Chandra Observations of Fermi-LAT and Radio Pulsar Fields

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ABSTRACT: We continue our campaign of multi-wavelength observations of Fermi-LAT gamma-ray sources utilizing the Chandra ACIS-S instrument. These observations are for search and determine properties of significant X-ray point sources that might be associated with the recently discovered rotation-powered pulsars J1514-4946, J1658-5324, J1302-32, J2017+06, and J1103-5403. All of these pulsars were originally discovered in radio searches of Fermi-LAT unassociated gamma-ray sources. Chandra can localize X-ray point sources with arc second positional accuracy and characterize their X-ray spectral properties. We report on the X-ray fluxes and spectral properties of the associated X-ray sources found in our observations and compare these properties with those of other rotation-powered X-ray and gamma-ray pulsars. We also discuss other interesting sources uncovered by our observations in the fields of our target pulsars.

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Table 1: Fermi-LAT/Chandra Sources

<table>
<thead>
<tr>
<th>Pulsar Name</th>
<th>Initial Gamma-Ray Association</th>
<th>Galactic Longitude</th>
<th>Galactic Latitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>J1103-5403</td>
<td>2FGL J1103.9-5356</td>
<td>287.42°</td>
<td>+5.53°</td>
</tr>
<tr>
<td>J1302-32</td>
<td>2FGL J1302.4-3257</td>
<td>305.58°</td>
<td>+29.86°</td>
</tr>
<tr>
<td>J1514-4946</td>
<td>2FGL J1514.1-4946</td>
<td>325.25°</td>
<td>+6.81°</td>
</tr>
<tr>
<td>J1658-5324</td>
<td>2FGL J1658.4-5324</td>
<td>334.87°</td>
<td>-6.63°</td>
</tr>
<tr>
<td>J2017+0603</td>
<td>2FGL J2017.3+0603</td>
<td>48.62°</td>
<td>-16.03°</td>
</tr>
</tbody>
</table>

Note: PSR J1103-5403 was detected at radio wavelengths by searching in the field of 2FGL J1103.9-5356 for radio pulsations. This 2FGL source is now well believed to be associated with the AGN PKS J1103-5356.

Pulsar position is a red cross in the larger view and a 3" radius circle centered on the radio position in the close-up view. Green is the 2FGL error ellipse. Other X-ray sources in the field are in yellow.

On February 2, 2011 Chandra observed for 10 ks the field of 2FGL J1514.1-4946 (Abdo et al. 2011) from which pulsations with period 3.589 ms had recently been detected in the radio (Camilo et al. 2012). At that time the position of the pulsar was not well known and the then-best position was centered on the back-illuminated S3 chip in order to increase the ACIS-S sensitivity to point sources. We detected a faint X-ray point source at the now-known radio position of the pulsar as shown in the close-up image. The S/N of the point source is ~2.1 and a net count rate of 9.1x10^-4 c/s making this a marginal detection of a point source. If this source is real we estimate its 0.5-7.0 keV flux at ~6.1x10^-15 ergs cm^-2 s^-1, very close to the Chandra ACIS-S point source sensitivity limit.

On January 29, 2011 Chandra ACIS-S observed for 10 ks the field of 2FGL J1658.4-5324. This is a P = 2.439 ms X-ray and radio pulsar with a spin-down luminosity of ~3.4x10^34 ergs s^-1 and a surface magnetic field strength of ~10^10 G. This ACIS-S X-ray source was a marginal detection with S/N = 3.4 at the nominal radio pulsar position, i.e., very close to the Chandra ACIS-S point source sensitivity limit.

Conclusions

References:
Camilo et al. 2012, in preparation

Using the ACIS-S instrument on the Chandra observatory we have observed the fields of five Fermi-LAT γ-ray sources that were initially unidentified in any other energy range. Subsequent analysis of data obtained for all of these γ-ray sources has shown them to be either pulsars in the radio and Fermi-LAT energy ranges, or in the case of 2FGL J1103.9-5356 observations revealed the source to be an AGN. These Chandra observations have identified faint X-ray sources in the case of 3 of our 5 targets, namely, J1514-4946, J1658-5324, and J2017+0603. For the γ-ray pulsar J1032-32 we have yet to determine a solution for the exact radio/γ-ray pulsar position and so no X-ray source has been identified for this pulsar. In the case of PSRJ1103-5403, the original gamma-ray source (2FGL J1103.9-5356) is now believed to be associated with the AGN PKS J1103-5356. We have found no X-ray source at the position of the radio pulsar PSRJ1103-5403 (see Keith et al. 2011).