Report on the Ph.D. thesis by Norman Gürlebeck

In his Ph.D. thesis *Matter Models in General Relativity with a Decreasing Number of Symmetries* Norman Gürlebeck presents several general-relativistic counterparts of classical Newtonian problems, namely the implications of general relativity for charged shells and stationary configurations of uncharged dust and perfect fluid.

The Thesis begins with a spherically symmetric model of concentric massive shells of opposite charge. Using the usual energy conditions, the subspace of physically admissible configurations within the parameter space of this model is identified.

In the Chapter 3, much more general dipole layers of electric charge are studied in the approximation of test electromagnetic fields on curved background. There, using the standard geometric approach, the discontinuity of potentials across a (hyper)surface is interpreted as distribution of dipoles. The general results are then applied to the test-field solutions of Maxwell equations in the Schwarzschild spacetime.

In Chapter 4, the matter in the form of a stationary and rigidly rotating dust is considered. Assuming the axiall symmetry, the solution of Einstein equations near the rotation axis is found in the form of inner multipole expansion. It is shown, that independently on the exterior solution (and its desired asymptotic flatness), the general relativity does not admit such rigidly rotating dust configurations with constant energy density.

In the Chapters 5 and 6 (and four appendices) Norman Gürlebeck pursues a special class of self-gravitating stationary configurations of rotating perfect fluid − Dedekind ellipsoids. First he presents a brief overview of Newtonian ellipsoidal equilibrium configurations made of homogeneous perfect fluid, focusing on properties of Newtonian Dedekind ellipsoids and their rod-limit. Then, in the last chapter, the general relativistic effects in the first post-Newtonian approximation are studied. It is shown, how a surprising singular behavior of 1-PM corrections found in the previous studies can be cured using the general-relativistic ambiguity in the choice of coordinates, introduced here as two new parameters in an ansatz for the velocity field of the fluid. These new parameters also enabled, for the first time, to describe in 1PM approximation the whole sequence of Dedekind ellipsoids which spans from the axially-symmetric case to the rod-like configurations. The singularities arising in the latter limit are studied as well.

The Thesis is well written with very few typos (e.g. indices in Eq. (15.b) on page 9). I appreciate, that for all presented models the attention is paid to discuss their Newtonian counterparts. The Chapter 6 includes very detailed discussion of aspects, where the results differ from earlier works. Also, even though the analysis requires very complicated formulas the results are presented in a very clear way.

The text of Thesis appropriately extends the included five published or accepted papers in high-ranking scientific journals. These publications show that Norman Gürlebeck's work is at the level usual in the international context for Ph.D. degree in theoretical physics and I can thus recommend it to be accepted as Ph.D. thesis on our faculty.

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