Contribution ID: **11** Type: **Invited oral contribution**

Nuclear theory for astrophysics applications

Monday 10 October 2005 17:25 (25 minutes)

Important effort has been devoted in the last decades to measure reaction cross sections. These measurements are fundamental to put the nuclear astrophysics models on a sound basis. However, despite such effort, many nuclear applications, and most particularly nuclear astrophysics, still require the use of theoretical predictions to estimate experimentally unknown cross sections. Most of the nuclear ingredients in the calculations of reaction cross sections need to be extrapolated in an energy or/and mass domain out of reach of laboratory simulations. In addition, some applications often involve a large number of unstable nuclei, so that only global approaches can be used. For these reasons, when the nuclear ingredients to the reaction models cannot be determined from experimental data, it is highly recommended to consider preferentially microscopic or semi-microscopic global predictions based on sound and reliable nuclear models which, in turn, can compete with more phenomenological highly-parametrized models in the reproduction of experimental data.
The latest developments and improvements made in the prediction of ground-state properties, nuclear level densities, gamma-ray strength functions and fission properties within global microscopic models are reviewed. The direct as well as indirect experimental data available to test these models are discussed. It is shown to what extent previous and future experiments can bring new constraints or insights on the existing models.

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Session Classification: Nuclear Astrophysics

Track Classification: Nuclear astrophysics