

Symposium Rare Events: optimal solutions and challenges – from charge transfer reactions to supervolcanoes (SYRE)

jointly organized by
the Working Group on Energy (AKE),
the Extraterrestrial Physics Division (EP),
the Molecular Physics Division (MO),
the Theoretical and Mathematical Physics Division (MP), and
the Quantum Optics and Photonics Division (Q)

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Rare events may be believed at first sight to be ignorable in the model design and description of systems. However, in some cases they may play an important role in the overall evolution of a system and therefore deserve careful assessment. Depending on the system considered, very different theoretical approaches will be needed to derive quantitative conclusions about their possible impact. This Symposium informs about the occurrence and relevance of rare events in a rather heterogeneous range of systems including chemical reactions and complex natural systems such as the sun or the volcanic activity of the earth with concomitant consequences on climate and life on earth. Setting the scene in the first talk, it is shown that rare events are significant not only in natural systems but, as recent events demonstrate, also for developments in society and economics.

Overview of Invited Talks and Sessions

(Lecture room: Audimax)

Invited Talks

SYRE 1.1	Wed	16:30–17:00	Audimax	Rare and large events: examples from the natural sciences and economics — ●THOMAS GUHR
SYRE 1.2	Wed	17:00–17:30	Audimax	The roles of energy-level and electronic-coupling fluctuations in the control of biomolecular and small-molecule charge transfer reactions — ●SPIROS SKOURTIS
SYRE 1.3	Wed	17:30–18:00	Audimax	What do we know about extreme solar events? — ●ILYA USOSKIN
SYRE 1.4	Wed	18:00–18:30	Audimax	The climate impact of very large volcanic eruptions: An Earth system model approach — ●CLAUDIA TIMMRECK

Sessions

SYRE 1.1–1.4	Wed	16:30–18:30	Audimax	Symposium Rare Events: optimal solutions and challenges – from charge transfer reactions to supervolcanoes
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SYRE 1: Symposium Rare Events: optimal solutions and challenges – from charge transfer reactions to supervolcanoes

Time: Wednesday 16:30–18:30

Location: Audimax

Invited Talk SYRE 1.1 Wed 16:30 Audimax
Rare and large events: examples from the natural sciences and economics — •THOMAS GUHR — Universitaet Duisburg-Essen

After an introduction to rare, large and extreme events, I discuss an economics issue which continues to catch our attention: the risk involved with credit contracts and the obvious severe consequences for the stability of the financial system. It is known that the distribution of credit losses has a dangerously heavy tail due to rare, but drastic events. I will show that the tail cannot be reduced in typical economic situations - contrary to some claims made by the financial industry.

Then I turn to an at first sight completely unrelated topic: distributions of wave intensities in disordered systems. In particular, there are recent microwave experiments which yielded quantitative results. I show that both issues, credit risk and intensity distributions, can be studied from a unifying viewpoint by relating them to the underlying non-stationarities.

Finally, I sketch some interesting new results on the statistics of records.

Invited Talk SYRE 1.2 Wed 17:00 Audimax
The roles of energy-level and electronic-coupling fluctuations in the control of biomolecular and small-molecule charge transfer reactions — •SPIROS SKOURTIS — Department of Physics, University of Cyprus, Nicosia, Cyprus

Charge transfer reactions are ubiquitous in biology and chemistry and are central to the molecular electronics and energy materials technologies. Charge transfer physics is very rich, with transport mechanisms ranging from tunnelling to thermally activated hopping. Due to the floppiness of biomolecules molecular conformational fluctuations play an active role in biological charge transport. I give a review of recent trends in the theory and simulation of molecular and biomolecular charge transfer rates, focusing on the role of electronic-coupling and energy-level fluctuations in proteins and DNA. Activated rare events of energy-level matching and of electronic-coupling enhancement are often the determinants of the charge transfer rates in these systems. I also discuss the possibility of driving structural fluctuations in small-molecule systems by external fields in order switch on and off charge transfer reactions.

Invited Talk SYRE 1.3 Wed 17:30 Audimax
What do we know about extreme solar events? — •ILYA USOSKIN — University of Oulu, Finland

Sun is the main driver of the life on Earth. However, extreme eruptive energetic events on the Sun can be hazardous in many respects, particularly for the modern technology and communication dependent society. It is crucially important, for technological and human being safety, to learn what could be the worst case scenario for an extreme solar event and what is its probability to occur. The era of direct scientific exploration of the Sun is short - from few decades to a century, and yet several strong harmful events had happened. Can we expect even greater events? How often? What shall we prepare for? In order to answer these questions, one has to rely upon indirect methods by analysing natural proxy archives.

Here we overview methods able to reveal the history of extreme solar events in the past, from thousands to millions of year, based on an analysis of cosmogenic isotopes in terrestrial archives (polar ice cores and tree rings) and in lunar rocks. The obtained statistics is discussed and a probability density function for extreme solar events to occur is presented.

Invited Talk SYRE 1.4 Wed 18:00 Audimax
The climate impact of very large volcanic eruptions: An Earth system model approach — •CLAUDIA TIMMRECK — Max-Planck-Institut für Meteorologie, Hamburg, Germany

Large volcanic eruptions are an important driving factor of natural climate variability. In particular very large volcanic eruptions (super eruptions) produce extremely strong radiative forcing, which can affect the Earth system for longer times than the pure atmospheric residence time of the volcanic aerosol. Applying such radiative forcing provides a wide range of possibilities to investigate the complex feedback mechanisms of the Earth system, e.g., which processes will be activated, how stable will the system be, are positive or negative feedback loops dominant. Super eruption simulations with Earth system models (ESMs) are therefore an ideal test bed for the quality and performance of such models. Here we present and discuss MPI-ESM simulations of very large volcanic eruptions in different seasons and hence different states of the climate system carried out in the frame of the MPI-M Super volcano project. New insights have been gained in this project about volcanic impacts on atmospheric composition and dynamics, but most notably also about their impact on ocean dynamics, the hydrological and the carbon cycle and on marine and terrestrial biogeochemistry. Major achievements are the improved understanding of the volcanic imprint on decadal to multi-decadal time scales and the importance of the microphysical treatment of the volcanic aerosol size distribution.