Differences Between Radio-loud and Radio-quiet Gamma-ray pulsars as revealed by Fermi

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\begin{itemize}
  \item By comparing the properties of non-recycled radio-loud γ-ray pulsars and radio-quiet γ-ray pulsars, we have searched for the differences between these two populations. We found that the γ-ray spectral curvature of radio-quiet pulsars can be larger than that of radio-loud pulsars. Based on the full sample of non-recycled γ-ray pulsars, their distributions of the magnetic field strength at the light cylinder are also found to be difference.
\end{itemize}
Another interesting result is the comparison for magnetic field between two populations. The distribution and statistical test was not shown the difference in $B_{Surface}$, while we can show the definitely difference in $B_{Light cylinder}$.

$B_{LC}$ is function of $P$ and $\dot{P}$. To investigate if the difference in $B_{LC}$ is caused by the distributions of their rotational parameters, we have also applied the A-D test separately on $P$ (p-value~0.006) and $\dot{P}$ (p-value~0.2).

Since $B_{LC} \sim B_S P^{-3}$, the differences between radio-loud and radio-quiet populations should stem from the rotational period $P$. We noted that $P$ of radio-loud pulsars are generally smaller than radio-quiet pulsars.

Therefore, shorter period pulsars will have wider radio cone and hence more favorable to be radio-loud. And thence the radio-quietness in the pulsar population might be a result of their narrower radio cones.
In re-examining the distributions of nominal values of \( \frac{F_Y}{F_X} \), we confirmed the difference between the radio-loud and radio-quiet pulsars as claimed by Marelli et al. (2015).

Concerning the difference in \( \frac{F_Y}{F_X} \), we consider a geometric effect together with assumption that the X-ray are coming from the regions near the polar cap.

In this case its intensity \( F_X^{PC} \) should depend on the angle between the magnetic axis and the viewing angle \( \theta \), namely \( F_X^{PC} \propto \theta \).

Then radio-loud pulsars should have smaller \( \theta \) than those radio-quiet pulsars.

This implies the mean \( F_X \) of radio-loud pulsars is larger than that of the radio-quiet pulsars.
 relation spearman probability

<table>
<thead>
<tr>
<th>relation</th>
<th>spearman</th>
<th>probability</th>
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<tbody>
<tr>
<td>radio-loud pulsar population</td>
<td>0.3</td>
<td>0.1</td>
</tr>
<tr>
<td>$E_{\text{cut}} \text{ vs } B_{\text{LC}}$</td>
<td>0.7</td>
<td>$2 \times 10^{-6}$</td>
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