Two Magnetar Candidates in HESS Supernova Remnants

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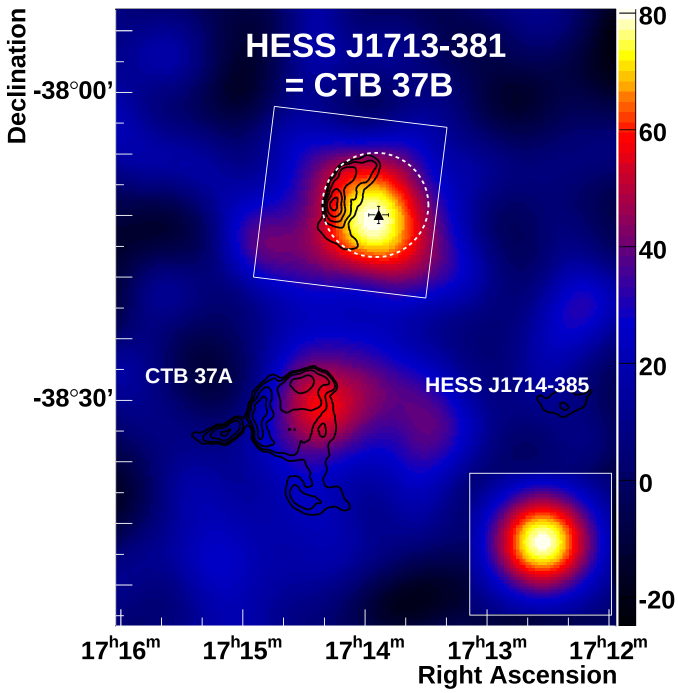
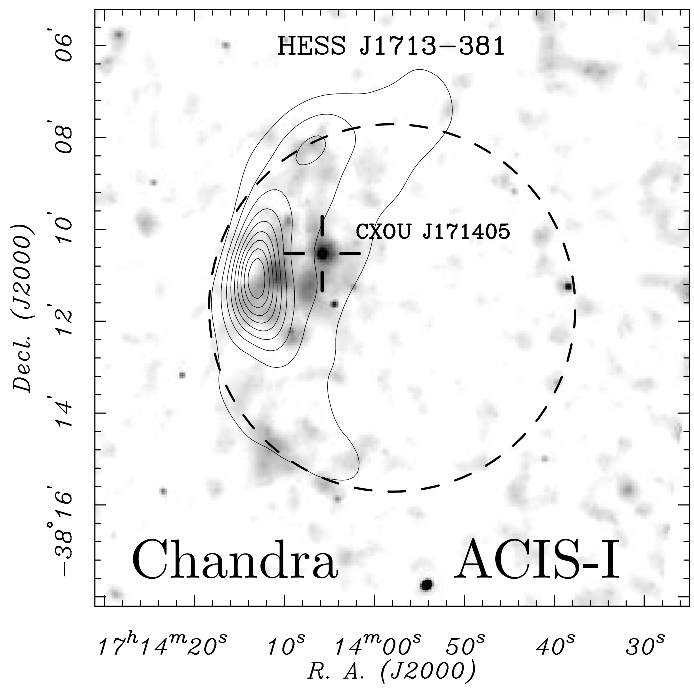
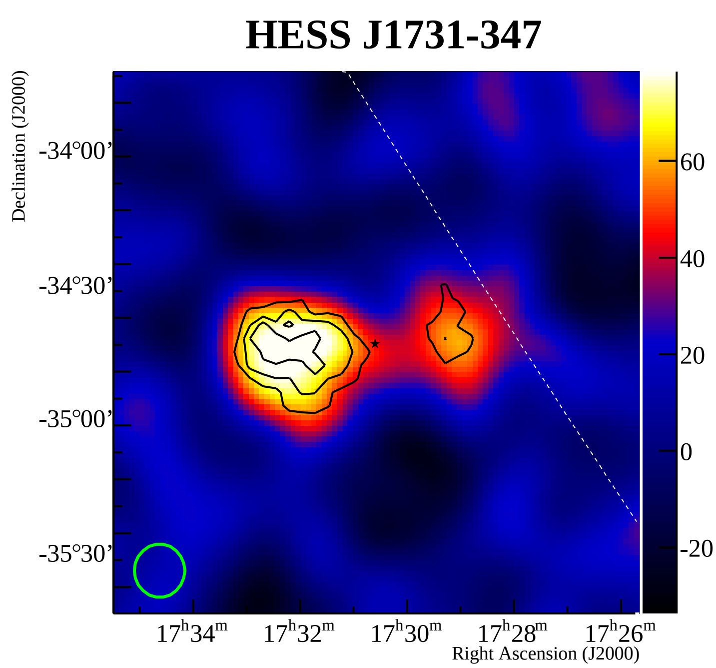
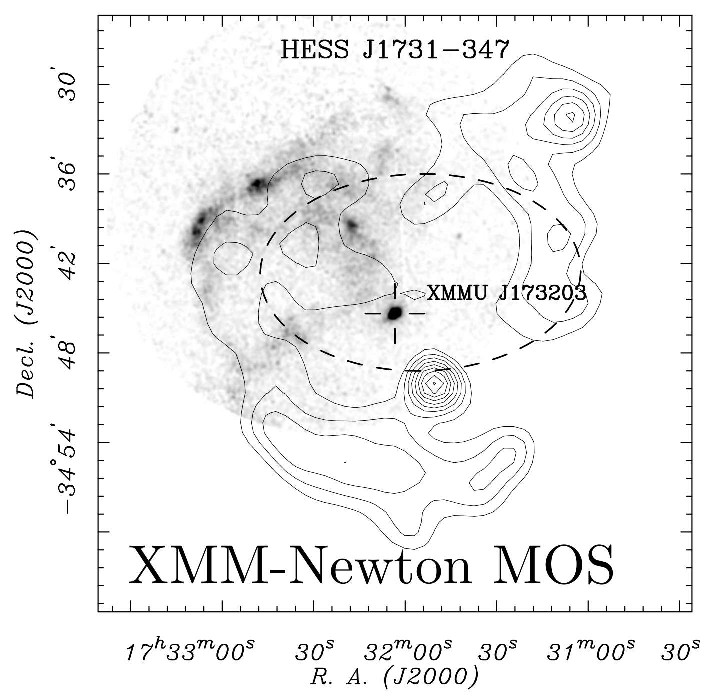




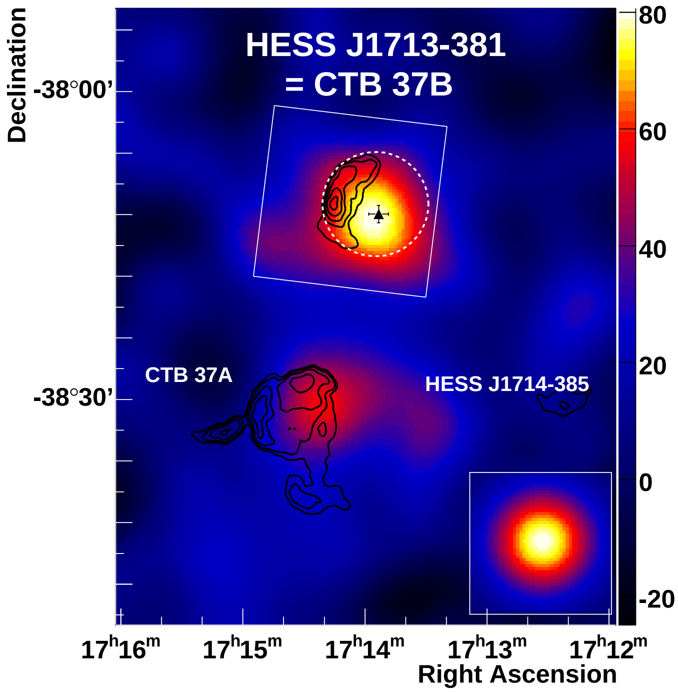


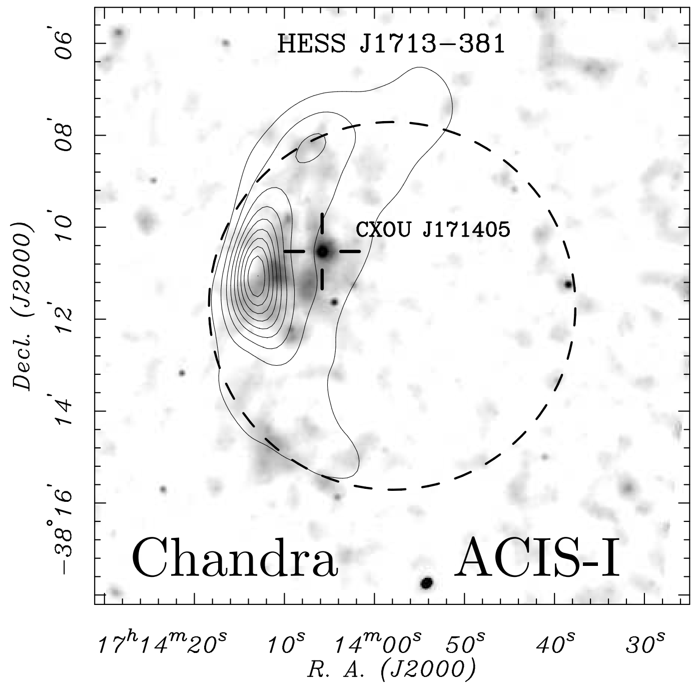


Aharonian et al. 2008, A&A, 486, 829

Nakamura, Bamba, Ishida, et al. 2009, PASJ, 61, S197

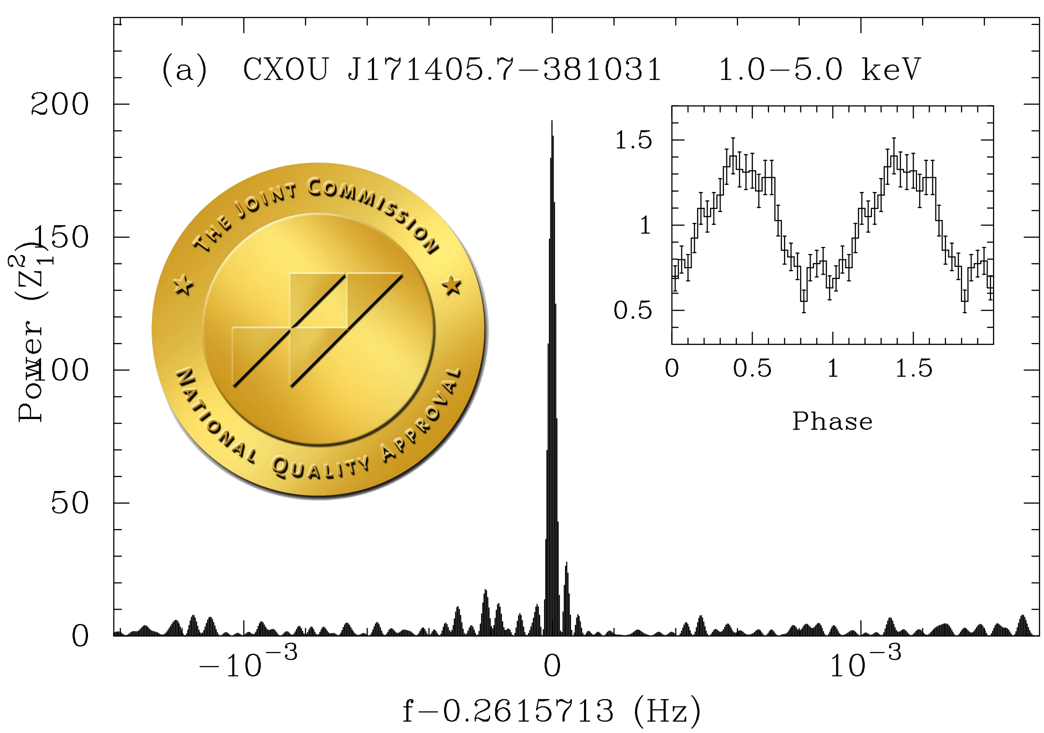
CTB 37B $d \approx 8$ kpc Age = 1600 − 4900 yr



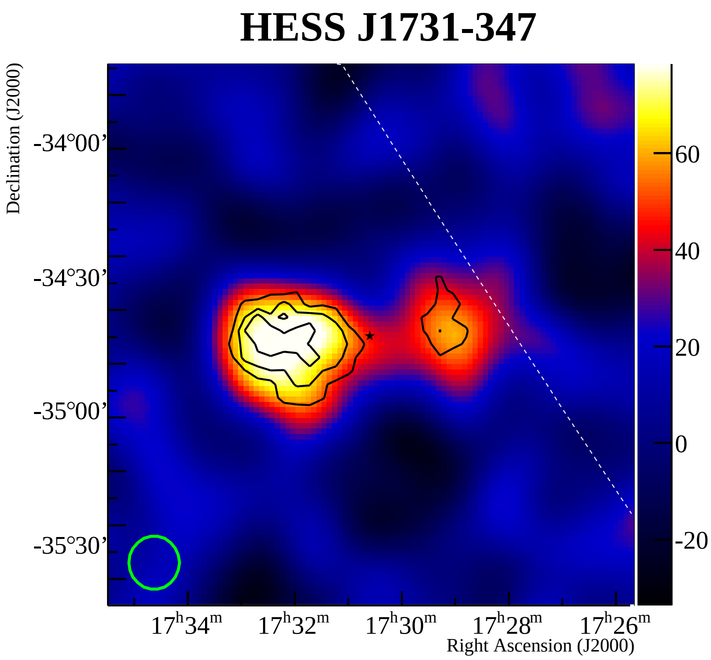


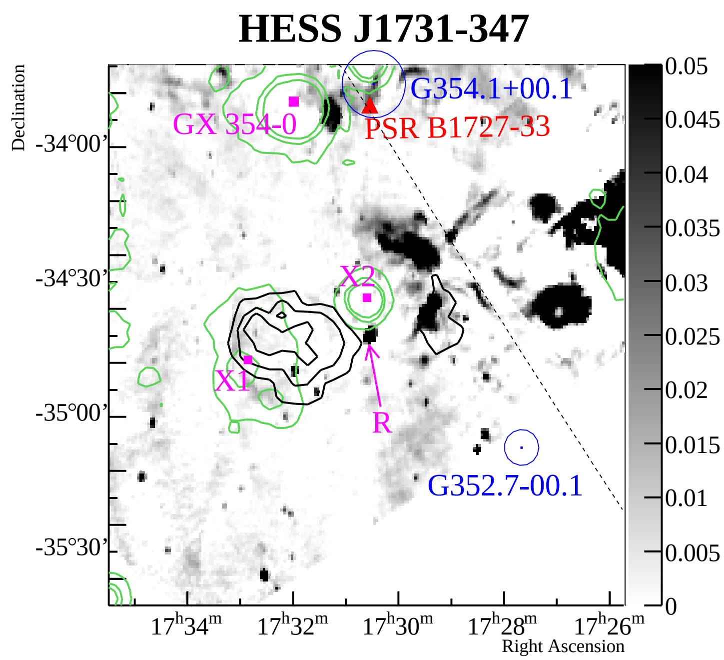
Chandra ACIS-S CC-mode detects 3.82 s Pulsar

Halpern & Gotthelf 2009, in preparation



Aharonian et al. 2008, A&A, 477, 353



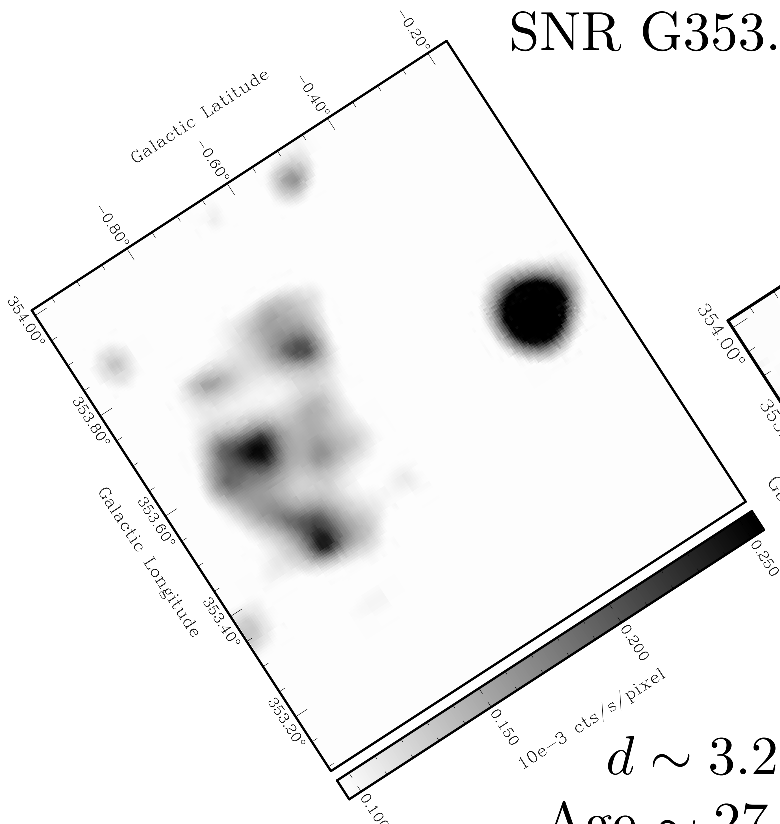


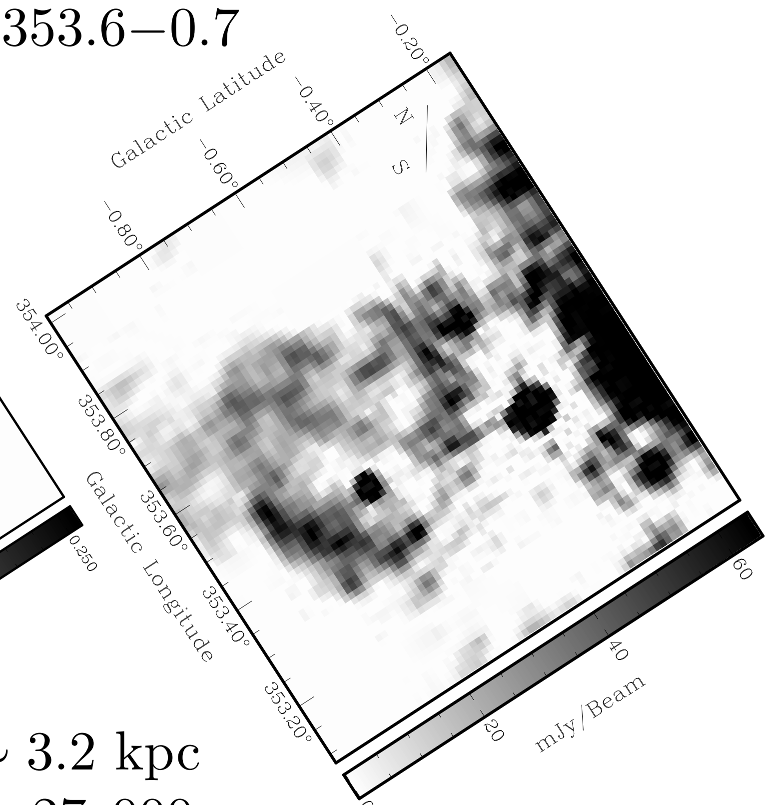
Tian, Leahy, Haverkorn, Jiang 2008, ApJ, 679, L85

ROSAT

1420 MHz

SNR G353.6−0.7

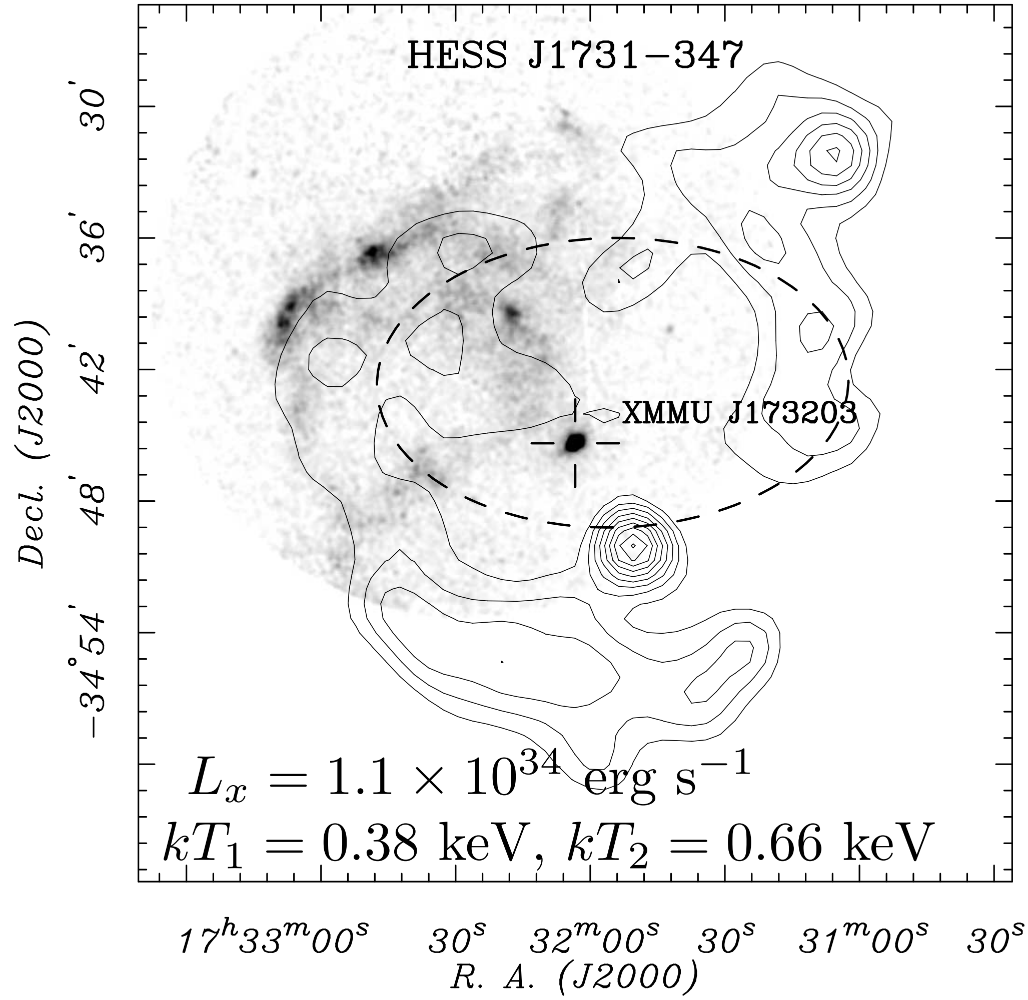




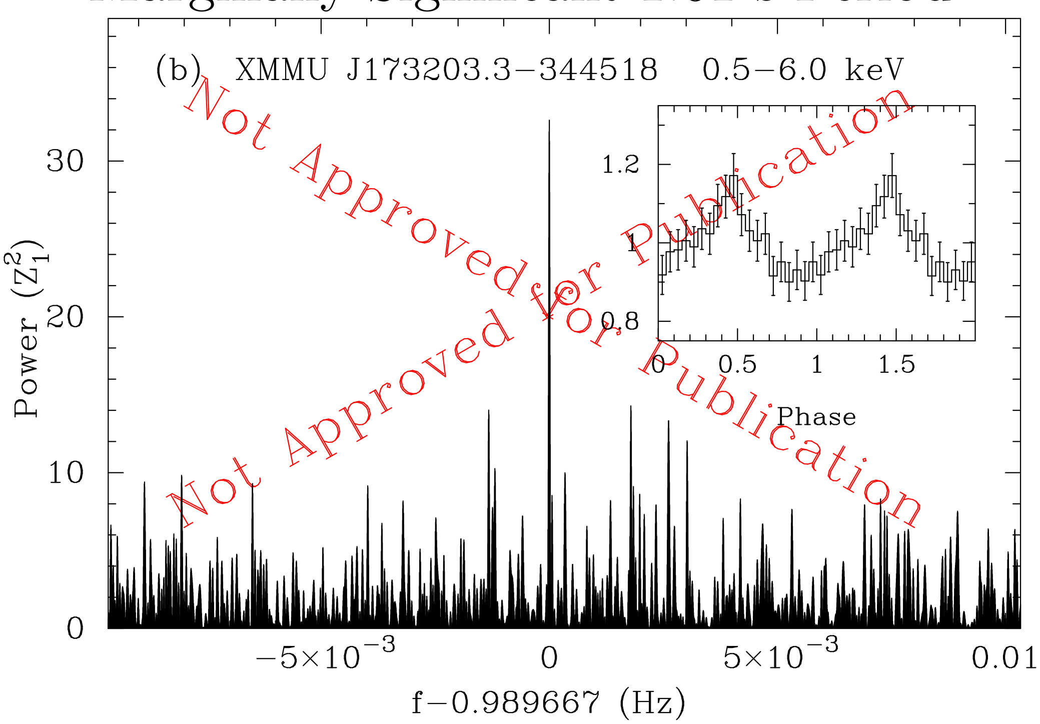
$d \sim 3.2$ kpc

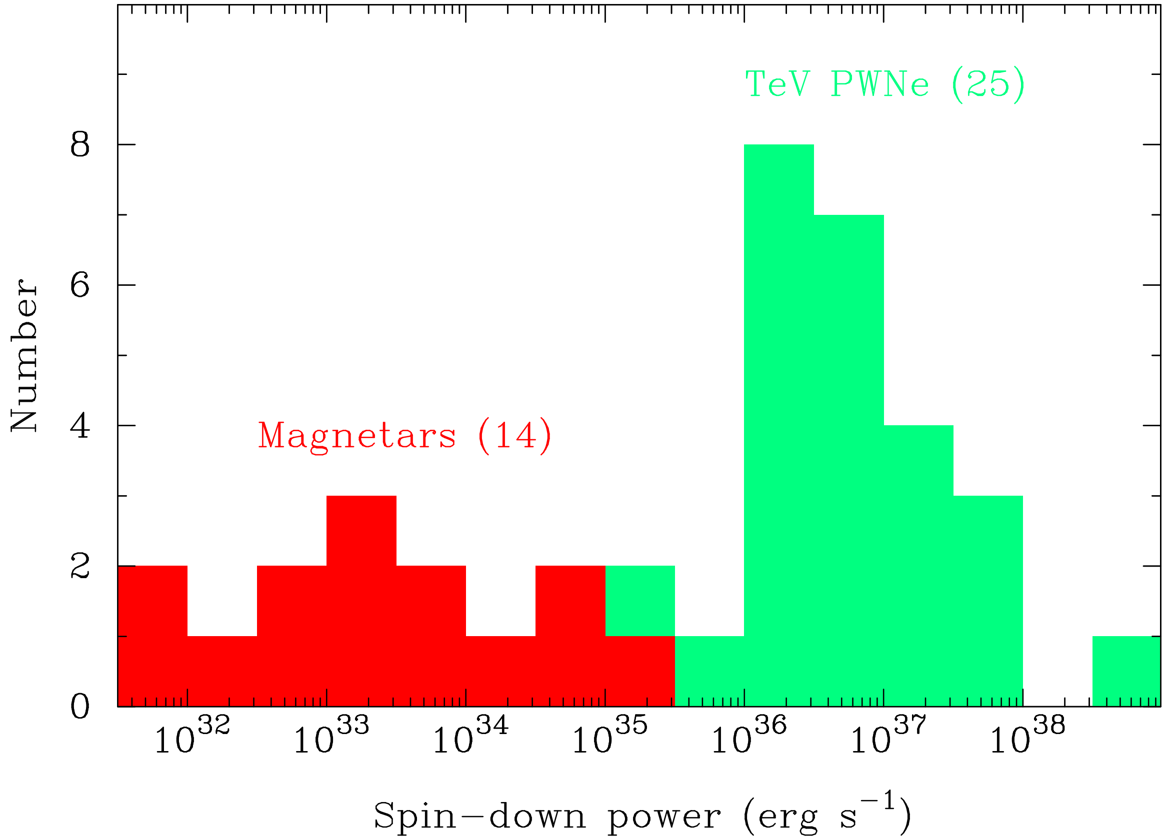
Age $\sim 27,000$ yr

Halpern & Gotthelf 2009, in preparation



Marginally Significant 1.01 s Period





Magnetars are *not* Expected to be TeV Sources

1. None of the 14 known magnetars have PWNe.
2. Spin-down power of magnetars is $< 10^{36}$ erg s^{-1}.
3. Magnetars are powered on closed B-field lines.
4. Maximum electron energy is limited to GeV in theory (Beloborodov & Thompson 2007, ApJ, 657, 967).

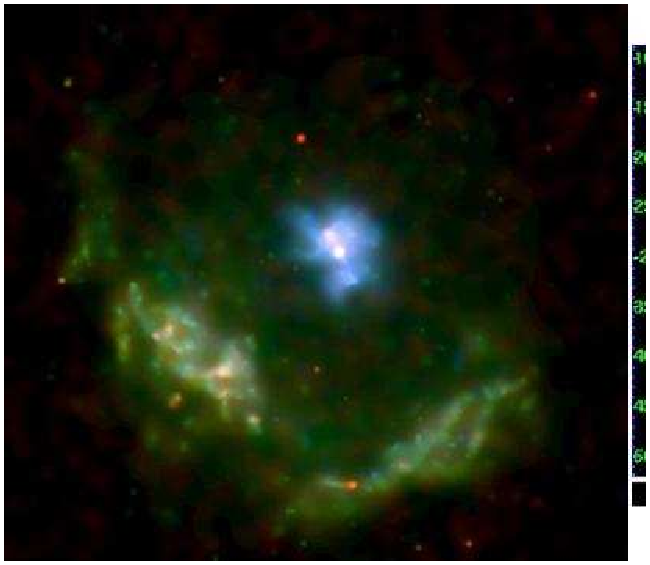
CONCLUSION

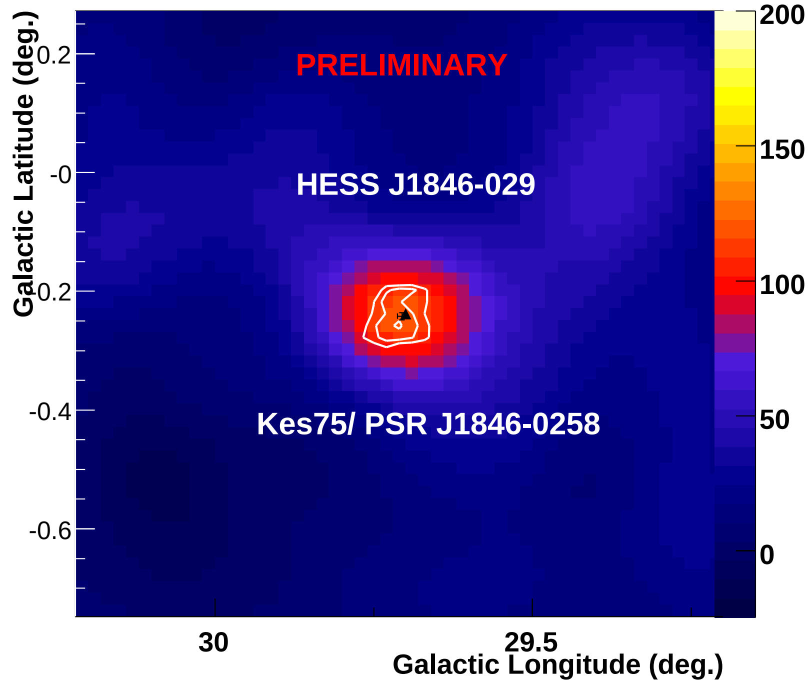
HESS J1713−381 and HESS J1731−347
are SNR shells, not PWNe.

But wait . . .

. . . Maybe Magnetars *are* Expected to be TeV Sources

Kes 75/PSR J1846−0258





"Transitional" Magnetar-Pulsar with PWN

$P = 0.32$ s, $\dot{E} = 8 \times 10^{36}$ ergs s^{-1}, $B_s = 5 \times 10^{13}$ G

Magnetar-like X-ray bursts:
Gavriil et al. 2008, Science, 319, 1802

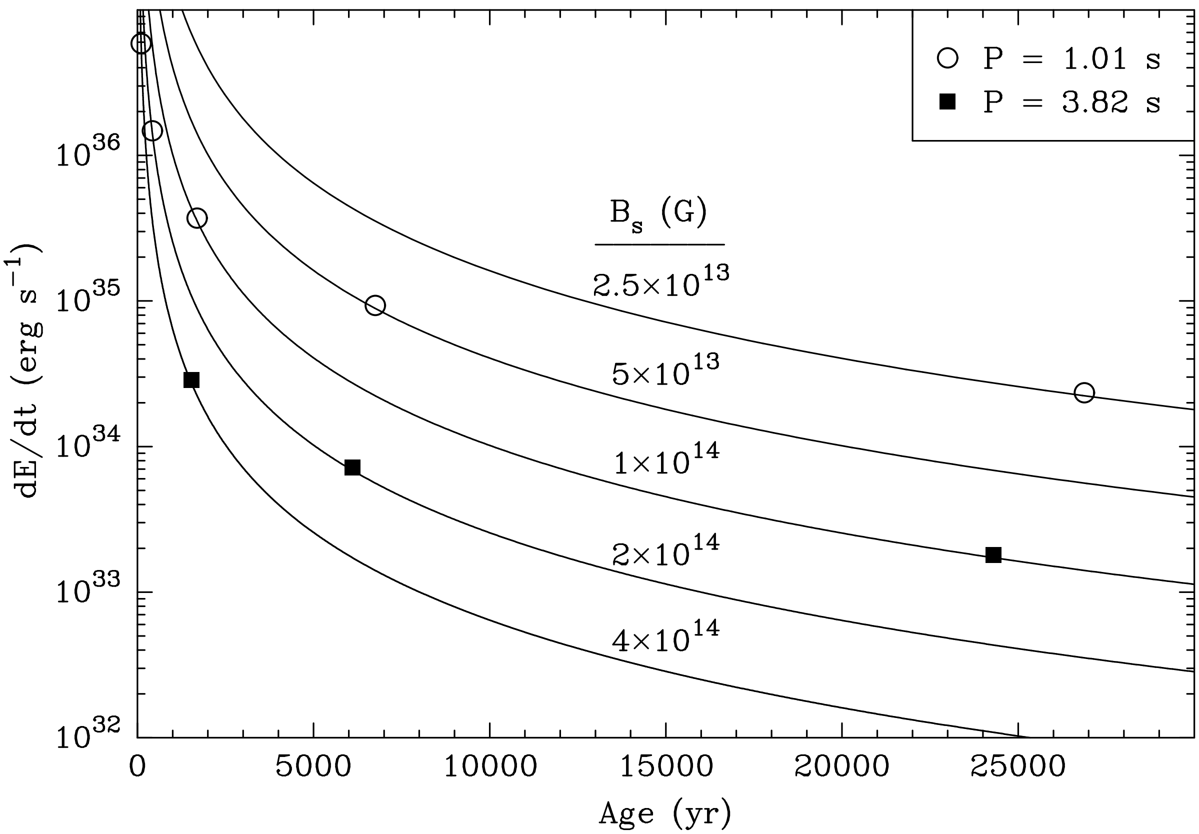
X-ray variability:
Kumar & Safi-Harb 2008, ApJ, 678, L43
Ng, Slane, Gaensler, Hughes 2008, ApJ, 686, 508

TeV source: HESS J1846−029
Djannati-Atai et al. 2008, Proc. 30th ICRC, 2, 823

Some magnetars are transient *radio pulsars*:

XTE J1810−197: Camilo et al. 2006, Nature, 442, 892
1E 1547.0−5408: Camilo et al. 2007, ApJ, 666, L93

Magnetars could have left a "relic" PWN (following de Jager & Djannati-Atai 2008).



An electron that IC scatters a photon to E_γ(TeV) has synchrotron and inverse Compton liftimes:

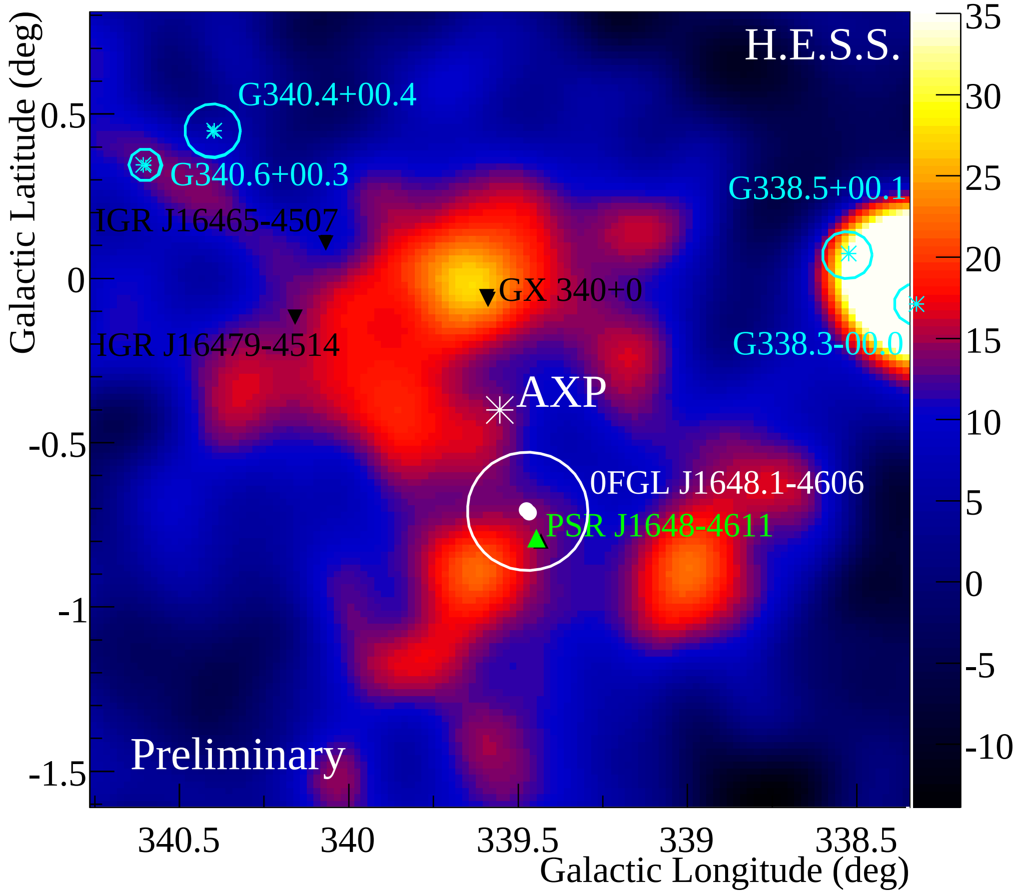
$$t_s \approx \frac{4200\,\mathrm{yr}}{\sqrt{E_\gamma(\mathrm{TeV})}} \left(\frac{B}{10\,\mu\mathrm{G}}\right)^{-2}$$

$$t_{\mathrm{IC}} \approx \frac{8 \times 10^4\,\mathrm{yr}}{\sqrt{E_\gamma(\mathrm{TeV})}}$$

the latter for IC scattering on the microwave background.

Ohm, Horns, Reimer, Hinton, Rowell, et al. arXiv:0906.2637

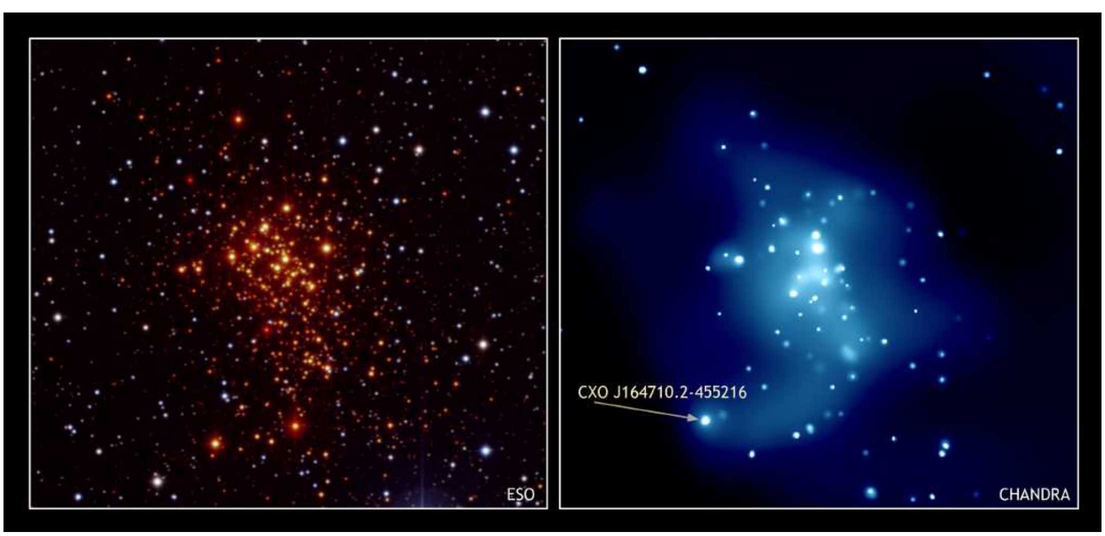
H.E.S.S. Observation of Star Cluster Westerlund 1 . . .



. . . that contains AXP CXOU J164710.2−455216

$\tau_c = 70$ kyr

Muno et al. 2006, ApJ, 636, L41



CONCLUSIONS

1. CTB 37B very likely contains a magnetar with $P = 3.82$ s and $B_s \geq 2 \times 10^{14}$ G.
2. G353.6−0.7 contains either a magnetar or a low B-field neutron star (CCO).
3. HESS J1713−381 and HESS J1731−347 may or may not be powered in part by magnetars.
4. Observations to measure $\dot{P}$ have been proposed.