A model for the radio emission pattern of the Crab pulsar

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The Crab pulsar is known for its exceptionally complex radio profile with pronounced frequency evolution. In addition to the interpulse and precursor, similar to those seen in some other pulsars, it shows several peculiar components, which are spread out over the whole pulse period and exhibit substantially distinct spectral and polarization properties. The nature of these components is still obscure.

We extend our physical model of the precursor and interpulse to include the rest components of the Crab pulsar profile. Our generalization of the induced scattering of the main pulse into background is concerned with the specification of the type of motion of the scattering plasma particles. In the outer magnetosphere, the particles participate in the resonant absorption of radio waves and are known to acquire substantial transverse momenta. Therefore, we consider the induced scattering by the particles performing relativistic helical motion.

The scattering from different harmonics of the particle gyrofrequency takes place at different altitudes in the magnetosphere and, because of the rotational effect, may give rise to different components in the pulse profile. It is demonstrated that the induced scattering from the first harmonic into the state under the resonance can account for the so-called low-frequency component (LFC) in the radio profile of the Crab pulsar. This idea is strongly supported by the polarization data observed. Then the high-frequency components (HFC1 and HFC2) may result from the subsequent backward induced scattering of the LFC emission in weaker magnetic fields. Similarly, the high-frequency interpulse, which is shifted to the earlier pulse phase, may arise as a result of the backward induced scattering of the precursor component.

Based on an analysis of the fluctuation behavior of the scattering efficiencies, the transient components of similar nature are predicted for other pulsars.