Large Scale Structure Formation in Pulsar Degenerate Relativistic Outer Layer

Irakli Jokhadze [a], Nana L. Shatashvili [a,b], Alexander G. Tevzadze [a], Swadesh M. Mahajan [c]

e-mail: irakli.jokhadze2013@ens.tsu.edu.ge

[a] Department of Physics, Faculty of Exact and Natural Sciences, Ivane Javakhishvili Tbilisi State University (TSU), 3 Chavchavadze Avenue, Tbilisi 0179, Georgia

[b] TSU Andronikashvili Institute of Physics, Tbilisi 0177, Georgia

[c] Institute for Fusion Studies, The University of Texas at Austin, Austin, TX 78712, USA

The relativistic generalized vorticity tensor is constructed for the outer layer of the compact objects. The possibility of the existence of the double Beltrami-Bernoulli (BB) relaxed states/structures [1,2] is explored for the pulsar's degenerate relativistic outer layer close to the surface. Theoretical formalism is based on the degenerate relativistic fluid equations taking into account the gravitational effects – the metric tensor is that of the Schwarzschild. The BB equilibrium is defined by two relativistic Beltrami conditions and Bernoulli equation for degenerate electron and positron fluids; as a result, Triple Beltrami states are obtained. For finding the illustrative numerical solutions of large-scale flows and magnetic fields equations are written in spherical coordinates and are expanded using spherical harmonic functions. Preliminary estimations for large-scale flow formation [3] in the pulsar outer layer close to the surface are performed. It is expected that the generated flows in compact object atmosphere will contribute to the matter and the energy of the large-scale jet; then, discovered effect can play an important role in the model of relativistic disk-jet structure formation around the compact objects like AGN and Pulsar. Constructed model can be applied for the exploration of observational features of relativistic jets.

The work of IJ and NLS was partially supported by Shota Rustaveli National Science Foundation Project N FR17_391; I.J.-s work was partially supported by World Federation Of Scientists National Scholarship Programme, Geneva, 2018.

References

[1] S. M. Mahajan. *Temperature-transformed "minimal coupling": Magnetofluid unification. Phys. Rev. Lett.*, **90**:035001, (2003).

[2] N. L. Shatashvili, S.M. Mahajan, V. I. Berezhiani: *Mechanisms for multi-scale structures in dense degenerate astrophysical plasmas.* Astrophys. Space Sci **361**:70 (2016).

[3] A. A. Barnaveli, & N. L. Shatashvili: *Mechanism for flow generation/acceleration in dense degenerate stellar atmospheres.* Astrophys. Space Science **362**(9), 164 (2017).