Radio profile components outside of the main pulse

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The profiles of some pulsars contain the additional components (e.g. interpulses, precursors, etc) outside of the main pulse. These components show peculiar spectral, polarization and fluctuation properties. At the same time, there is a growing observational evidence that the precursor and interpulse emissions interact with each other and with the main pulse.

The additional components are usually interpreted in terms of several geometrical models, which place their origin well apart from the emission region of the main pulse. With the assumption of a favorable orientation of the pulsar with respect to an observer, the component location in the pulse profile is readily reproduced. However, it is still unclear how these independently generated components can be affected by the main pulse emission and by each other.

We, for the first time, propose a physical model of the precursor and interpulse components. It allows us to explain the peculiarities of these components as well as their connection to the main pulse. The precursor and interpulse are considered as consequences of the main pulse propagation through the secondary plasma flow in the open field line tube of a pulsar. Namely, they are assumed to result from the induced scattering of the main pulse into background. Although the initial intensities of the background are expected to be extremely small, the main pulse intensities are so high that the induced scattering can be very efficient and a significant part of the radio pulse energy can be transferred into the background.

The scattered radiation tends to concentrate in the direction corresponding to the maximum scattering probability and can form a separate component in the pulse profile. In the regime of a superstrong magnetic field, the scattered component appears nearly aligned with the local magnetic field direction. Taking into account the effect of rotational aberration in the scattering region, one can identify the scattered component with the precursor. In the regime of a moderately strong magnetic field, the scattered component is antiparallel to the velocity of the scattering particles and can be recognized as an interpulse.

The spectral evolution, fluctuation behavior and polarization properties of the additional components will be examined. A detailed comparison with the observational results will be given, and the perspectives of the multifrequency studies of the complex profiles will be outlined.