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Low Frequency Profiles of the Crab Pulsar

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Abstract. Integrated profiles of the Crab pulsar at frequencies 102, 111, 127, 147, and 196 MHz compensated for the interstellar scattering are presented. Observed profiles were compensated for interstellar scattering and intrinsic pulsar profiles were restored. The component structure and their frequency evolution was analyzed. The main pulse is two-component and a so-called precursor is its first component. The interpulse have two components too.

Our observations at 102 MHz were performed in 1992- 1994 with the Large Phased Array BSA radio telescope in Pushchino. All detailes of these observation one can see in Kuzmin, Losovsky & Sitnikov (1996). At 111, 127, 147, and 196 MHz we used Rankin et al (1970) and Manchester et al. (1972) observations data.

To compensate the observed profile for interstellar scattering and restore the original profile we used a descattering method (Kuzmin and Izvekova, 1993). The intrinsic pulse profile $x(t)$ was obtained from the observed one $y(t)$ by inverse Fourier transform of its spectrum $X(\omega)$

$x(t) = 1/2\pi \int X(\omega)\exp(j\omega t)d\omega,$

while

$X(\omega) = Y(\omega)/G(\omega).$

Spectrum of the observed profile $Y(\omega)$ and the frequency response of an interstellar medium $G(\omega)$ was found by Fourier transform of observed profile $y(t)$ and transient characteristic of interstellar medium $g(t)$ as:

$Y(\omega) = \int y(t)\exp(-j\omega t)dt,$

$G(\omega) = \int g(t)\exp(-j\omega t)dt.$

We accept simple thin screen model of scattering for which the transient characteristic is represented by truncated exponent

$g(t)$ =0 for $t < 0$ and $\exp(-t/\tau_{sc})$ for $t \geq 0$.

The value of scattering broadening τ_{sc} was measured from observations by the least-squares fitting of the modeled scattered Gaussian template to the observed profile. In 100-196 MHz frequency range it approximated by $\tau_{sc}(f) = 25ms(f_{MHz}/100)^{-4}$.

The resulting descattered profiles are shown in Fig.1. For frequency dependence analysis we plot in this figure also the integrated profiles at higher frequencies 410 (Manchester 1971) and 1400 MHz (Lyne and Smith 1993).

At 410 MHz integrated profile consist of three components. To the main pulse usually referred only the second component. The first component usually

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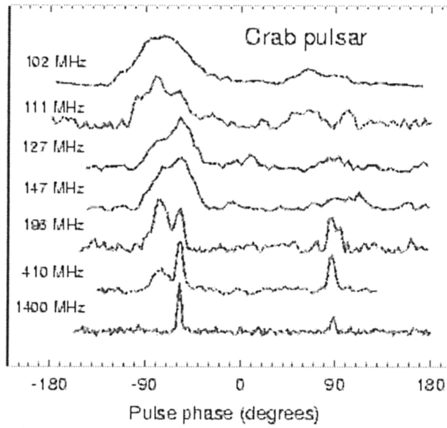

Figure 1. Descattered integrated profiles of the Crab pulsar at 102, 111, 127, 147, 196, 410 and 1400 MHz. The alignment is arbitrary.

identifies as the precursor. The third component, situated 13.37 ms after the main pulse identified as an interpulse.

We suggest that so-called precusor is not a separate formation, but the first component of a two-component main pulse. The frequency behavior of the this main pulse (the width and spacing between components) is similar to the frequency behavior of an common pulsar profile.

The ratio of amplitudes of components depends on frequency. First component of the main pulse is near equals to the second one below of about 200 MHz and decrease at higher frequencies. The interpulse has a maximum near 400 MHz and decrease both to higher and to lower frequencies. The interpulse seems to have two components too, spaced by approximately 30^o.

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