



POLITÉCNICA

DEPARTAMENTO DE INGENIERÍA ENERGÉTICA



Máster Universitario en “Ciencia y Tecnología Nuclear”

Master Erasmus Mundus SARENA (Safe and Reliable Nuclear Applications)

ADVANCED ONLINE SEMINAR

“Neutron-Nucleus Resonance Theory and Applications”

Dr. Luiz Leal

Researcher. Institute for Radiological Protection and Nuclear Safety (IRSN), France



The intent of the seminar is to describe methodologies used to perform nuclear data evaluation for neutron-nucleus interaction. Additionally, data processing using available tools will be presented. Descriptions will be given on how the nuclear cross section libraries are prepared for multi-group and Monte Carlo applications.

The techniques for neutron cross section evaluation in the resolved and unresolved resonance region will be present. Brief review of resonance theory, scattering theory, will describe together with procedures, methods of analysis, and criteria for selecting experimental data. The class also addresses the treatment of data for reactor applications.

Dr. Luiz Leal is currently in charge of Scientific Excellence at the Neutronics and criticality risk department at the Institut de Radioprotection et de Sûreté Nucléaire (IRSN), France. Before joining IRSN, he worked at the Oak Ridge National Laboratory (ORNL) from 1993 to 2015 as a Distinguished R&D Staff member in the Nuclear Data and Criticality Safety Group at the Reactor and Nuclear Systems Division. Throughout his career, he has actively collaborated with faculty members and co-advised students in many universities, including RPI, Massachusetts Institute of Technology, Georgia Institute of Technology, University of Texas, Austin, Pennsylvania State University, Institut Polytechnique de Grenoble (France), University of Orsay (France), and Korea Advanced Institute of Science and Technology (South Korea). He is a Fellow of the American Nuclear Society (ANS) and 2016 Reactor Physics Division (RPD) recipient of the Eugene P. Wigner Reactor Physicist Award..

Tuesday 15 to Friday 18 June, from 15:30 to 17:30 (CET)

This Seminar will be developed online in MS-Teams: <https://short.upm.es/pcwj4>

[Follow the link](https://short.upm.es/pcwj4)

Advanced Seminar on Neutron-Nucleus Interaction: Theory and Applications

Dr Luiz LEAL

SEMINAR OUTLINE:

First and Second Days:

I. Resolved Resonance Representation of the Cross Sections

- A. Scattering Theory
 - 1. Collision Matrix, U
- B. Resonance Theory
 - 1. R-Matrix Theory
 - 2. Relationship between Collision Matrix, U, and R-Matrix
 - 3. Derivation of the Level Matrix, A
- C. Practical Resonance Formalisms Derived from the R-Matrix
 - 1. Single-Level Breit-Wigner (SLBW)
 - 2. Multi-Level Breit-Wigner (MLBW)
 - 3. Reich-Moore (RM)
 - 4. Adler-Adler (AA)
 - 5. Multipole (MP)

II. Temperature Effects

- a) Doppler Broadening - Derivations: ψ and χ Analytical and Numerical
- b) Resolution Broadening

III. Unresolved Energy Region Cross Section Representation

- a) Method and Analysis
- b) Probability Table

Third and Fourth Days:

I. Method of Data Evaluation

- a) Data Selection
- b) Data Reduction
- c) Data evaluation Code (SAMMY) - General Overview
- d) Covariance Data

II. Brief introduction to the Nuclear Data Library Format (ENDF)

- a) Visit and inspection of the nuclear data evaluation repository;

III. Resonance Analysis in the Resolved and Unresolved Energy Region

- a) Data evaluation Code (SAMMY) - General Overview
- b) Covariance Data

IV. Cross Section Library Generation - Processing Codes: AMPX, NJOY

V. Resonance Treatment (Resonance Shielding)

- a) Narrow Resonance Approximation, Bondarenko Approach
- b) Shielding Factor Method

VI. Cross Section Uncertainty Analysis

- a) Sensitivity/Uncertainty Analyses