

Master work in applied nuclear physics

“Charge exchange of highly charged ions in helium gas”

Engineering Programme / Master in Physics - Degree Project (Ex-jobb)

Applied Nuclear Physics 30 credits (20 weeks)

The division of applied nuclear physics is involved in fission-yield measurements at the IGISOL facility in Jyväskylä, Finland. High-precision measurements on neutron-induced fission yields are planned to enhance the accuracy of nuclear data, both for the development of fundamental fission models and for nuclear applications. The IGISOL technique has been successfully applied to study proton-induced fission reactions and will now be directed towards fission yields from a reactor-like neutron spectrum. The neutrons will impinge on a fissionable target such as uranium or thorium giving rise to two fission products. These are produced in a back-to-back kinematics and one of which will be emitted in the reaction chamber. The reaction chamber is filled with He gas, which acts as stopping gas for the emitted fission products. Once the fission products are stopped they are transported via the He gas flow to a mass separator and a Penning trap for further identification.

The master project aims at investigating the charge exchange between the initially highly ionized fission products and the helium gas. It is anticipated that a large fraction of the ions eventually end up as singly charged due to the large electronegativity of the helium atoms. However, it is likely that the size of this fraction varies for different elements (referred to as the chemical effect). Such a variation will cause a systematic uncertainty in the fission-yield measurements and it is therefore important to try to quantify this effect and if necessary correct for it.

The effect can be quantified using suitable software (such as Root or Matlab) to numerically solve a set of rate equations that governs the charge exchange between the ions and the helium atoms. These calculations can then be compared to mean-charge estimations obtained with the dedicated software CASP (<http://www.casp-program.org/>). It might also be possible to go to Jyväskylä to measure these effects using the IGISOL facility.

Start date

Upon agreement

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