Abstract for the general public: Testing new ideas on the polarized radio pulsar emission.

Author: Jarosław Dyks

Radio pulsar emission belongs to the most complex and enigmatic phenomena in astrophysics. The observed pulsar profiles sometimes exhibit strikingly symmetric shapes (interpreted as a sightline cut through nested conal emission beams), other times they are complicated and without symmetry. Their polarization (ie. the type and degree of directional ordering of radio wave oscillations) is equally difficult to predict. One time it is the S-shaped curve that corresponds to the passage of our sightline near the magnetic pole, whereas in other cases the polarization is full of distortions, not-only-orthogonal jumps, and is accompanied by the circular polarization (rotation of the plane of wave oscillation). The pulses themselves show strange slow variability in the form of radio flux modulation or drift of emission within the pulse window (subpulse drift). In spite of more than half-century-long interpretive efforts and growing amount of data from always-better radio telescopes, the causes of these phenomena, or their origin, remain unsolved. The goal of this project is to understand these phenomena through performing new types of data analysis based on the most fresh interpretive ideas.

There has recently been an innovative model of the nested cone structure proposed, which is the only one that correctly predicts both the cones' proportions and the special (orthogonal) polarization of the core components in radio profiles. The model also explains the merging rate, shape and the apparently excessive size of bifurcated (split) components observed in pulsar profiles (particularly of the outstanding bifurcated component in the pulsar J1012+5307). The features are explained as the effects of blueshift and spectral convolution typical of relativistic scattering (collisions of electrons with radio waves). Within the project we will construct a 3D model of this phenomenon and will test quantitatively if the scattering is indeed capable of explaining the above-described observations. This way we will learn if it is possible to reproduce the observed profile structure and the changes of profiles' shapes at different frequencies. We will also learn if it is possible to precisely reproduce the the shape of the outstanding bifurcated component in J1012+5307, hence what are the magnetospheric conditions in the plasma that generates the component. This will be the first-ever precise physical model of a component in a pulsar profile.