Chandra Observations of Radio Pulsars

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X-ray observations of spin-powered pulsars (PSRs) provide valuable diagnostics of emission mechanisms and acceleration processes operating in pulsar magnetospheres and winds. We present the results from ACIS observation of several radio pulsars that belong to different categories of the diverse pulsar population. These include the 1-Gyr-old "sleeping" pulsar B1833-16, 20-kpc-old PSR J1825-1446, 20-kpc-old PSR B1800-21 with a pulsar-wind nebula (PWN), the famous 4-kpc-old PSR B0531+21 with a planetary system, and a few others. The pulsars exhibit different X-ray spectral slopes suggesting that the contribution of polar cap thermal emission may become more important as pulsar ages. Although the pulsar X-ray luminosities generally correlate with the spin-down power $E_{\text{dot}}$, a strong scatter in the $L_X - E_{\text{dot}}$ dependence suggests that other factors (e.g., the magnetic field geometry and orientation of magnetic and spin axes) are equally important. A compact 10'' size PWN around PSR B1082-22 shows a bow-shock-like morphology reminiscent of those found for several other PWNe. To provide a more complete picture, we compare our results with those from other Chandra observations of spin-powered pulsars.

**1. Vela-like Pulsar: B1800-21**

- Radio data: $\pi = 1.54\pm0.04\text{ pc}$, $d = 3.9\text{ kpc}$
- ACIS Exposure: 30 ks
- P/W fit: $E_{\text{dot}} = 1.9 \times 10^{34} \text{ erg/s}$
- $L_X = 5.6 \times 10^{29} \text{ erg/s}$ (0.3-8 keV)
- $B_{\text{ref}} = 0.02 \text{ pc}$
- $v_p = 2800 \text{ km/s}$
- $D = 1\text{''}$
- $E_{\text{dot}} = 6.9 \times 10^{36} \text{ erg/s}$
- $P = 89.3 \text{ ms}$
- $A = 0.86 \text{ Gyr}$
- $D = 350\pm20 \text{ pc}$
- $A = 11 \text{ kyrs}$

**2. Middle-aged Pulsar: J1825-1446**

- Radio data: $\pi = 2.2\pm0.3\text{ pc}$, $d = 770\text{ pc}$
- ACIS Exposure: 30.23 ks
- P/W fit: $E_{\text{dot}} = 2.2 \times 10^{36} \text{ erg/s}$
- $L_X = 1.3 \pm 0.8 \text{ erg/s}$
- $\Gamma \approx 1.5$
- $n_{\text{H},22} = 1.1$
- $L_{\text{bol}} \approx 3 \times 10^{22} \text{ erg/s}$
- $T = 8.5 \times 10^{-5} \text{ $E_{\text{dot}}$ (in $10^{34} \text{ erg/s}$)}$
- $D = 40 \pm 8 \text{ m}$
- $R = 13 \text{ km}$
- $\tau \geq 1$

**3. Recycled Planetary Pulsar: B1257+12**

- ACIS Exposure: 20 ks
- $E_{\text{dot}} = 7 \times 10^{34} \text{ erg/s}$
- $L_X = 8.5 \times 10^{29} \text{ erg/s}$ (0.3-8 keV)
- $L_{\text{bol}} = 8 \times 10^{30} \text{ erg/s}$ (bolometric)
- $R = 280 \text{ m}$
- $\beta = 1.2\pm0.8\text{ ergs (bolometric)}$
- $\chi^2 = 5.0 / 3$
- $\tau \geq 0.50$

**4. Old Pulsar: B1133+16**

- ACIS Exposure: 30 ks
- $E_{\text{dot}} = 9 \times 10^{31} \text{ erg/s}$ (0.3-8 keV)
- $L_X = 6 \times 10^{32} \text{ erg/s}$ (0.3-8 keV)
- $L_{\text{bol}} = 1.2 \times 10^{32} \text{ erg/s}$ (0.3-8 keV)
- $R = 280 \text{ m}$
- $\beta = 1.2\pm0.8\text{ ergs (bolometric)}$
- $\chi^2 = 9.0 / 3$
- $\tau \geq 0.50$