«ETTORE MAJORANA» FOUNDATION AND CENTRE FOR SCIENTIFIC CULTURE

TO PAY A PERMANENT TRIBUTE TO ARCHIMEDES AND GALILEO GALILEI, FOUNDERS OF MODERN SCIENCE AND TO ENRICO FERMI, THE "ITALIAN NAVIGATOR", FATHER OF THE WEAK FORCES

INTERNATIONAL SCHOOL OF STATISTICAL PHYSICS

14th Course: *EXPLORING AND QUANTIFYING ROUGH FREE ENERGY LANDSCAPES*

ERICE-SICILY: 15 – 20 MAY 2018

Sponsored by the: • Italian Ministry of Education, University and Scientific Research • Sicilian Regional Government

PROGRAMME AND LECTURERS

Free energy, kinetics and mechanisms of self-assembly of peptides and proteins using path sampling simulations
• P.G. BOLHUIS, University of Amsterdam, Amsterdam, NL

Sampling the conformational landscape of oligonucleotides using replica exchange and metadynamics
• G. BUSSI, SISSA, Trieste, IT

Metadynamics as a tool to investigate key molecular events for neuronal function and dysfunction
• P. CARLONI, German Research School for Simulation Sciences, FZJ, Jülich, DE

Exploring protein-membrane interplay with molecule simulations
• M. DAL PERARO, EPFL, Lausanne, CH

Exploring the free energetics and kinetics of nucleation processes: from crystallization to cavitation
• C. DELLAGO, University of Vienna, Vienna, AT

Free energy landscapes of proteins and RNA
• A.E. GARCIA, Los Alamos National Laboratory, Los Alamos, NM, US

Quantifying the free energy landscapes associated to drug-target binding
• L.F. GERVASIO, University College London, London, UK

Hierarchical energy landscapes: From specific to general
• H. GRUBMÜLLER, Max Planck Institute of Biophysics Chemie, Göttingen, DE

Determining free energies, rates and mechanisms from molecular simulations
• G. HUMMER, Max Planck Institute for Biophysics, Frankfurt, DE

Multiscale simulations of partially disordered systems
• C. PETER, University of Konstanz, Vienna, DE

Free energies and molecular kinetics from biased simulations
• E. ROSTA, King's College London, London, UK

Multiscale enhanced sampling in the simulation of micelles and membranes
• J. STRAUB, Boston University, Boston, MA, US

Identifying and enhancing important fluctuations in complex systems with maximum caliber and metadynamics
• P. TIWARY, University of Maryland, College Park, MA, US

Dimensionality reduction and collective variables: Our tools for understanding complex free energy landscapes
• G.A. TRIBELLO, Queen's University Belfast, UK

Exploring free energy landscapes with variationally-enhanced sampling
• O. VALSSON, Max Planck Institute of Polymer Research, Mainz, DE

Exploring free energy landscapes with coarse-grained models
• G.A. VOTH, University of Chicago, Chicago, IL, US

PURPOSE OF THE COURSE

Experimental science has made great strides in recent years to characterize and visualize complex processes at the nanoscale. Yet there will always remain fundamental limits on length and time scales at which data can be obtained that prevent such techniques from observing chemical and biological mechanisms in action. It is here that simulation techniques stand out, in principal providing fully detailed descriptions of molecular processes as they occur. However, when observed at this resolution, most processes of scientific interest are extremely complex with transitions between functional states occurring only rarely due to either large energy barriers that must be surmounted or unlikely interactions between species. When combined, these factors imply that the mechanisms of such transitions require traversing tortuous paths through a landscape of metastable states that would rarely be traversed in normal atomistic simulation time scales. Moreover, such simulations would be unlikely to provide enough statistics to get a full picture of representative states and the rates of transition between them. It is therefore imperative to develop methods and the theory supporting these methods that allows for rapid sampling of free energy landscapes and their transition paths by decomposing and simplifying the problem, i.e., by controllably smoothing or subdividing the rough landscapes seen across all areas of molecular science. In this Erice School, experts in the field will discuss their most recent advances in enhanced sampling techniques and their application to elucidating complex molecular mechanisms, especially but not exclusively in the context of biological applications. Topics span areas from biological self-assembly, protein-ligand interactions, protein folding, and enzyme kinetics, and new technical developments will be discussed in the areas of dimensionality reduction, coarse-graining, Markov state modeling, and free energy sampling.

APPLICATIONS

Persons wishing to attend this Course should apply write to:

Professor Gregory A. Voth
Department of Chemistry, The University of Chicago
5735 S Ellis Ave, Chicago, IL 60637, USA

PLEASE NOTE

Participants must arrive in Erice on May 15, no later than 7 p.m.

POETIC TOUCH

According to legend, Erice, son of Venus and Neptune, founded a small town on top of a mountain (750 metres above sea level) more than three thousand years ago. The founder of modern history — i.e. the recording of events in a methodic and chronological sequence as they really happened without reference to mythical causes — the great Thucydides (~500 B.C.), writing about events connected with the conquest of Troy (1183 B.C.) said: «*After the fall of Troy some Trojans on their escape from the Achaei arrived in Sicily by boat and as they settled near the border with the Sicanians all together they were named Elymi: their towns were Segesta and Erice.*» This inspired Virgil to describe the arrival of the Trojan royal family in Erice and the burial of Anchise, by his son Enea, on the coast below Erice. Homer (~1000 B.C.), Theocritus (~300 B.C.), Polybius (~200 B.C.), Virgil (~50 B.C.), Horace (~20 B.C.), and others have celebrated this magnificent spot in Sicily in their poems. During seven centuries (XIII-XIX) the town of Erice was under the leadership of a local oligarchy, whose wisdom assured a long period of cultural development and economic prosperity which in turn gave rise to the many churches, monasteries and private palaces which you see today. In Erice you can admire the Castle of Venus, the Cyclopean Walls (~800 B.C.) and the Gothic Cathedral (~1300 A.D.). Erice is at present a mixture of ancient and medieval architecture. Other masterpieces of ancient civilization are to be found in the neighbourhood: at Motya (Phoenician), Segesta (Elymian), and Selinunte (Greek). On the Aegadian Islands — theatre of the decisive naval battle of the first Punic War (264-241 B.C.) — suggestive neolithic and paleolithic vestiges are still visible: the grottoes of Favignana, the carvings and murals of Levanzo.

Splendid beaches are to be found at San Vito Lo Capo, Scopello, and Cornino, and a wild and rocky coast around Monte Cofano: all at less than one hour's drive from Erice.

More information about the other activities of the "ETTORE MAJORANA" FOUNDATION AND CENTRE FOR SCIENTIFIC CULTURE can be found on the WWW at the following address:
http://www.ccsem.infn.it

M. PARRINELLO – G.A. VOTH
DIRECTORS OF THE COURSE

P. HÄNGGI – F. MARCHESONI
DIRECTORS OF THE SCHOOL

A. ZICHICHI
PRESIDENT EMFCSC