Master projects in theoretical nuclear physics

The KTH nuclear physics division welcome applications for the following master and summer projects within theoretical nuclear physics. Please don't hesitate to contact Chong Qi (chongq@kth.se) for more details.

Mass calculations of all nuclei with a single potential

Supervisors: Ramon Wyss and Chong Qi

Masses constitute the major property of atomic nuclei. Calculations of nuclear masses has attracted the physics community during many decades. Last not least, the interest in nuclear astrophysics with respect to the creation of all elements, the discovery of super heavy nuclei, and the exploration of the drip line has led to new demand for high accuracy mass calculations.

Different models are used to calculate masses, where in principle one can differentiate between three different types:

1) The micro-macro model combining a phenomenological potential, a semis classical smoothing procedure and bulk properties of the liquid drop model.
2) Microscopic models based on the Skyrme force or relativistic mean field
3) Shell model kind of calculations with input from real masses

The accuracy of those models is in the range of 700kev, rms deviation roughly. The group at KTH has since long been working the micro-macro model and developed an approach including the 'Wigner Kirkwood' method and the Woods Saxon potential, with parameters that have been developed by us.
In a reason study, we have preliminary results indicating that we obtain reasonable results based on the Woods Saxon potential only. This constitutes a new route for mass calculations, that would be highly interesting to explore. If it will work out, it will replace the mic-mac method 1) and remedy uncertainties associated with it.

Your task would be to optimize the fitting procedure to all know masses of even-even nuclei in order to find the best fit possible. Special emphasis will be on the accuracy with respect to iso spin, the Coulomb and pairing energy. In a second step, one may embark on the inclusion of odd-even and odd-odd nuclei.

Machine learning for nuclear many-body problems

We would like to explore the possibility to apply neural network and machine learning algorithms in solving quantum many-body problems like nuclear structure and hadron structure. We would like to focus on one of the two fundamental questions: To image the proton structure and to predict the nuclear mass based on physics models we have developed. But the student is also welcome to join our other ML related projects if interested.