On the nature of the physical connection between the radio- and high-energy emissions of pulsars

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The radio emission and the non-thermal high-energy emission of pulsars are undoubtedly generated by different mechanisms, which are still a matter of debate. At the same time, the recent simultaneous observations indicate the existence of the radio – optical/X-ray correlation in pulsars. Namely, the high-energy profiles and intensities appear to be affected by the radio pulse intensity. This strongly supports the high-energy emission mechanisms based on the radio photon reprocessing by ultrarelativistic plasma particles in the open field line tube of a pulsar.

One of the ways of the photon reprocessing is concerned with the resonant absorption of pulsar radio emission by the secondary plasma particles. The process occurs in the outer magnetosphere and can strongly modify particle momenta. As a result, the spontaneous synchrotron emission of the particles falls into the optical/X-ray range and can account for the observed characteristics of the pulsar high-energy emission. Within the framework of this mechanism, the radio and high-energy luminosities are believed to correlate.

Recently we have examined an additional mechanism, which can transfer radio photons into the high-energy band. The particles participating in the resonant absorption can efficiently scatter the radio photons, which are still below the resonance. These under-resonance photons are chiefly scattered to the high harmonics of the particle gyrofrequency, into the range of the spectral maximum of the particle synchrotron emission, and the total scattering cross-section of a gyrating particle is much larger than that of the particle at rest. Based on a detailed study of the low-frequency scattering by gyrating particles we conclude that although the scattered power never exceeds the synchrotron power of the particle, it is the process that can explain a specific change of the X-ray light curve with the radio pulse intensity, which is observed in the Vela pulsar.