Glitch Observations in Slow Pulsars

Gemma Janssen[1] & Ben Stappers[2,1]

[1] Sterrenkundig Instituut 'Anton Pannekoek', Universiteit van Amsterdam, The Netherlands

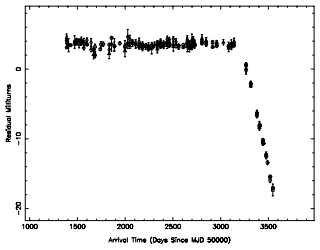
[2] Stichting Astron, Dwingeloo, The Netherlands

Abstract We have analyzed 5.5 years of timing observations of 7 "slowly" rotating radio pulsars, made with the Westerbork Synthesis Radio Telescope. We present improved timing solutions and 30, mostly small new glitches. The most interesting results are: 1) The detection of glitches one to two orders of magnitude smaller than ever seen before in slow radio pulsars 2) Resolving timing-noise looking structures in the residuals of PSR B1951+32 by using a set of small glitches 3) The detections of three new glitches in PSR J1814-1744, a high-magnetic field pulsar.

Glitches: The Basics

- Glitch: a sudden spin-up of the neutron star
- Vortex unpinning results in angular momentum transfer from superfluid interior to the crust
- Increase in rotation frequency is often combined with a change in spindown rate, sometimes relaxation or exponential decay can be measured
- Typical sizes: $10^{-9}\nu$-$10^{-6}\nu$
- Mostly seen in young pulsars with high spindown rates
- A glitch can be recognized as a sudden bend-down of the residuals to the timing model. The arrival times are earlier than expected due to the faster pulsar rotation.

New Results: PSR B0355+54

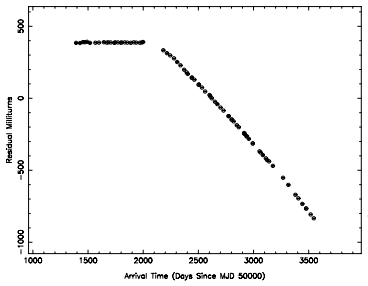


- We have detected 4 glitches in PSR B0355+54. These glitches are one to two orders of magnitude smaller than seen before
- Simulations show that we are able to detect such small glitches.

Residuals of PSR B0355+54. A miniglitch is visible at MJD 53200.

New Results: PSR J1814-1744

- This pulsar has a magnetic field and spin parameters similar to those of Anomalous X-ray pulsars. However, high-B radio Pulsars and AXPs show very different emission.
- We found 3 new glitches in J1814-1744, which gives us a new tool to compare both classes of neutron stars.



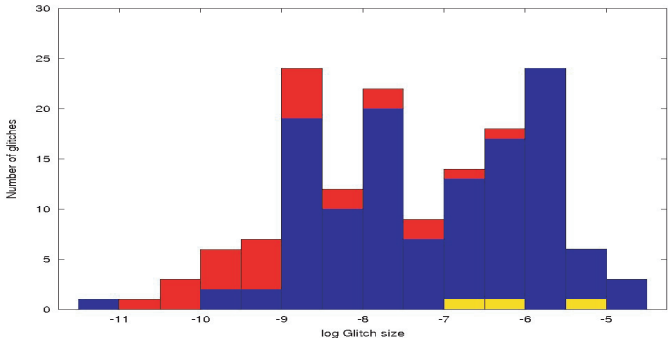
- Result: glitches are comparable!

Glitch detection in PSR J1814-1744. The residuals bend down around MJD 52100.

Results: General & Conclusions

Our 30 new glitches are 20% of the total number of glitches known. We have extended the range of glitches magnitudes towards smaller sizes. The overall glitch size distribution is consistent with a flat distribution in log-space, and we believe the lack of the smallest glitches at the lower end of the distribution is mainly generated by detection limits.

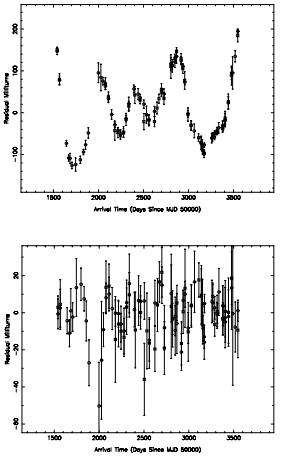
In some special cases we have shown that it is possible to resolve timing noise looking structures by using a set of small glitches. More research is needed to investigate the role of small glitches as a part of timing noise.



Glitch size histogram, showing all now known glitches. Glitches found in this study are shown in red, AXP glitches (overlapping) in yellow.

New Results: PSR B1951+32

- Located in supernova remnant CTB 80, high proper motion.
- A lot of timing activity is seen in the residuals.
- Timing solution including 4 small glitches resolved the timing noise looking structures in the residuals!



Timing residuals for PSR B1951+32. The upper plot shows the residuals to a model including two frequency derivatives. The bottom plot show the 10 times better solution including 4 small glitches.

References

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gemma@science.uva.nl

The Dutch Pulsar Group 2006

http://www.astron.nl/~stappers/pulsar.html