ESF Short Visit Grant – Final Report

I visited the research group lead by Prof. E. Mueller at the Max-Planck-Institute for Astrophysics in Garching, Germany with the purpose of collaborating on a new project regarding the computation of models of relativistic stars in spacetimes without the assumption of circularity.

The main person from Prof. Mueller's research group working on this project is Mr. Reiner Birkl, for whom this project constitutes a major part of his Ph.D. Thesis. During my visit I worked closely with Prof. Mueller and Reiner Birkl on creating the first numerical code capable of solving the full Einstein's equations for stationary axisymmetric spacetimes without the assumption of circularity. My own contribution in this project was to create a new version of my existing numerical code for circular axisymmetric spacetimes which Reiner Birkl could use as a basis for creating the new code and to discuss at length and advise him on various strategies for solving this problem. We also spent time improving on the system of equations which was presented previously in the literature (but never solved numerically).

Our efforts paid off and Reiner Birkl has just finished testing the first version (GRNS-v1.0) of the new numerical code, capable of constructing models of non-circular, stationary, axisymmetric spacetimes in full general relativity. This code will become the basis for computing initial data for configurations such as rotating proto-neutron stars or accretion disks with meridional circulation or magnetized neutron stars with mixed poloidal-toroidal magnetic fields, which were inaccessible with existing numerical codes.

We are currently working on a first publication, which will present the new numerical code in detail as well as a first application in generalizing a configuration with meridional currents that had been presented previously by Prof. E. Mueller and collaborators in the Newtonian limit. The contribution of the ESF Short Visit Grant will be acknowledged in this publication.

We are planning to continue our collaboration and apply the new numerical code to several interesting astrophysical problems in the next few years, with the help of new students or post-docs in the MPA or Thessaloniki groups.

Best regards,

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