ÉCOLE POLYTECHNIQUE MONTRÉAL

October 20, 2002

NJOY/CALENDF list

Re: Availability of three NJOY/CALENDF PhD projects

I am happy to announce the availability of three PhD projects (including scholarship) at École Polytechnique. The three subjects are related to NJOY and CALENDF methodologies and are involving programmation in the DRAGON framework. The Fortran programmation resulting from these three project will be released under the LGPL (Lesser General Public License) and will therefore be available worldwide. Each scholarship is $20000.00 (can) plus the registration fees. The possible beginning dates are January 2003, May 2003 or September 2003. The lectures will be provided in French, but the thesis redaction could be performed in French or English.

If you are interested in any of these three projects, please send a CV and a short motivation letter to my Email address (`alain.hebert@polymtl.ca`) before November 30. The web site of École Polytechnique is `www.polymtl.ca`.

The main objective of this research proposal is the improvement of the self-shielded model, embedded in lattice codes. In today's DRAGON calculations, this model is responsible of the biggest part of the modelization error. These errors are acceptable for current types of Canadian nuclear reactors (CANDU, Slowpoke, etc.) but are becoming more important for the following new generations of reactors:

1. ACRs (Advanced Candu Reactors) and research reactors with spectral shifts induced by the presence of light and heavy water. The ACR is an innovative concept of reactor with increased safety and reduced costs.
2. use of resonant burnable poisons (gadolinium, erbium, etc.)
3. high burnups, use of mixed oxyde (MOX) fuel and transuranium poison burning
4. intermediate (supercritical water cooled) and fast spectrum reactors

Progress made in the last five years in the development of a new version of the code DRAGON have made possible its use for the complete generation of two–group cross section libraries used in full-core calculations. These progress have made the code more user-friendly, more robust, and have improved its scripting capabilities (using Java). The next step, proposed here, is an improvement of its accuracy and an increase of its applicability domain obtained through

- an improvement of its self–shielding model

- the integration of improved flux solution modules for the Boltzmann equation (characteristics and S_n methods).

The target of each PhD project is to bring a specific contribution of the CALENDF methodology to industrial use.[1] More specifically, a new self-shielding model will be implemented and calculation schemes will be written for the ACR. The increased accuracy bring by the new self-shielding methodology will be useful to represent the spectral shift effects which characterize the ACR. The self-shielding methodology will be implemented in Fortan and the calculation schemes will be implemented in Java (a UML model will be set).

The three available PhD projects are:

1. Development and application to production cases

This project will bring the self-shielding methodology proposed by Keltoum and Ribon to a level of development sufficient for production calculations.

- Calculation of the cross section moments from NJOY information and processing of the cross section data using an improved version of DRAGR. Construction of a database from ENDF-B or JEF data.
- Coupling of the new approach at lower energies with the Physical Subgroup method at higher energies.
- Conception of the calculation schemes and validation of the method for burnup–dependent industrial problems.

2. Development of the interoperability with the method of characteristics

The self-shielding methodology will be combined to a powerful flux solution technique based on the method of characteristics. Special care must be taken on the following points:

- Accuracy and stability of the method in cases of very small and very high cross sections (as the base points of a probability table are varying over many orders of magnitude). The $\Sigma_t = \Sigma_s$ case will be investigated.
- Development of an efficient acceleration technique. The Suslov method will be investigated.

3. Development of the interoperability with the method of discrete ordinates

This sub-project will permit the complete interoperability of a discrete ordinate (S_n)

[1] B. Oum Keltoum Aziza and P. Ribon, "Tables de probabilité non statistiques. Description des effets du ralentissement", *Proc. Int. Conf. on the Physics of Reactors: Operation, Design and Computation*, Marseille, France, April 23 – 27, 1990.

solution with the various part of a lattice code including the self-shielding model, the leakage model and the equivalence model.

Sincerely yours,

Alain Hébert
professor
École Polytechnique de Montréal
Institut de Génie Nucléaire
alain.hebert@polymtl.ca

cc: Dr. Jean Koclas, Directeur de l'Institut de Génie nucléaire