Multipoles re-emergence and central compact objects

A. P. Igoshev[1*], J. G. Elfritz[2], S. B. Popov[3]

[1]Department of Astrophysics/IMAPP Radboud University Nijmegen P.O. Box 9010 6500 GL Nijmegen The Netherlands

[2]Anton Pannekoek Institute, University of Amsterdam, Postbus 94249, NL-1090GE Amsterdam, the Netherlands

[3]Lomonosov Moscow State University, Sternberg Astronomical Institute, Universitetski pr. 13, 119991 Moscow, Russia

Multiple recent studies highlight the essential role of the small scale magnetic field for accreting and isolated pulsars as well as for the central compact objects. To understand the evolution of such magnetic field the detailed numerical simulations are required. For the first time we perform the simulations of the crust confined magnetic field of a radio pulsar containing the high order multipoles [1]. Our aim is to analyse the field re-emergence which follows the fall-back of material after the supernova explosion. We find that the high order multipoles which are potentially responsible for the activation of radio pulsar emission, survives the fall-back episode. For a first few kyrs the strength of higher order multipoles is suppressed strongly, so the external poloidal magnetic field of a neutron star looks exactly dipolar which is in a good agreement with observations of the central compact objects which show no sign of radio pulsations. The re-emergence timescales for multipoles with number $l > 6$ is significantly shorter than the dipole re-emergence timescale. Thus the relative strength of multipoles ($l > 6$) is larger during few 10 kyrs till 1 Myr. It means that we expect to observe old-looking pulsars (large spin-down age) in which partly re-emerged magnetic field activated the radio emission but the dipolar component is still weak which set the huge spin-down age. We discuss the observational prospects to discover such objects.

References

[1] A.P. Igoshev, J.G. Elfritz & S.B. Popov, *MNRAS* 462, 3689 (2016)

*E-mail: ignotur@gmail.com