Existence and uniqueness of rigidly rotating stars to second order in perturbation theory in GR

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Abstract:

Static and spherically symmetric perfect fluid stars in General Relativity (GR) are known to (exist and) be unique given an equation of state satisfying some mild conditions and the value of the central pressure [1]. However, much less is known in the rotating case, for which we do not even have a single explicit solution describing a rotating finite object with its corresponding asymptotically flat exterior. In the rotating case we only have results on existence of solutions sufficiently close to Newtonian configurations [2, 3]. On the other hand, of course, the problem has been very succesfully tackled resorting to numerical integration and perturbation methods. The most widely used perturbation framework is the Hartle-Thorne model, which describes slowly rigidly rotating stars in the strong field regime by using perturbation theory up to second order, under a number of explicit and implicit assumptions. Amongst the explicit, equatorial symmetry is assumed, as well as that the perturbation parameter is the angular velocity. And implictly, in particular, the way the perturbed matching is performed, which was dealt with by some of us [4], and the structure of the fields when expanded in spherical harmonics.

In this talk I present the result of a series of works in collaboration with Mars and Reina where the Hartle-Thorne model is fully derived from first principles, starting from the most general stationary and axisymmetric perturbation to a static and spherically symmetric configuration. Our results prove in particular that, at this level of approximation, the spacetime must be equatorially symmetric and is fully determined by two parameters, namely the central pressure and the rotation parameter of the fluid. In that sense, we present a result on existence and uniqueness of rigidly rotating stars to second order in perturbation theory in GR.

References

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