NAUSICAA Project

**N**eutron **AU**gmented **S**αβ **I**n **C**ross sections **A**lternative **A**ssessment

The NAUSICAA project is a collaborative research study including the Institute Laue-Langevin (ILL), the Institut de Radioprotection et de sûreté Nucléaire (IRSN) and the University of Florence. It aims to increase significantly the accuracy of the international neutron cross section libraries for reactor physics (ENDF, JEFF, JENDL...) which could be tremendously improved by introducing direct measurements. The results of this project could be extremely useful for many kinds of neutron models like heavy water reactors and neutron cold sources.

One caveat of the neutron cross section libraries is indeed the evaluation process of thermal neutron cross sections in liquids, especially in hydrogenated liquids in which inaccurate approximations are employed. This problem could be solved by the direct use of measured structure factors S(Q,ω), where Q is the neutron momentum transfer and ω is the neutron energy transfer. Until now all evaluations related to thermal neutron were based upon experiments performed with a momentum transfer Q=0, like IR or Raman. The extension on the whole Q domain is carried out by approximate laws which become clearly wrong in the case of liquids like water. This means that measurements of a real S(Q,ω) enable to get rid of the extension laws approximations and thus to significantly enhance the accuracy of the cross sections.

Neutron inelastic scattering experiments were carried on ILL instruments with light and heavy water. The measured S(Q,ω) have been treated, normalized and processed by the code NJOY (directly through the THERMR sub-code) in the ACER format. The measurements were completed by molecular dynamics simulations. A benchmark with the MCNP model of the ILL reactor was carried out with success.

The first step of the study is now completed and is being published. We have demonstrated the feasibility and the reliability of this method. Two additional steps are foreseen in the next future and will be carried out in parallel. One is the refinement of the light and heavy water data at ambient temperature and pressure. The other is performing the same measurements and treatments but with cryogenic liquids like liquid hydrogen and deuterium. The study of cryogenic liquids is not trivial and will require several years to carry out the measurements in the best conditions.

Our project is to rely upon two PhDs, one for each step. The first one will be centred on water data refinement, based upon both measurements and Molecular Dynamics calculations, and its benchmark with real models using MCNP like codes. The second one will be focused only on the cryogenic liquids because of the difficulty of experiments and the lack of adapted quantum modelling tools.

The NAUSICAA project should begin in early 2015 and last until the end of 2018. The total cost for each PhD could be assessed around 350k€ each, including salaries, that is a total cost of 700k€ for the whole project, without permanent staff salaries.

This project won’t be possible without an international collaboration with partners able to share manpower, expertise, instruments or experimental devices and obviously cash. We are now looking for close collaborations with research organisms interested by the NAUSICAA project and open to share the resources need for achieving this project.