Internship in theoretical nuclear phyiscs

Exploring machine learning techniques to describe nuclear reactions

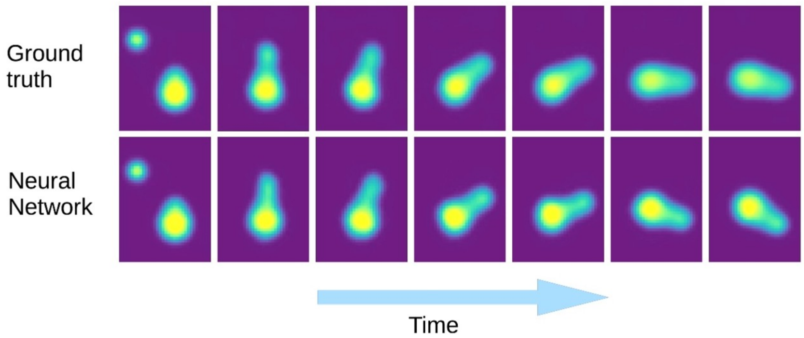
The description of nuclear reactions is important to understand the properties of nuclei and unravel the interplay between the structure and dynamics. Insights into these reactions are required to obtain a good comprehension of the mechanisms leading to the synthesis of new super-heavy elements and to understand the origin of the elements formed in the stars.

State-of-the-art theoretical calculations (Time-dependent Density functional theory) offer a microscopical description of these reactions and more generally the nuclear dynamics. However, they require a large computational time limiting the range of applicability. Machine learning models can circumvent these limitations by providing surrogate models (a model fitted on another model) to perform large-scale calculations. The fast model can then be applied to integrate over all the initial degrees of freedom (impact parameter, orientation of the deformed nuclei).

The student will evaluate the accuracy of the machine learning model. Depending on his/her background and interest, he/she will have the opportunity to either:

- Explore new machine-learning techniques to improve the model. Testing different architecture, learning techniques...
- Investigate new physical applications with the current surrogate model. This includes the fusion cross-section calculations, quasi-fission, multi-nucleon transfer reactions, and giant resonances.

Fig: Example of a comparison between the microscopic and the surrogate model



Expected skills: Knowledge in neural network techniques, numerical methods, quantum mechanics, and nuclear theory.

This work can be pursued by a Ph.D. thesis (already funded).

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