



Internship in theoretical nuclear physics

Study of the reaction mechanisms for the synthesis of super-heavy nuclei

The so-called super-heavy nuclei (SHN) are expected to exist beyond the liquid drop limit of existence defined by a vanishing fission barrier, thanks to the quantum mechanical shell effects. Their synthesis by fusion-evaporation reactions is an experimental challenge due to the extremely low cross-sections. Modelling the complete reaction in order to guide the experiments is also a difficult challenge, as models developed for lighter nuclei cannot simply be extrapolated. Fusion reactions are hindered compared to what is observed with light nuclei because of the very strong Coulomb interaction is enhanced by the strong repulsion caused by the large number of positive charges (protons) in the system in competition with the attractive strong (nuclear) force in a highly dynamic regime. The predictive power of the models needs to be improved, although the origin of the hindrance phenomenon is qualitatively well understood. The quantitative ambiguities are large enough to observe few orders of magnitude differences in the fusion probabilities calculated by different models. A small change in the cross-section could result in many months being required to perform successful experiments. At GANIL, in collaboration with other institutes, we have developed a model that describes all the three steps of the reaction to synthesise super-heavy nuclei. Future developments will focus on finding ways to assess the models in order to improve their predictive power, including the design of dedicated experiments to constrain the so-called fusion hindrance. During the internship, the student will first assess previous attempts with a careful uncertainty analysis which has not been done so far. Standard methods as well as state-of-the-art data analysis methods such as Bayesian analysis may be used.

Expected skills

Nuclear physics, computing

This work leads to a [PhD-thesis](#)

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