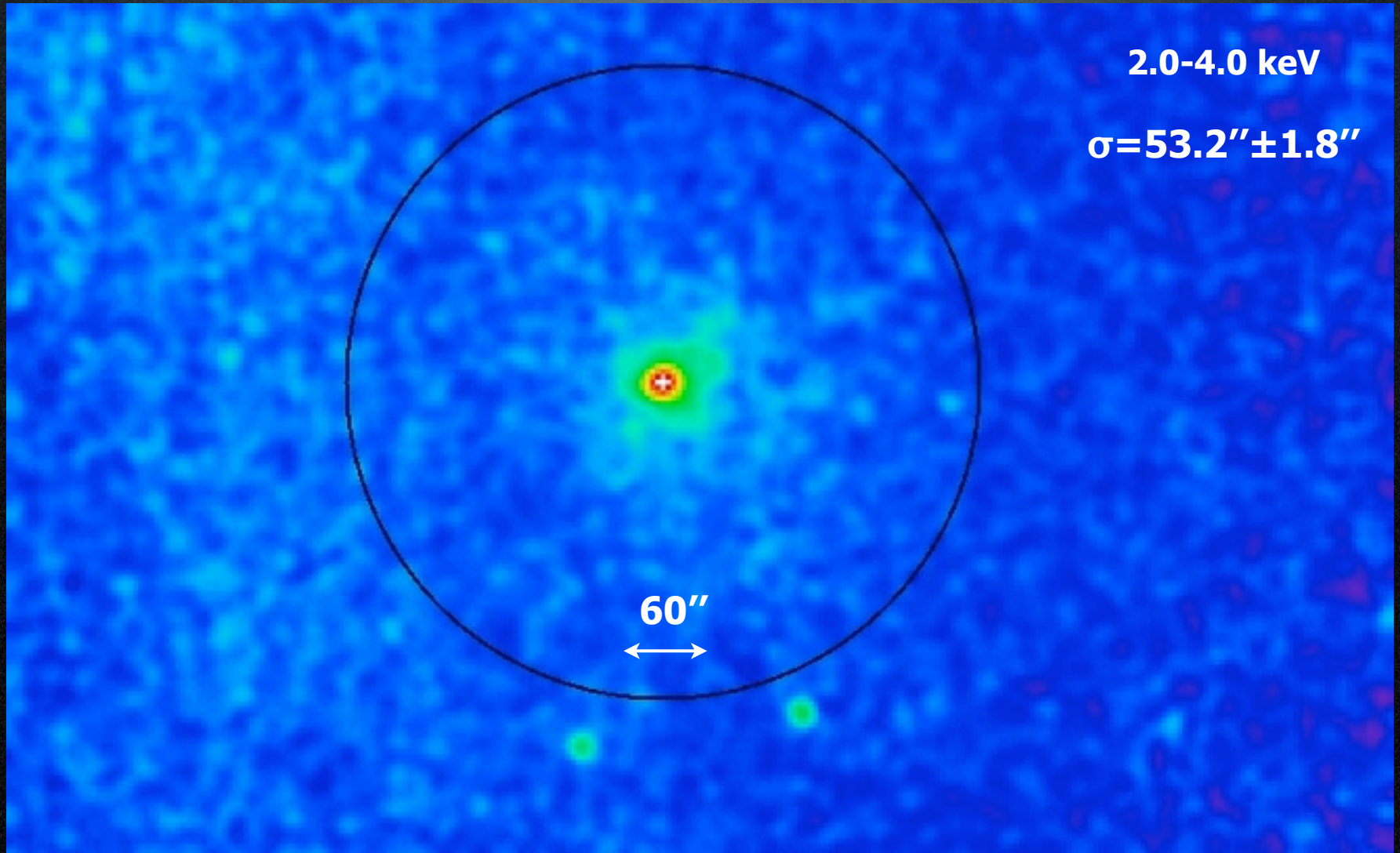
PSR J0855-4644 BANDLMH



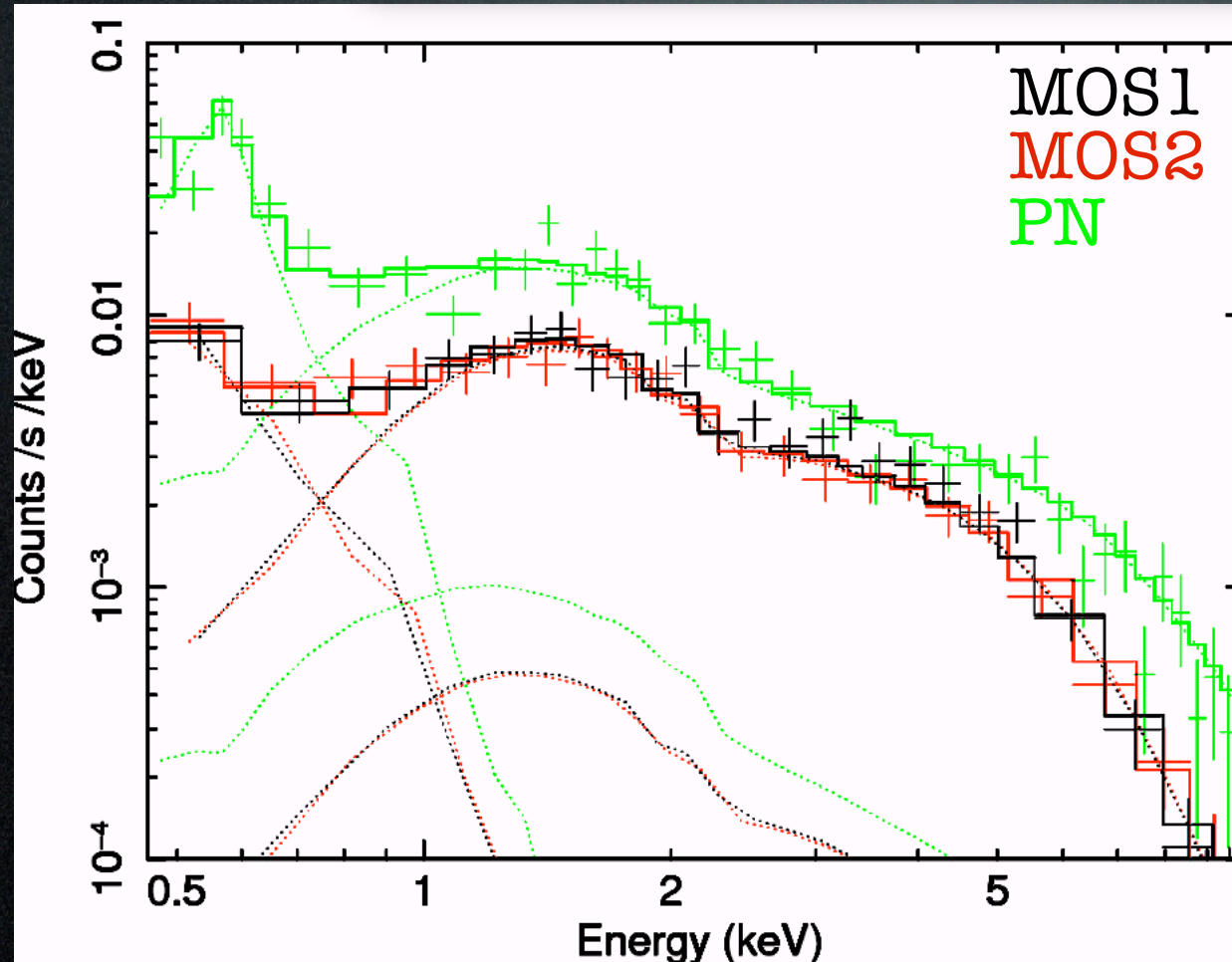
PWN morphology



PWN morphology



Distance to PSR J0855-4644



Pulsar parameters

$$P = 64 \text{ ms}$$

$$\dot{E} = 1.1 \times 10^{36} \text{ ergs/s}$$

$$\tau_c = 140 \text{ kyr}$$

X-ray properties

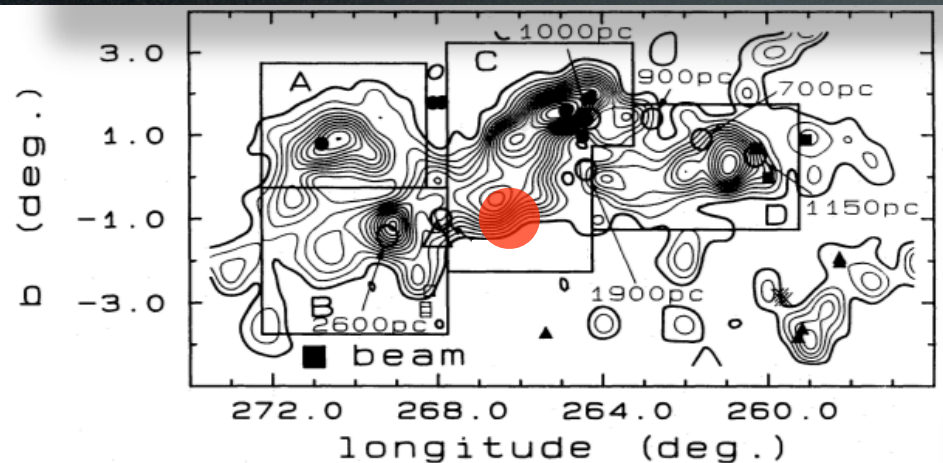
$$N_H = (0.55 \pm 0.10) \times 10^{22} \text{ cm}^{-2}$$

$$\Gamma_{\text{psr}} = 1.24 \pm 0.08$$

$$F_{2-10\text{keV}} = (2.9 \pm 0.4) \times 10^{-13} \text{ (ergs/cm}^2\text{/s)}$$

kT and N_H from Vela
thermal emission fixed
from the nebula

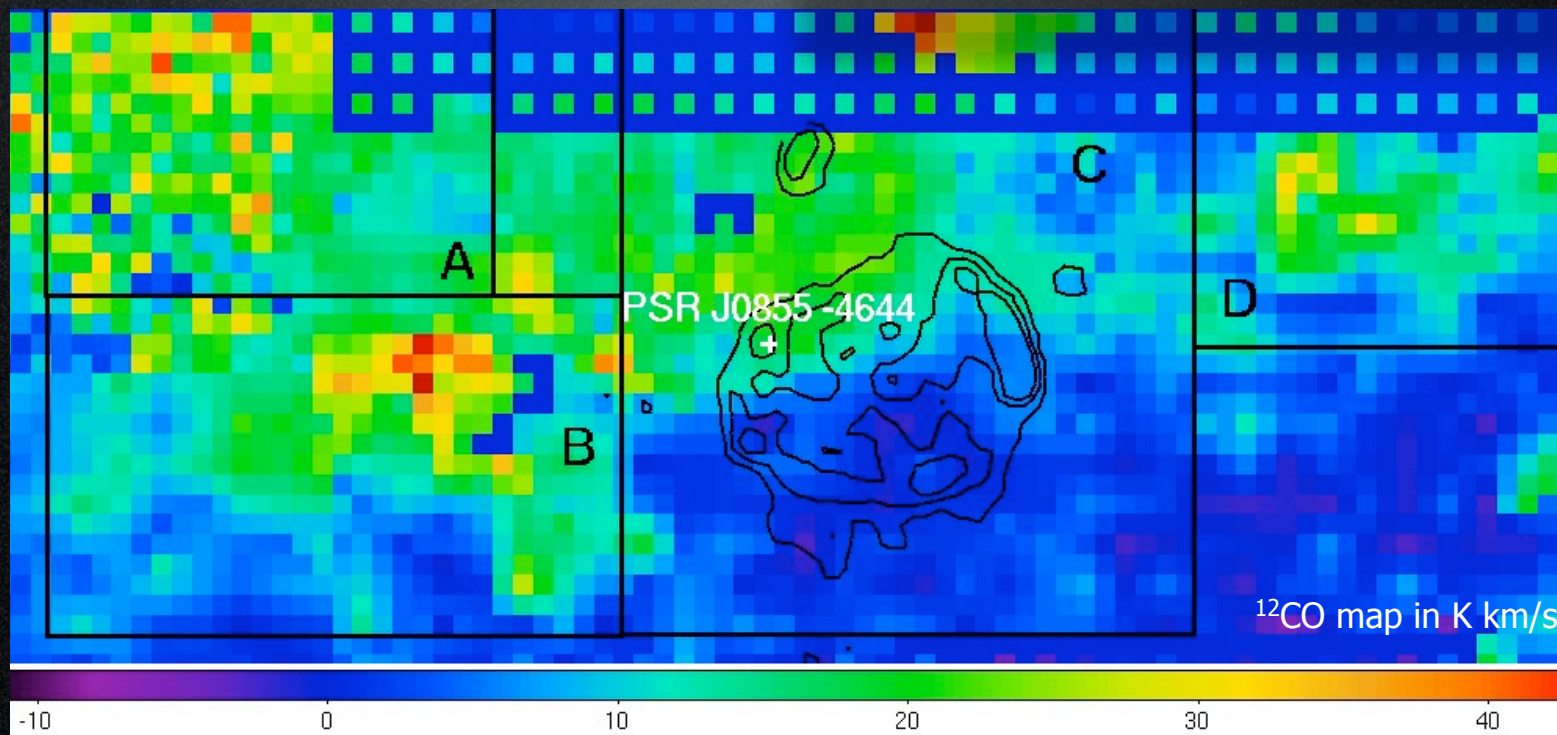
The Vela Molecular ridge



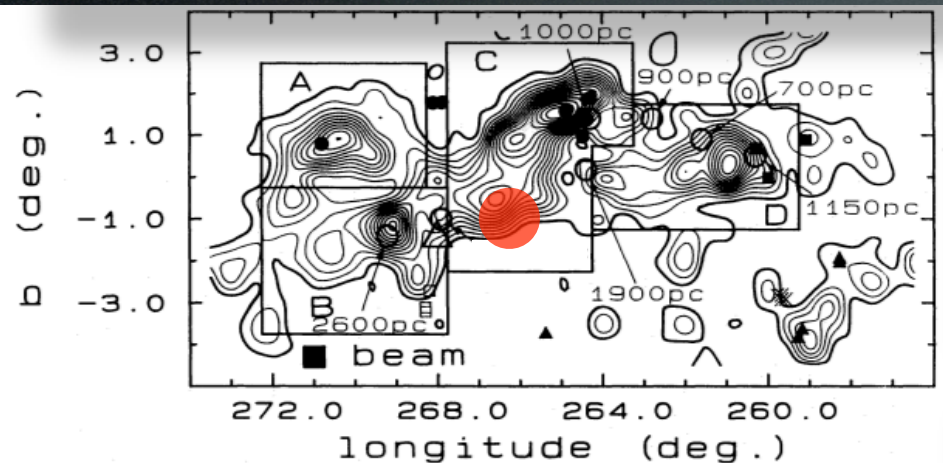
← Murphy+91 Cloud definition

A, C, D clouds @ 700 ± 200 pc
(Liseau+92, Reynoso+96, Moriguchi+01)

^{12}CO integrated cube (Dame+01)



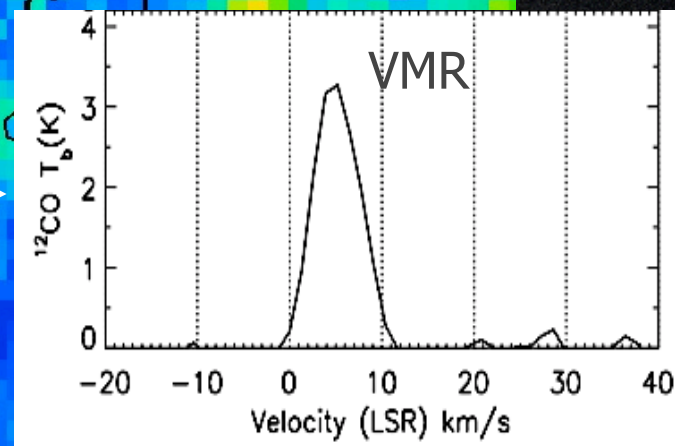
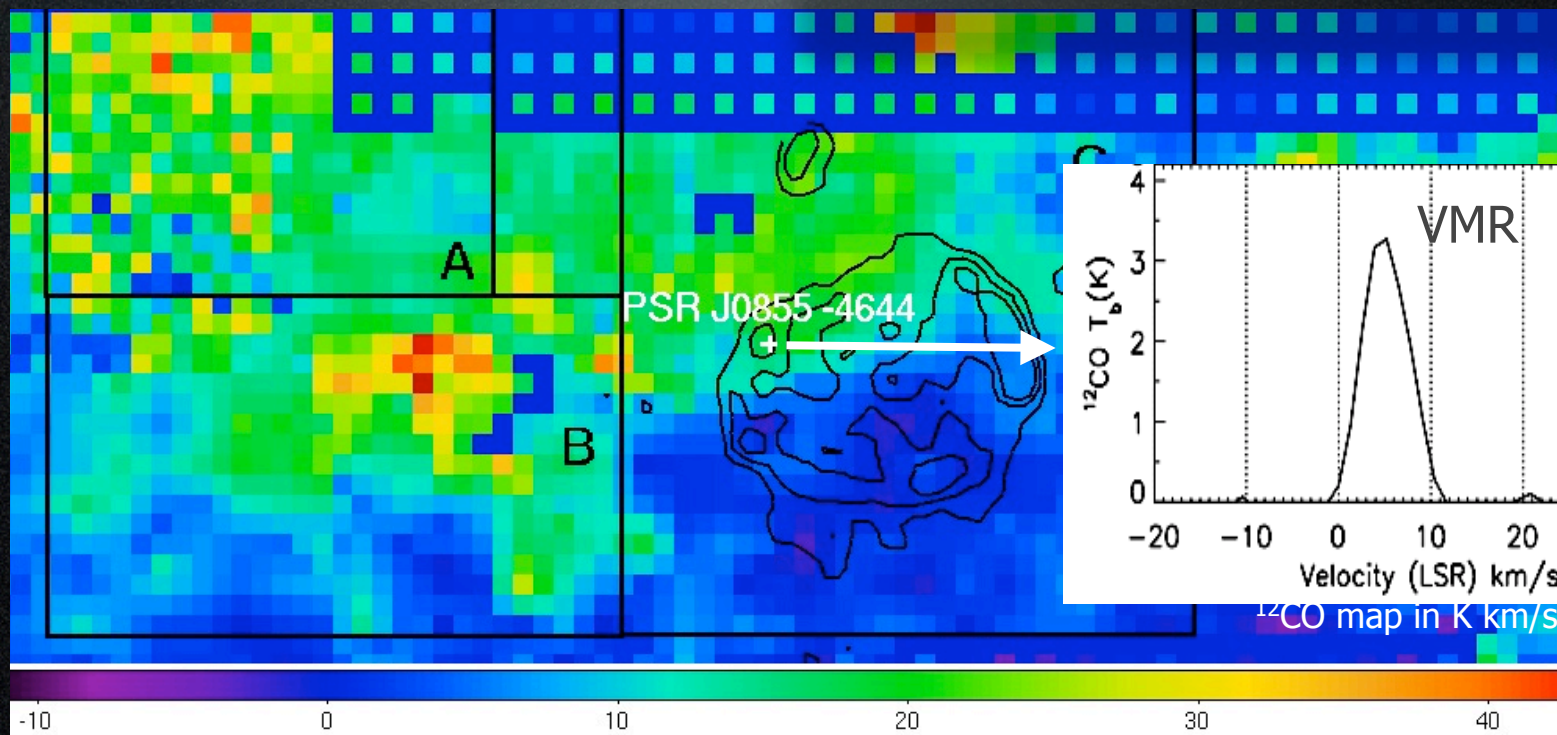
The Vela Molecular ridge



← Murphy+91 Cloud definition

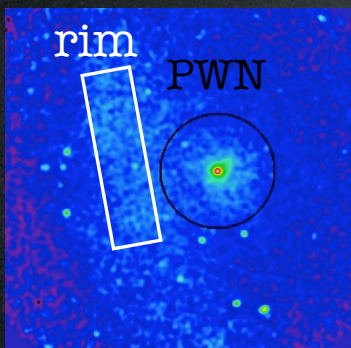
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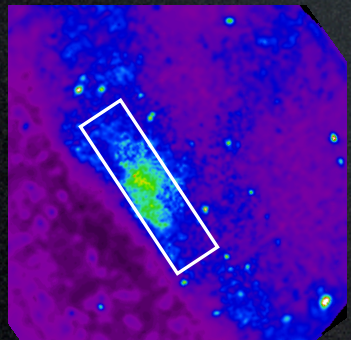
Is the VelaJr SNR behind the VMR ?

XMM 1-6 keV map



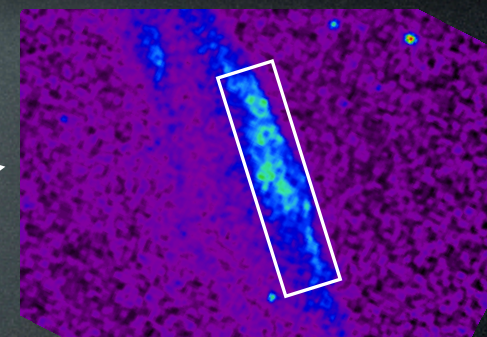
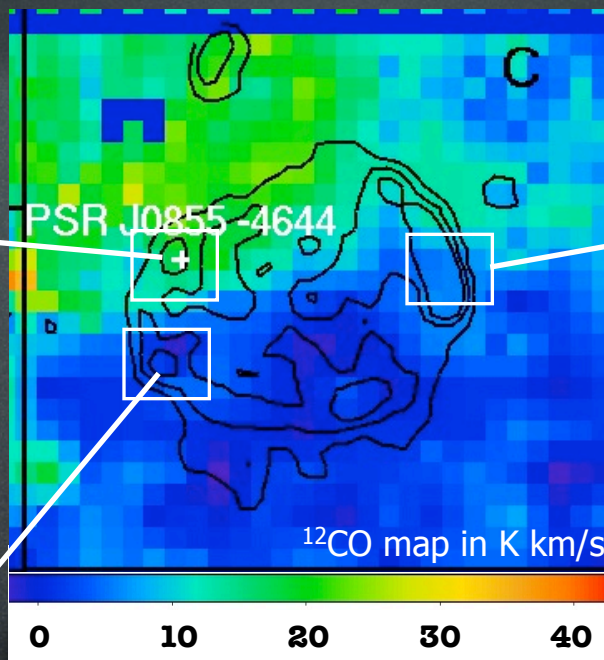
$$N_{\text{H}} = 0.95 \pm 0.11$$

$$\Gamma = 2.41 \pm 0.14$$



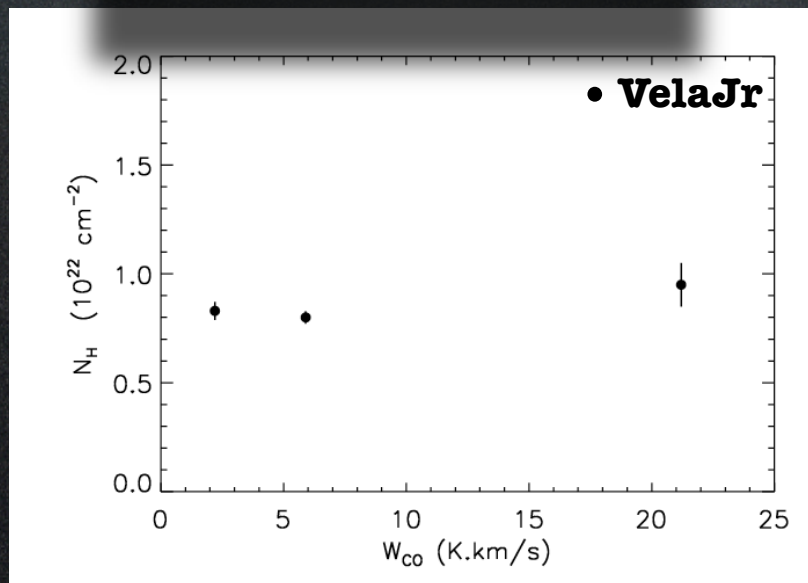
$$N_{\text{H}} = 0.83 \pm 0.05$$

$$\Gamma = 2.65 \pm 0.04$$



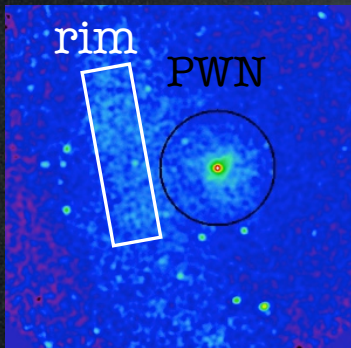
$$N_{\text{H}} = 0.80 \pm 0.03$$

$$\Gamma = 2.62 \pm 0.05$$



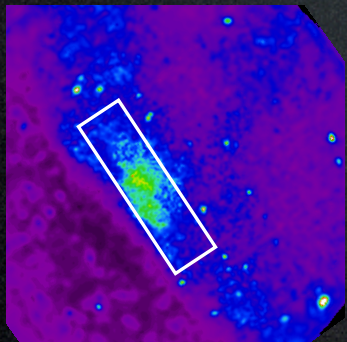
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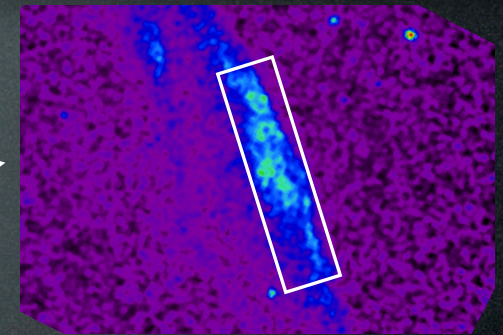
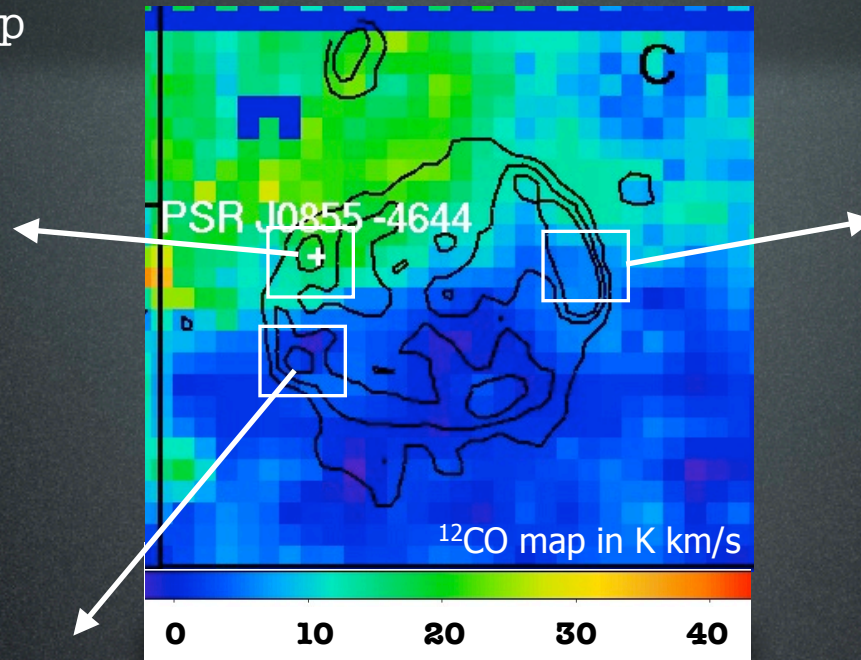
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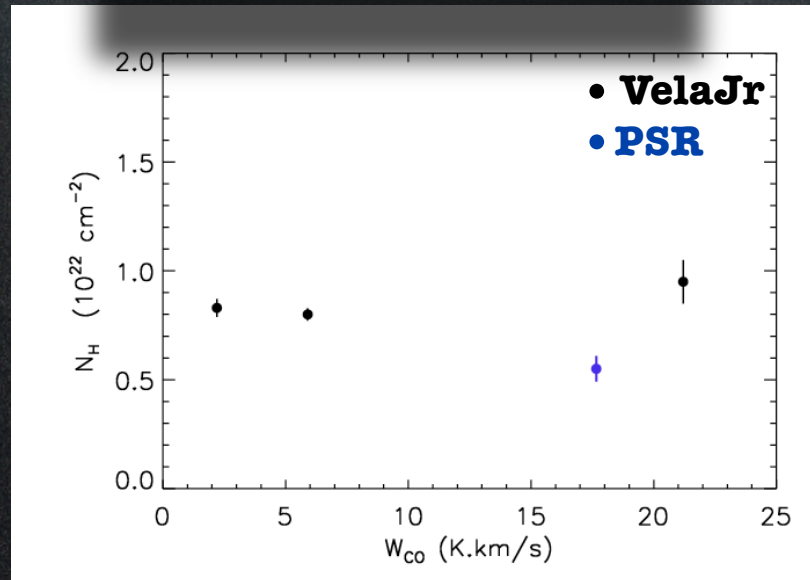
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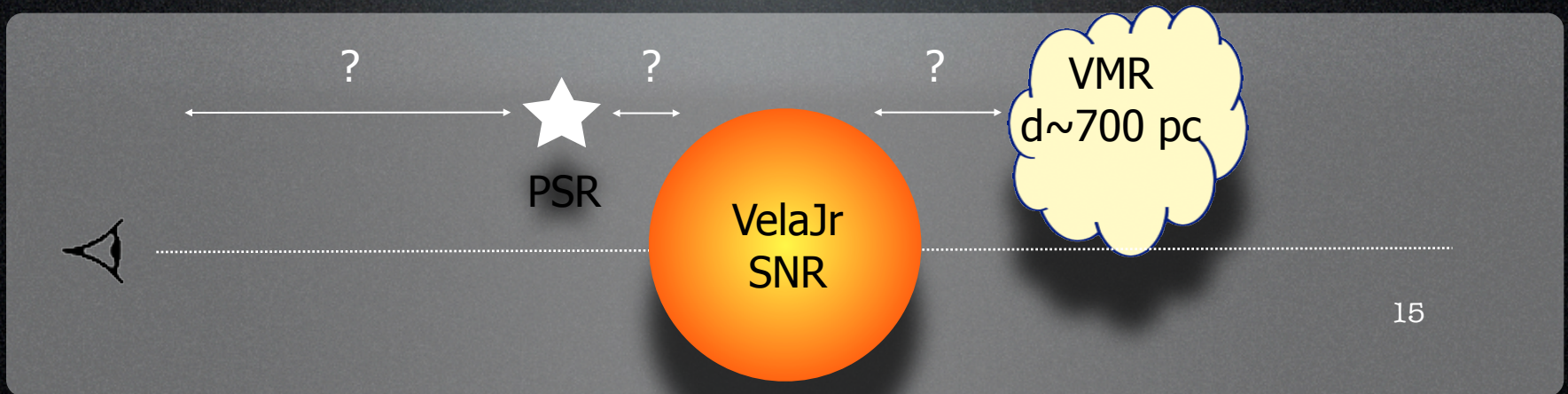
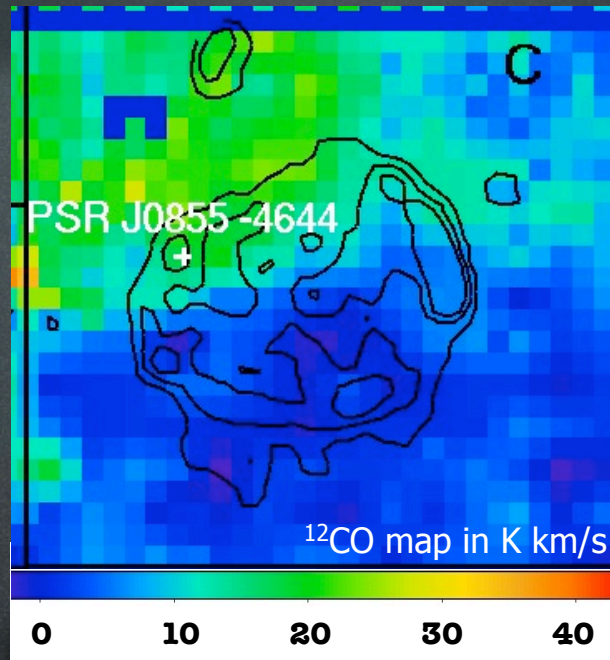
$$N_H = 0.80 \pm 0.03$$

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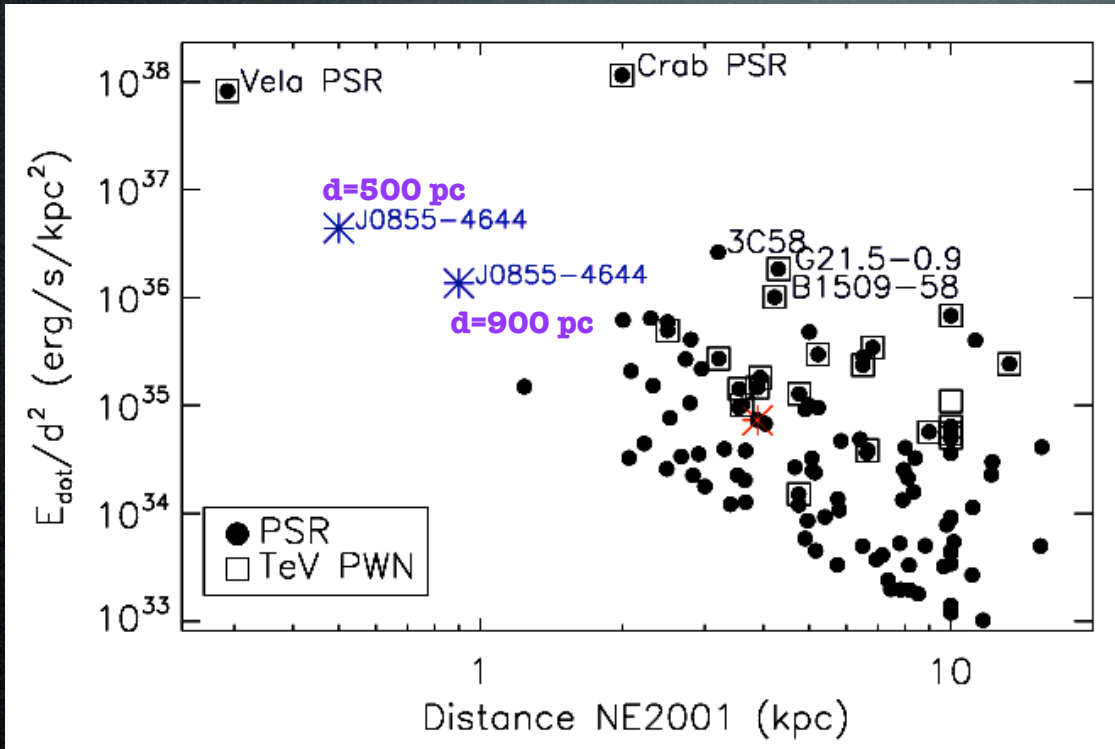


- No $W_{\text{CO}}-N_H$ correlation
- VelaJr and PSR are in the foreground
- Method is based on relative values of N_H not absolute values

Cartoon view



Changing distance changes everything



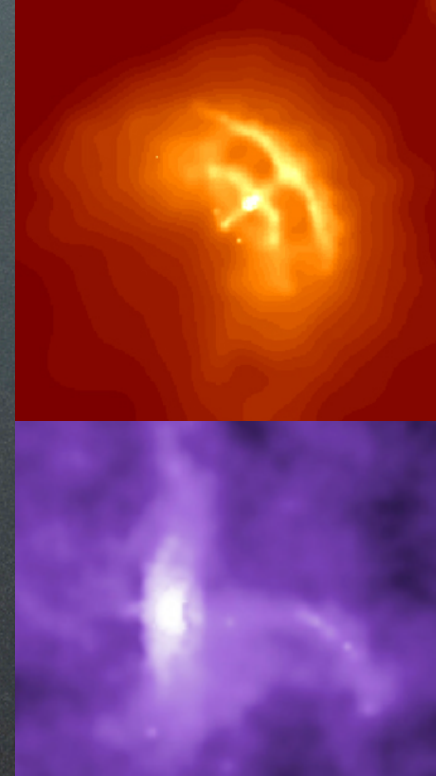
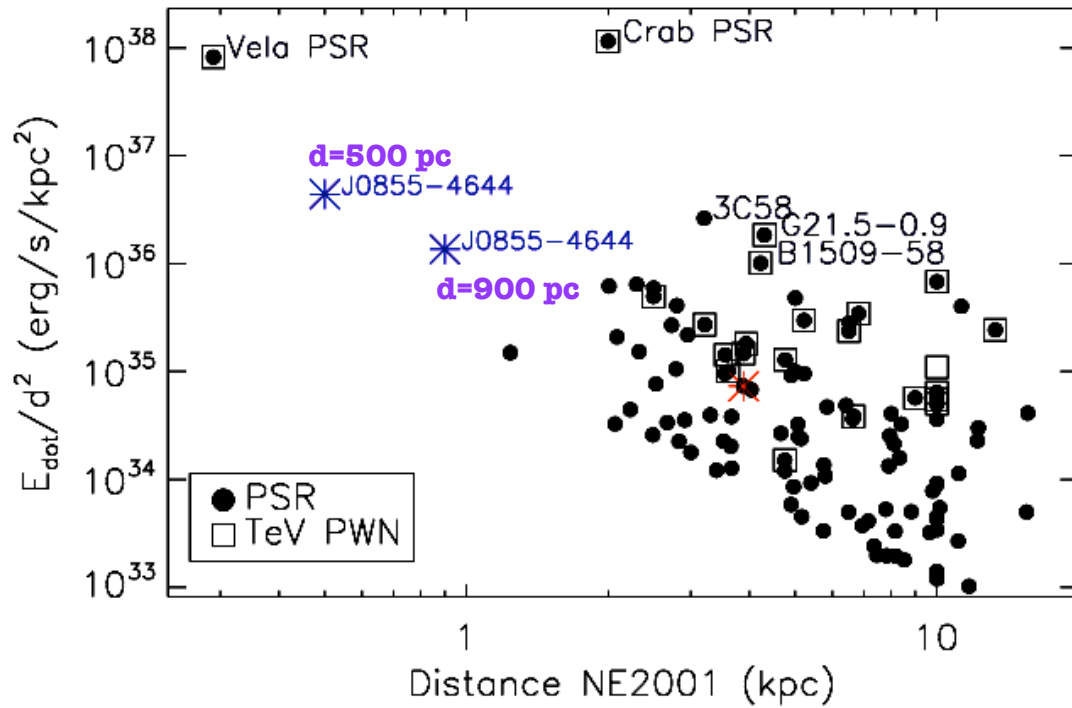
Only psr with $E_{\dot{\nu}} > 10^{35}$ ergs/s selected

- A nearby & energetic pulsar

- Why wasn't it discovered before ?

↓ ↓
Embedded in a complex region

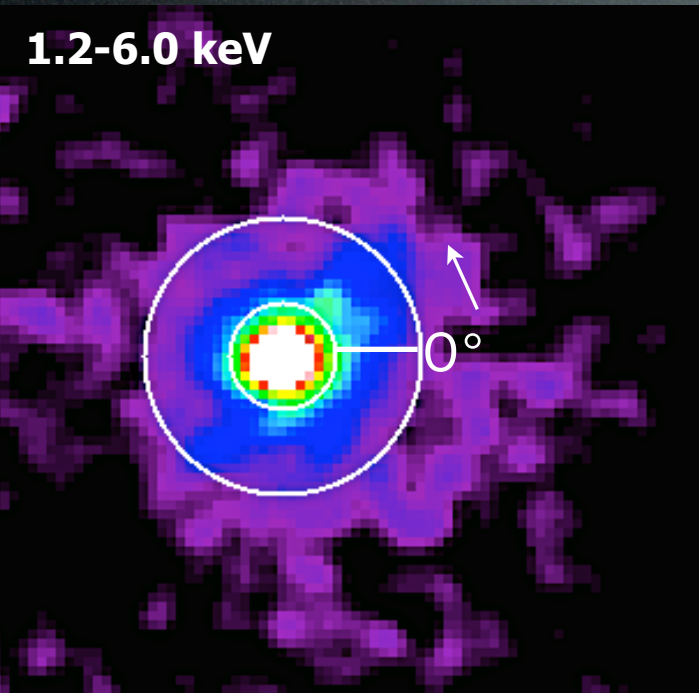
Morphology



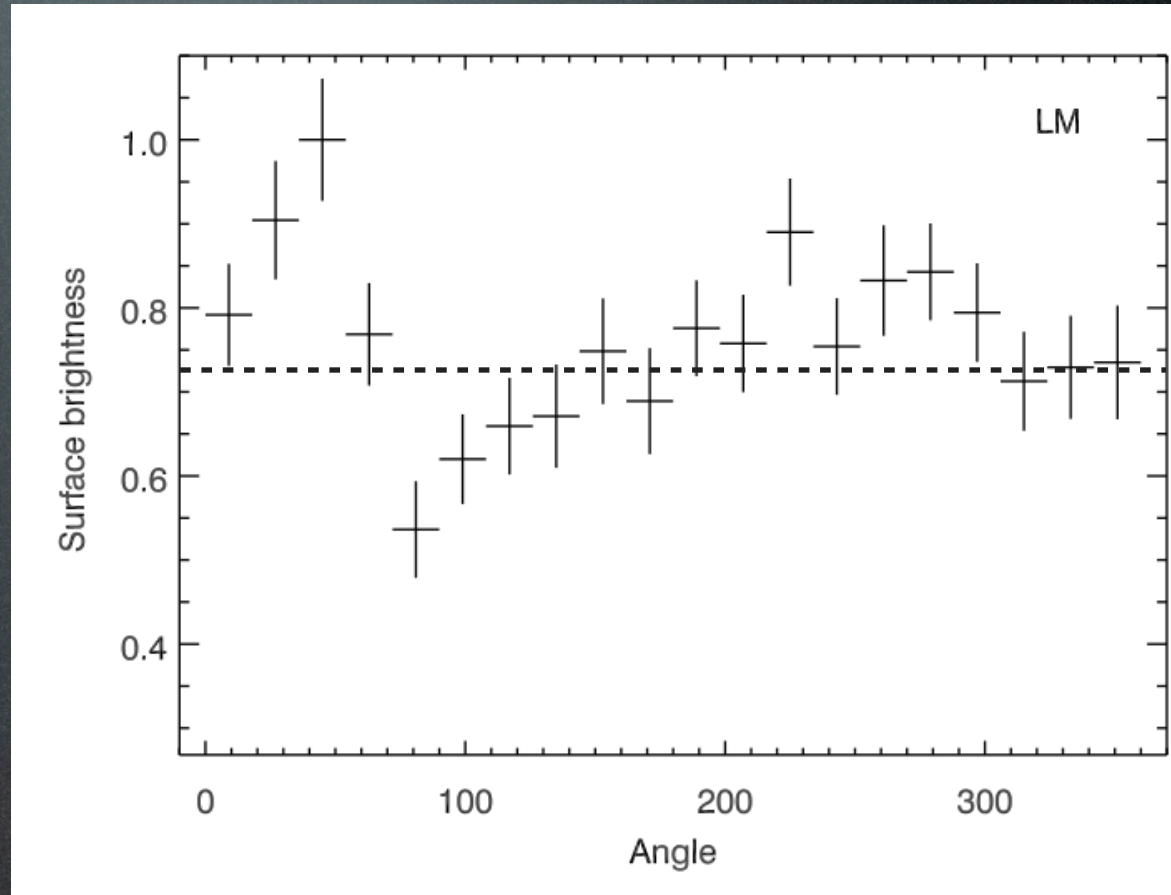
Vela PSR

3C58 PSR

Jet structures ?



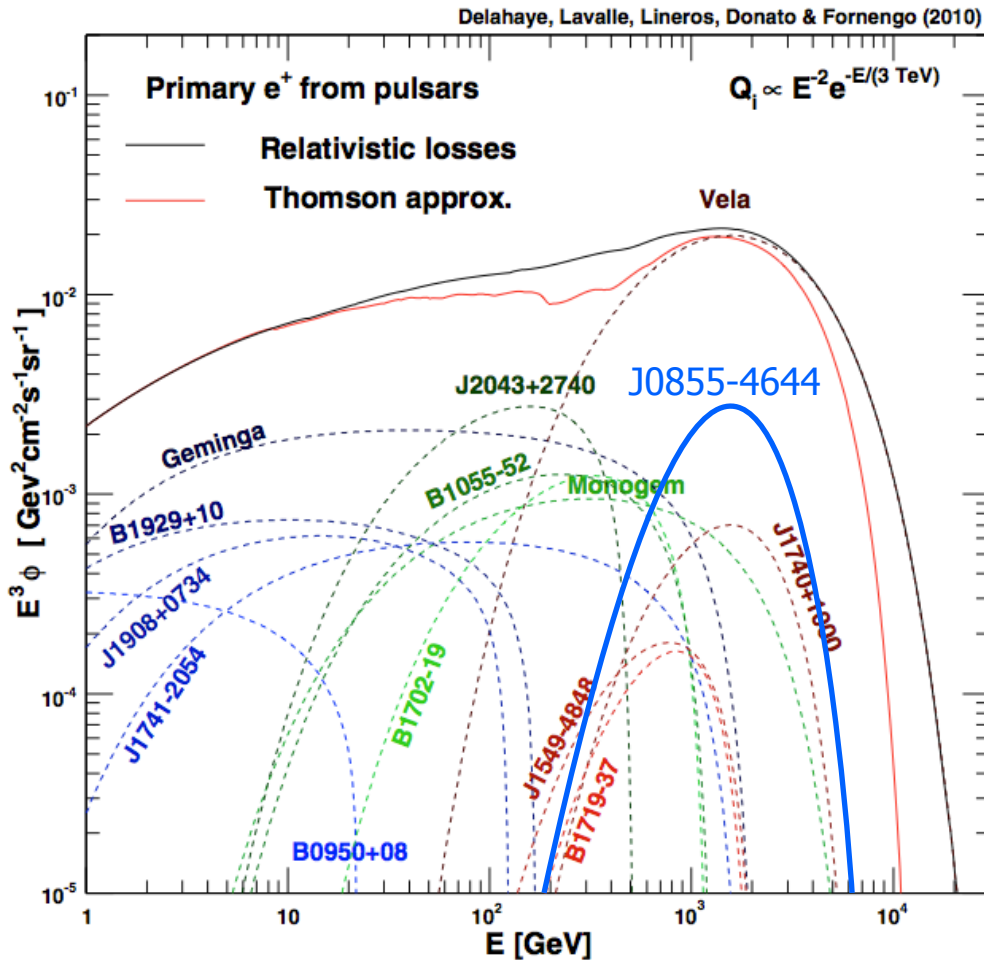
PSR J0855-4644



Chandra FWHM : 1''
XMM FWHM : 6''

Chandra proposal has been submitted

Strong contribution to the positron spectrum



J0855-4644

$$\dot{E} = 1.1 \times 10^{36} \text{ ergs/s}$$

$$\tau_c = 140 \text{ kyrs}$$

$$d < 0.9 \text{ kpc}$$

J1740+1000

$$\dot{E} = 2.3 \times 10^{35} \text{ ergs/s}$$

$$\tau_c = 114 \text{ kyrs}$$

$$d = 1.24 \text{ kpc}$$

More detailed
calculation
is on the way

Conclusion

A new nearby and energetic pulsar

- First X-ray detection of PSR J0855-4644 and discovery of a PWN
- Symmetric PWN (uncrushed nebula ?) suggests young object (10 kyrs ?)
- By comparing N_{H} and informations from the ISM (^{12}CO):
$$d(\text{PSR}) < d(\text{VelaJr}) < 900 \text{ pc}$$
- $d(\text{VelaJr}) < 900 \text{ pc}$ compatible with measurements of the shock's proper motion in X-rays $d \sim 700 \text{ pc}$ (Katsuda+10)
- Emphasize once again the difficulty to model the e^-/e^+ spectrum (knowledge of the nearby sources)
- New distance estimate of PSR J0855-4644 implies that it will have a significant contribution to the e^-/e^+ spectrum

Backup Slides

Is the PSR related to the VelaJr SNR ?



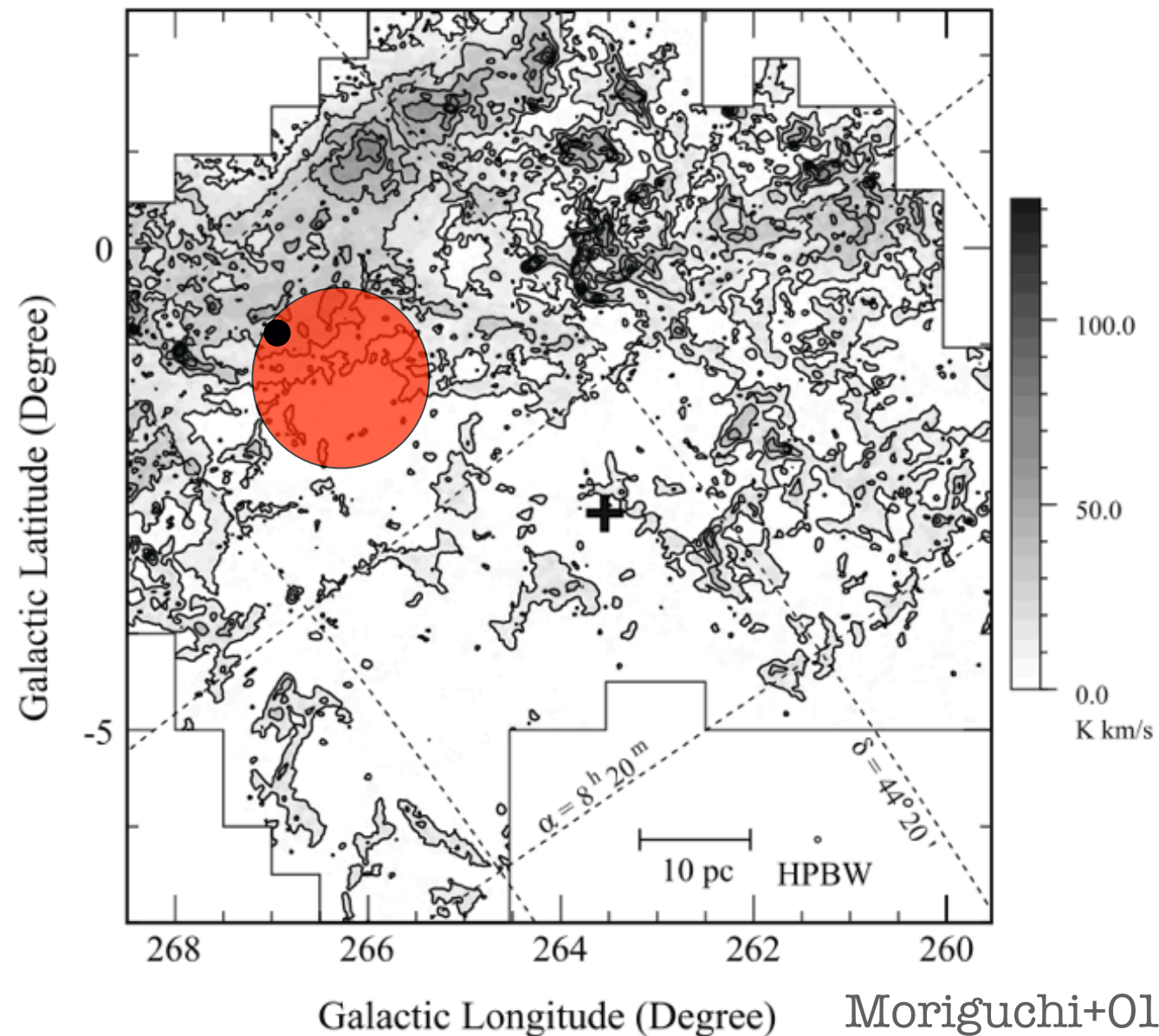
- Age and distance seem to be similar : $T \sim 1000-4000$ yrs
 $d \sim 1$ kpc

- VelaJr already has a CCO



- PSR tangential velocity : ~ 2800 km/s to explain current position
- Such a speed should create a trail/cometary structure

NANTEN VMR observations



C cloud @ ~ 700 pc

NANTEN
12CO integrated cube

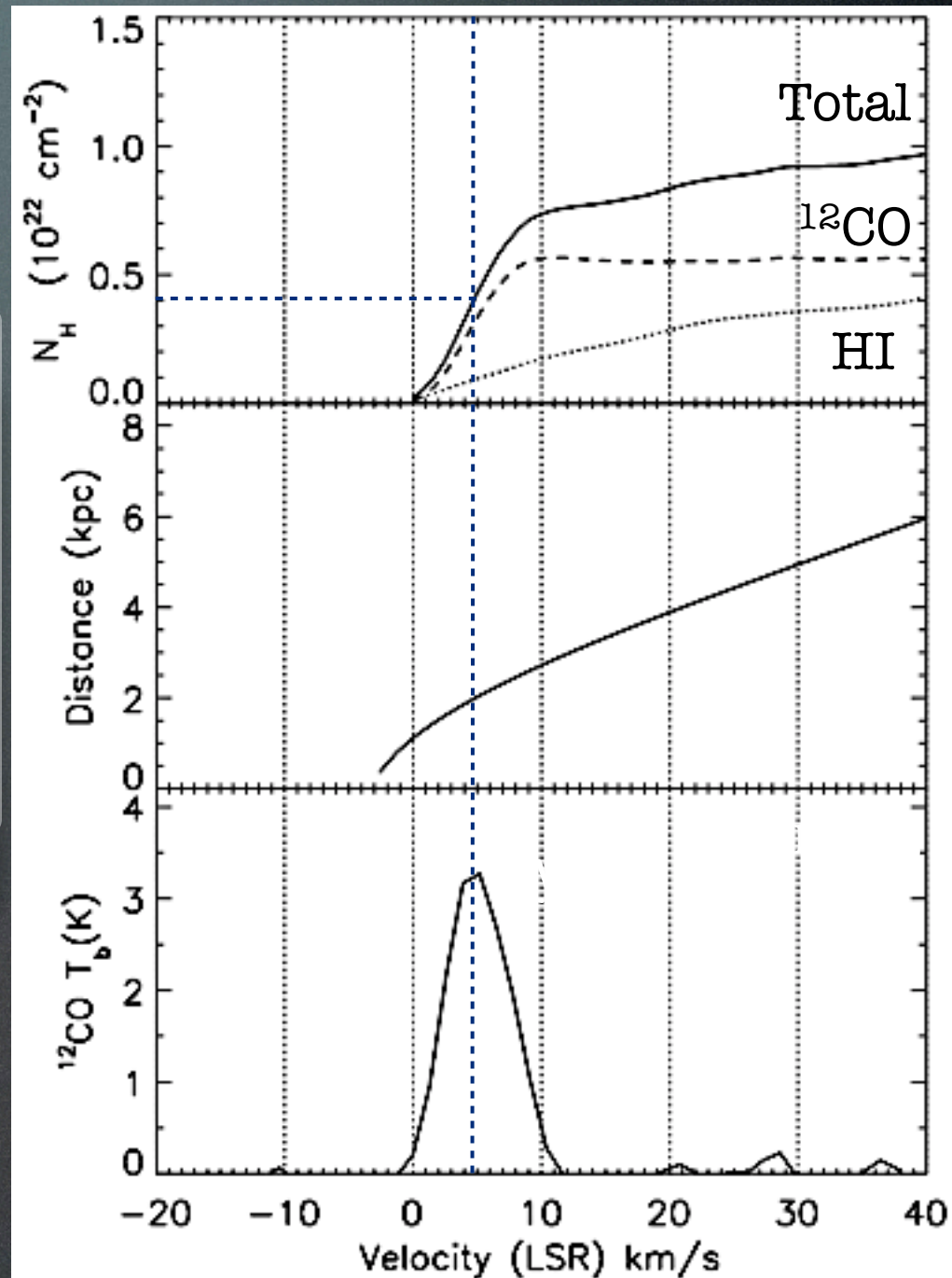
Vela Jr
SNR

● PSR

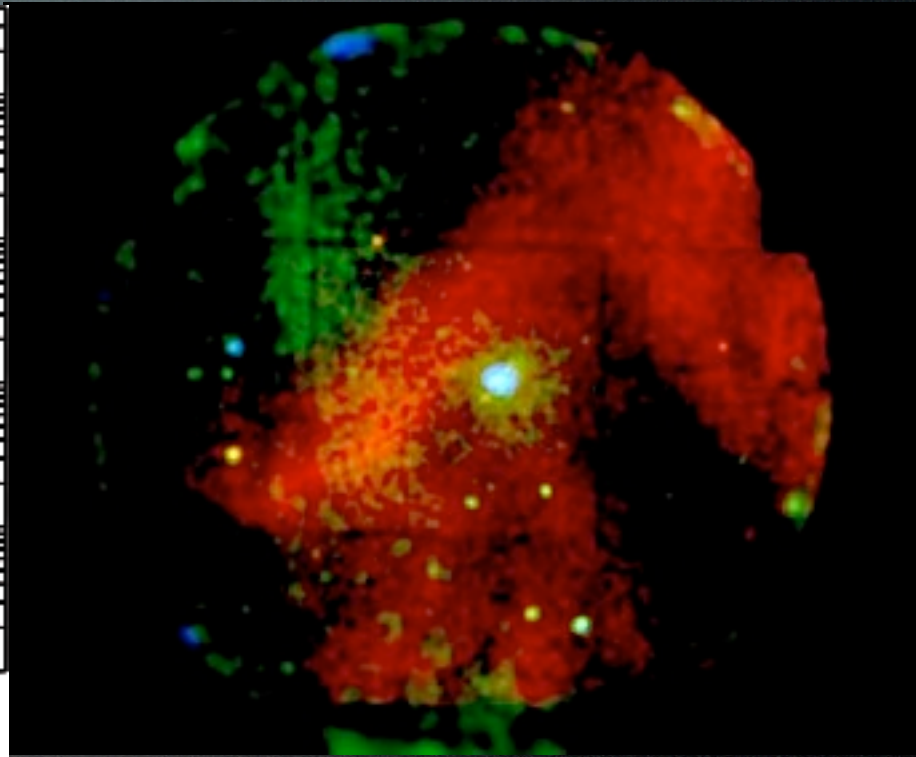
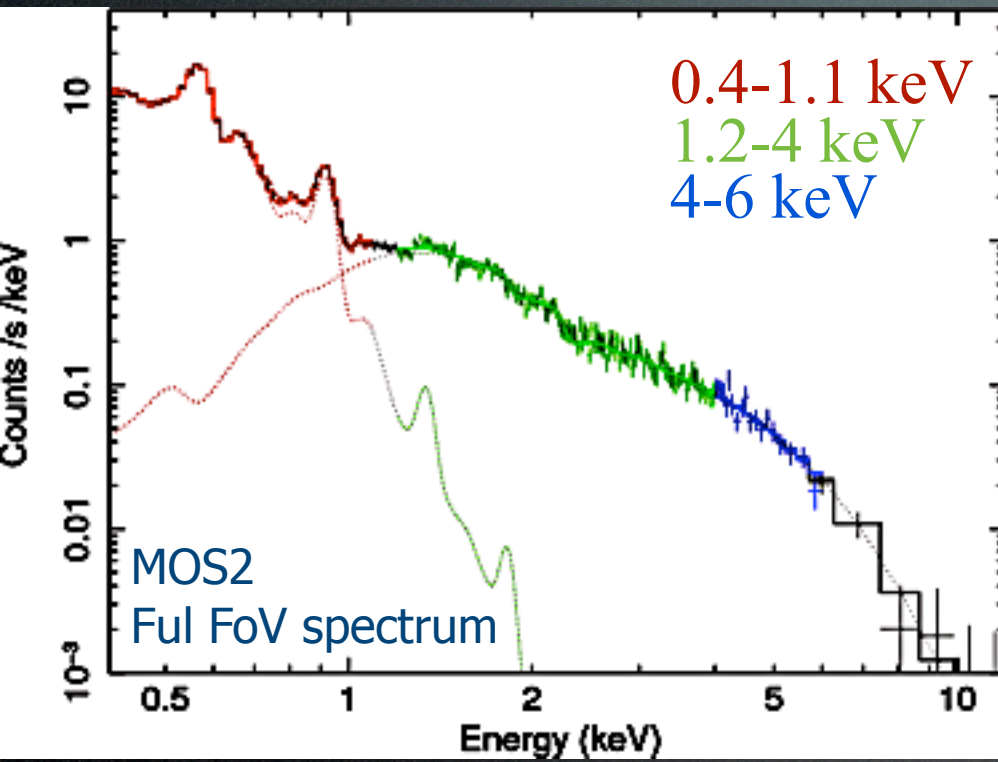
PSR distance Absorption column

- PSR is likely to lie at a distance $< 1 \text{ kpc}$ i.e. in the foreground of the Vela Molecular Ridge (VMR, $d=500\text{-}1 \text{ kpc}$)

- $n_{\text{H}}(\text{VelaJr SE rim}) \sim 0.9 \times 10^{22} \text{ cm}^{-2}$ and dist $\sim 0.7 \text{ kpc}$



Discovery of a new PWN in the Vela Jr region



Discovery of a new PWN in the Vela Jr region

