ESNT Workshop: Dynamics of Nuclear Fission

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Project of the *Espace de Structure et de réactions Nucléaires Théorique*

https://esnt.cea.fr

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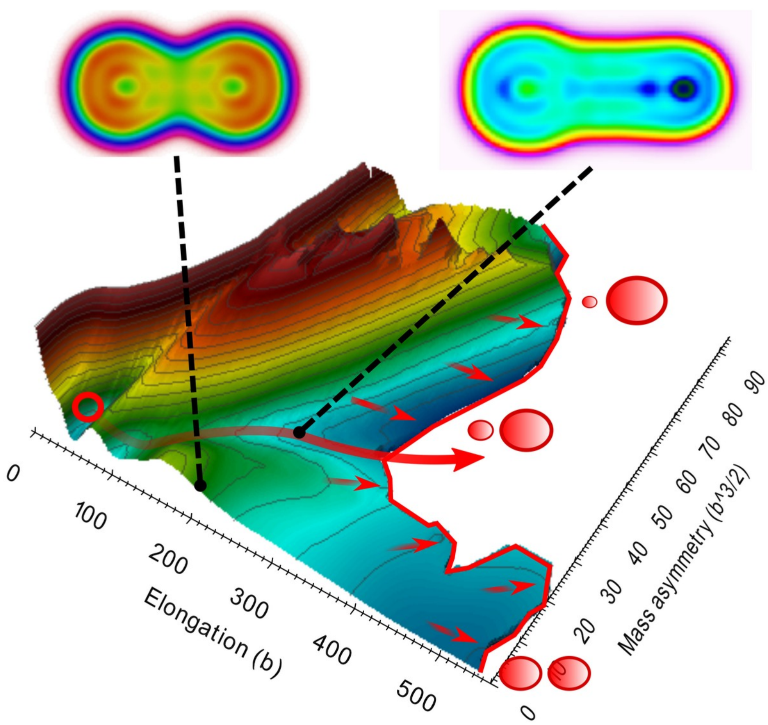
CEA Saclay, DPhN, Orme des Merisiers, b. 703, room 135, F-91191 Gif-sur-Yvette



I. SCIENTIFIC ISSUEtentative_program-v07.docx

The process of spontaneous or induced fission, by which an atomic nucleus breaks into two or more fragments, with a corresponding release of an enormous amount of binding energy, was discovered 85 years ago. Because of important technological applications, primarily in energy production, fission has since become the epitome of the field of low- and medium-energy nuclear physics. However, from a modern perspective, the fission process is particularly important as a representative case of large-amplitude collective motion in a self-bound mesoscopic system, that exhibits both classical and quantal characteristics. Fission is also relevant for the stability of superheavy elements, production of short-lived exotic nuclides far from stability, nuclear astrophysics and the mechanism of nucleosynthesis, neutrino interactions, etc.

A wealth of experimental results on nuclear fission have been accumulated over more than eight decades, and a basic understanding of the mechanism gained. A number of very successful phenomenological approaches and methods have been developed that reproduce, to various degrees of accuracy, low- and medium-energy fission observables. Even though the development of advanced experimental methods is essential for future fission studies, experiments need to be complemented by advances in theoretical modeling. A unified microscopic framework for the description of the entire fission process remains a formidable challenge for nuclear theory.

Several recent workshops and review articles have reported the latest advances and results of theoretical fission studies [1-5]. In particular, a workshop dedicated to the future of fission theory was held at the University of York in the autumn of 2019. Numerous aspects of phenomenological and microscopic modeling, from conceptual to computational, were discussed. The focus was primarily on prospective developments and challenges. The subsequent report, published as an article in J. Phys. G [6], has made a comprehensive list of recommendations, addressing all important challenges facing fission theory, as well as specific recommendations for the development of new theoretical methods and computing capabilities. In the five years since these recommendations were made, many new avenues have been explored and significant advances in the microscopic description of various aspects of the fission process have been reported. These range from instanton-motivated and configuration-interaction based studies of spontaneous fission, studies of nuclear structure shell-effects, development of new and/or more accurate models based on time-dependent density functional theory and time-dependent generator coordinate method, analysis of the role of dynamical pairing correlations, symmetry restoration, fission in odd-mass nuclei, improvements to the macroscopic-microscopic approach, generation of fragment angular momentum in fission, particles emitted in fission, rôle of fission on the r-process, etc. This list, of course, is not exhaustive and only illustrates the variety of topics that have been addressed in recent publications.

The proposed workshop will provide a forum for discussing the progress made by nuclear fission theory in the last five years, as well as addressing future developments. In addition to the most active researchers in the field, we also aim to involve young scientist as well as the local experimental teams. The specific goals of the workshop are listed below.

II. GOALS OF THE WORKSHOP

In summary, the goals of the project are:

1 Review the advances of nuclear fission theory in the last five years.

2 Examine the current stages of development of phenomenological and microscopic models and establish new connections between the two approaches.

3 Compare the computational strategies adopted by various research teams and identify challenges for the new generation of fission computer codes (dependable calculation of deformation energy surfaces, collective inertia, functional optimization, time evolution, symmetry restoration).

4 Discuss with experimental teams the desired levels of accuracy for the description of specific fission observables including uncertainty quantification.

5 Identify new applications of nuclear fission theory, particularly in the field of nuclear astrophysics.

6 Issue a set of specific recommendations for developing a unified framework for the description of spontaneous and induced fission, that will start from nuclear structure and extend to the modeling of fission observables that are relevant for applications.

III. TENTATIVE PROGRAM

	Monday	Tuesday	Wednesday	Thursday
09h30	**Plompen**	**Morfouace**	**Piau**	**Gaudefroy**
10h30	**Romain**	**Kessedjian**	**Chebboubi**	**Scamps**
11h15	*Break*	*Break*	*Break*	*Break*
11h45	**Washiyama**	**Vretenar**	**Lemaitre**	**Magierski**
12h30		Lunch	Lunch	Lunch
13h45	**Zdeb**	**Ryssens**	**Marevic**	**Sanchez-Fernandez**
14h30	**Verriere**	**Li**	**Pillet**	*End (14h30)*
15h15	*Break*	*Break*	*Break*	
15h45	**Newsome**	**Lau**	**A. Bernard**	
	End (16h15)	*End (16h30)*	*End (16h15)*	

IV. LIST OF SPEAKERS

A. Bernard
CEA, DAM, DIF, 91297 Arpajon, France
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Generation of Bogoliubov states from machine learning

A. Chebboubi

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Prediction and emulation of prompt n/g with FIFRELIN

L. Gaudefroy
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On the neutronless fission of 252Cf(sf)

S. Giuliani
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Theoretical description of yields: Toward a fast and efficient global model

G. Kessedjian
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Evaluation of fission yields

N.-W. T. Lau
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Towards an improved description of nuclear fission with the time-dependent generator coordinate method

J.F. Lemaitre
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Scission point model SPY

Z. Li
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Microscopic study on asymmetric fission dynamics of 180Hg within covariant density functional theory

P. Magierski
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Recent achievements with the TDSLDA

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Angular momentum distributions in fission fragments from microscopic theory

P. Morfouace
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Overview of recent measurements

J. Newsome
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Scalable generation of HFB potential energy landscapes

V. Piau
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Measurement of the prompt neutrons and gamma rays

N. Pillet
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Construction of continuous collective energy landscapes

A. Plompen
European Commission, Joint Research Centre (JRC), Retieseweg 111, B-2440 Geel, Belgium
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Neutron-induced fission cross sections: what have we learned from experiment

P. Romain
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Fission cross section evaluation

W. Ryssens
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Fission properties of BSkG2

A. Sanchez-Fernandez
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Microscopic description of fission properties: paving the way for large-scale data generation

G. Scamps
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Collective model for spin generation

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Fission with TDGCM

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Generalized GCM for fission

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Collective inertia for spontaneous fission

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Fission and cluster emission from super-heavy nuclei

VII. RELATED BIBLIOGRAPHY

[1] N. Schunck and L. M. Robledo, Rep. Prog. Phys. **79**, 116301 (2016).

[2] K.-H. Schmidt and B. Jurado, Rep. Prog. Phys. **81**, 106301 (2018).

[3] A. Bulgac, S. Jin, and I. Stetcu, Front. Phys. **8**, 63 (2020).

[4] M. Verriere and D. Regnier, Front. Phys. **8**, 233 (2020).

[5] N. Schunck and D. Regnier, Prog. Part. Nucl. Phys. **125**, 103963 (2022).

[6] M. Bender *et al.*, J. Phys. G: Nucl. Part. Phys. **47**, 113002 (2020).