Surface magnetic field structure and Hall evolution in the crust

S. B. Popov[1*], R. Taverna[2], R. Turolla[2], A. P. Igoshev[3]

[1]Sternberg Astronomical Institute, Moscow, Russia

[2]Padova University, Italy

[3]Radboud University, Nijmegen, The Netherlands

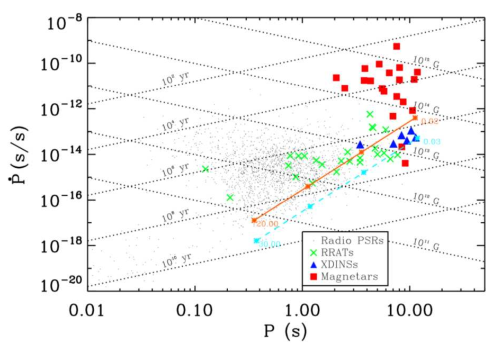

Figure 1: The P-$\dot{P}$ diagram showing the different INS classes. The full orange (dashed light blue) line corresponds to an age equal to two (three) Hall timescales; here an initial period $P_0 = 0.01\,\mathrm{s}$ has been assumed and the initial magnetic field is in the range $10^{12}\,\mathrm{G} \leq B_0 \leq 10^{15}\,\mathrm{G}$. The asterisks along the two lines mark the true age of the star in Myrs, the spacing between two symbols corresponds to a factor of 10 decrease, moving from left to right.

The evolution of magnetic field in isolated neutron stars is one of the most important ingredients in the attempt to build a unified description of these objects. A prediction of field evolution models is the existence of an equilibrium configuration, in which the Hall cascade vanishes. Recent calculations have explored the field structure in this stage, called the Hall attractor [1]. At first, we present results of calculations [2] (and comparison with observational data) of neutron star emission parameters related to the magnetic field structure in the crust.

We use X-ray data of near-by, cooling neutron stars to probe this prediction, as these sources are surmised to be close to or at Hall attractor phase. We show that the source RX J1856.5-3754 might be closer to the attractor than other sources of its class. Our modelling indicates that the properties of surface emission, assuming that the star is in the Hall attractor, are in contradiction to the spectral data of RX J1856.5-3754.

Then we discuss prospects for probing magnetic field configuration in the crust and in the outer space in different types of neutron stars, including central compact objects with emerging fields [3]. Especially, we focus on the possibility to test the Hall attractor hypothesis.

References

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