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Radio magnetars and pulsars with the gigahertz-peaked spectra

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Abstract. We discuss the latest results regarding a new type of pulsar radio spectra - the gigahertz-peaked spectra (GPS). We also present the results of pulsar flux density measurements preformed by using the interferometric imaging technique. The observations were made in January 2013, and we were able to observe six objects, and confirm one gigahertz-peaked spectra pulsar. For some of the GPS pulsars using the interferometric imaging is the only way to estimate flux densities, as most of them have relatively high dispersion measures, and at frequencies below 1 GHz the pulse smearing due to the interstellar scattering does not allow the use of standard methods.

Keywords : pulsars: spectra, radio-magnetars

Kijak et al. (2007, 2011a) provided a definite evidence for a new type of pulsar radio spectra which they called gigahertz-peaked spectra (GPS). These spectra show the maximum flux at so-called peak frequency above 1 GHz, while at higher frequencies the spectra look like a typical pulsar spectrum. Five pulsars are know to show this phenomenon, as well as two radio-magnetars (Kijak et al. 2013). Another special case is PSR B1259−63, in which the pulsar is in a wide eccentric binary with a *Be* type star. In this system the GPS effect shows only in a selected range of orbital configurations (Kijak et al. 2011b).

Most of the isolated GPS pulsars (as well as radio-magnetars showing this effect) find themselves in various peciliar environments, such as pulsar wind nebulae, supernova remnants, or HII regions. Authors of the above mentioned papers thus conclude that the GPS feature in their spectra can be caused by external factors. The GPS pulsars apparently are surrounded by some kind of environment that can affect the spectra

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of those pulsars in the same way as the stellar wind affects the B1259−63 spectrum (Kijak et al. 2011b).

To broaden our knowledge about this phenomenon we decided to conduct more flux density measurements for pulsars at lower frequencies. However, since most of the candidate sources have relatively high dispersion measures, at the frequencies below 1 GHz they are heavily affected by interstellar scattering (Lewandowski et al. 2013), which makes the measurement by standard methods unreliable or impossible (when the pulsar signal is completely smeared by this effect). Hence we conducted radio interferometric imaging observations of six pulsars, at low frequency, with the principle aim for measuring their flux densities, to be able to confirm if these pulsars have a GPS-type spectra. Our interferometric data were gathered with Giant Metrewave Radio Telescope at 610 MHz with 30 antennas and 435 baselines in January 2013.

For the first three pulsars, namely B1750−24, B1815−14 and B1849+00, the scattering time-scales at 610 MHz are large that interferometric imaging provides the only means to estimate flux for these cases. The remaining pulsars: B1800−21, B1822−14 and B1823−13 can be observed at low frequencies by conventional pulsar observations, but scattering may still play a role in the flux measurements, hence they were included in the project for verification purposes. We were able to confirm one GPS pulsar, PSR B1823−13. For two others - B1800−21 and B1822−14 - the results are inconclusive and these sources require further investigation. The remaining pulsars are apparently showing regular pulsar spectra down to 610 MHz (Dembska et al. 2014, in prep.).

The interferometric imaging technique provides a superior alternative to the flux measurements due to more robust flux calibration (baseline at zero level reduces errors made during baseline subtraction of a normal pulsar observation) and possibility of correction for instrumental and atmospheric gain fluctuations on very short timescales using self-calibration techniques (corrections are determined by the flux densities of the constant and bright background sources in the field and hence would not be affected by the pulse variation of the relatively weak pulsar). Thus, the interferometric imaging technique allowed us to estimate the flux measurement, making possible to observe weak or high DM pulsars at frequencies below 1 GHz and verify previous results. This will be helpful in searching for new GPS sources in future, especially in a case of objects for which determining the flux at low frequencies using standard pulsar observing methods is not possible.

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