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A number of recent works have highlighted that it is possible to express the properties of general-relativistic stellar configurations in terms of functions that do not depend on the specific equation of state employed to describe the nuclear matter of the compact stars. These functions are normally referred to as "universal relations" and have been found to apply both to static or stationary isolated stars, as well as to fully dynamical and merging binary systems. While a clear understanding of the origin of these relations is still lacking, progress has been made both in identifying the quantities they apply to and the regime in which the relations hold.

During the stay in Oxford I have worked on the completion of a paper where we provide evidence that a universal relation can be derived for the dimensionless moment of inertia and the stellar compactness. Although this relation is not surprising as it involves two quantities that have been shown to satisfy universal relations with other stellar properties, the paper has shown for the first time that a direct relation between the two exists. The relevance of this relation is that it improves on a previous expression by Lattimer and Schutz (ApJ, 629, 979, 2005), and hence provides a more accurate tool to constrain the equation of state of nuclear matter when measurements of the moment of inertia become available.

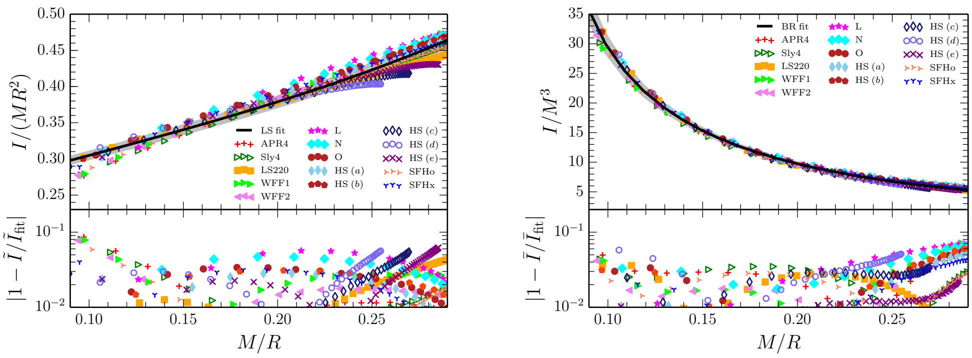

Figure 1: *Left panel:* Normalized moment of inertia $I/(MR^2)$ as a function of stellar compactness $\mathscr{C}$. The solid black line marks the relation found by Lattimer and Schutz. *Right panel:* Normalized moment of inertia $I/M^3)$ with the new fit.

The results of this work is summarised in part in Fig. 1, whose left panel reports the normalized moment of inertia $I/(MR^2)$ as a function of stellar compactness $\mathscr{C}$ and for a large number of different equations of state (EOS). The solid black line marks the relation found by Lattimer and Schutz with the shaded area indicating the error on the fitting coefficients. Similarly, the right panel shows the normalized moment of inertia $I/M^3)$ as a function of stellar compactness $\mathscr{C}$. The solid

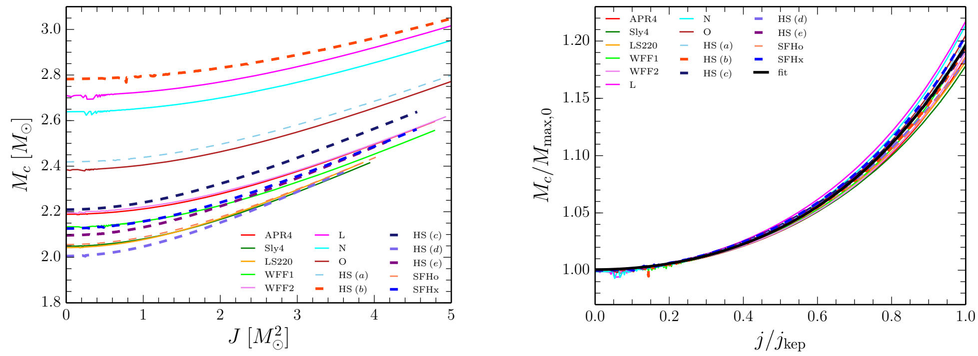

Figure 2: *Left panel:* Critical mass for different EOSs as a function of the stellar angular momentum. *Right panel:* Normalised critical mass shown as function of the normalised angular momentum.

black line marks the new fit, while the shaded band illustrates the error on the fitting coefficients. In both cases the bottom panels show the magnitude of the errors from the fit.

In addition, I have studied the occurrence of universal relations away from stable equilibrium solutions. The motivation behind this is the recent work that has pointed out the emergence of universal relations also in binaries about to merge hints to the possibility that such relations can be found also when considering stars that are marginally stable or unstable. As a result, I have studied if the critical mass for a uniformly rotating stellar configurations possesses any universal behaviour. The results of this investigation are presented in Fig. 2, whose left panel reports the critical mass for different EOSs as a function of the stellar angular momentum. Similarly, the right panel shows the critical mass for different EOSs when normalised to the corresponding maximum mass of the nonrotating configuration and shown as function of the normalised angular momentum expressed in terms of the maximum possible angular momentum. Clearly, in this latter case a universal relation appears and this rather tight, with deviations below 2%. An important consequence of this result is that it is now possible to predict to such precision the maximum mass that can be supported through rotation for any EOS and simply knowing what is the maximum mass of the nonrotating model, i.e., $M_{\rm crit,Kep} \simeq (1.1964 \pm 0.0179)\, M_{\rm max,0}$

In summary, the STSM in Oxford has been very useful as much of this work has benefited from continuous discussions with my host, Prof. J. Miller. The results of this investigation, which has been carried out in collaboration with Cosima Breu and a paper to MNRAS is under completion and will submitted in the coming weeks.