

ESOF2006 SPECIAL EDITION NEWSLETTER – 001

FEATURE ARTICLE

Clustering phenomenon in systems of varied degrees of complexity

Clustering is a general physical phenomenon manifesting itself at very different scales (levels) of matter organization or self-organization. A group of objects bound together by some interaction can be called a cluster. Such group of objects could be a group of nucleons in a nuclear matter, this can be a group of atoms, molecules or nanosize droplets stuck together on surface or this can be a group of galaxies in the Universe. Structure and properties of the cluster type of objects are pre-determined by forces holding constituents together within a system. In spite of difference in the scale of cluster systems and in the types of forces holding them together, they sometime allow very straightforward analogies. For example, the liquid drop model can be successfully utilized for the explanation of nuclear fission and for the understanding of stability of charged nanoclusters. Cluster is a relevant concept for different fields of science. Clustering phenomenon is relevant for astrophysics, atomic and molecular physics, chemistry, molecular biology, solid-state physics, nuclear physics, plasma physics and technology (clustering in the wireless or computer networks). In spite of that huge diversity of fields, are there some fundamental laws governing the behaviour and the properties of cluster systems at different scales? Could atomic clusters one day become the smallest devices or be used to make the smallest devices? Could one manipulate atomic cluster isomers for producing new materials and nanostructures? What is the difference between a nanocluster and a virus? What are the principles of the matter self-organization, self-assembling and functioning on the nanoscale? Are these principles much different from those governing clustering of galaxies in the Universe?

In my talk at the ESOF 2006 I will attempt to focus on at least some of these intriguing interdisciplinary questions. These questions are especially interesting because their answering brings us immediately to the frontiers of modern science.

For the illustration consider aggregation of atoms and small molecules into clusters, nanoparticles, microdroplets with complex molecular structure. In this process a diversity of complex nano- and mesoscopic objects and systems with the distinct cluster properties can be created. There are many examples of such systems, e.g. fullerenes, carbon nanotubes, endohedral objects, quantum dots, quantum wires, nano-fractals, nanoparticles embedded into thin films or attached to biomolecules and many more. Some of these objects have been discovered only recently, other became a subject of intensive investigations because of their potential important applications, e.g. in miniaturizing of electronic devices, advancing new bio-medical technologies, development of quantum computers. For some of the systems, e.g. for deposited clusters, nano-fractals, quantum dots etc, their contact with the surface plays an important role in the formation of their structure and properties. Investigations of clustering, self-assembly, stability, dynamic, thermal, optical and conductive properties of different mesoscopic, nano- and complex molecular structures are central the research work in many laboratories worldwide. Another perspective is the investigation of behaviour of these systems in external electric, magnetic and laser fields, as well as the structural transformations and dynamic processes induced by radiation, collisions, fission and fusion processes.



Although mesoscopic systems and nano-structures like atomic clusters, fullerenes, biomolecules, nano-fractals, quantum wires and quantum dots generally possess unique properties, a number of common open fundamental problems can be addressed for the most of the mentioned systems in spite of differences in their nature and origin: (i) what are the underlying principles of the self-organization and self-assembly of matter? How does function emerge at the nano-scale and in mesoscopic systems? (ii) are these principles classical or quantum? (iii) what are the criteria for the stability of complex mesoscopic and nano-systems? (iv) what are their characteristics, typical conformations and dynamical properties? (v) how do the properties (electric, magnetic, optical, transport, thermodynamic, quantum, etc) of mesoscopic and nano-systems come into play, and how do they change with variation of the system size? (vi) how are the properties of mesoscopic and nano-systems altered by an environment, such as a liquid medium, a solid substrate, a confining cage, a thin film or by an external electromagnetic field? (vii) how specific features of complex mesoscopic and nano-systems manifest themselves in physical, chemical and biological processes in which they are involved?

Searching for answers to these questions is a subject of intense, current investigations. Such studies, both theoretical and experimental, by a large number of research groups worldwide are the core of a new field combining mesoscopic, biological and nano- sciences ('mesobionano'-science).

The understanding of structure and dynamics of mesoscopic, bio- and nano-systems, their detailed theoretical description and complete understanding can only be achieved by utilizing a wide range of traditional approaches and methods known from theoretical physics and chemistry, combined with advanced computational techniques and with the use of powerful computers.

For more information on this key-note lecture, please click [here](#).

Written by Prof. Dr. Andrey Solovy'ov

EDITOR'S CHOICE

Thinking beyond experience: How to prepare for mega-disasters?

When preparing for (natural) disasters, we tend to rely on personal experience. But when we try to prepare for the most destructive events, we lack this experience, as mega-disasters are extremely rare; they may not happen for several generations. However, there are places where disaster management authorities and relief organisations need to plan for day X. Istanbul is such a place, threatened by the East Anatolian Fault. Depending on how this fault breaks, it can cause an earthquake with a magnitude of up to 7. It would hit a densely populated area of nearly 12 million inhabitants.

Geoscientists try to quantify the risk for Istanbul more precisely. Their data enable the authorities to set up detailed evacuation and rescue plans. They even get help from space: As the city changes more quickly than maps are published, satellites provide current information about the urban development.

However, all this changes after an earthquake or, in other parts of the world, after a hurricane or during a flood. But disaster management authorities and relief organisations can rely on the International Charter "Space and Major Disasters" that provides up-to-date satellite maps of disaster areas to facilitate evacuation and relief activities.

This feature is kindly supported by



The risk for mega-disasters increases as the concentration of population and assets increases – and therefore the need to be prepared; such as in Istanbul.

For more information on this scientific session, please click [here](#).

Written by Renate Ell

Clusters: from atoms to galaxies

What do atoms and galaxies have in common? Well guessed: Both form clusters.

A cluster is a group of objects bound together by any force. We find clusters among the smallest as well as among the largest objects: nucleons within the atomic nucleus, atoms and molecules form clusters – as well as galaxies in the universe.

Despite different sizes and dissimilar forces holding them together, clusters sometimes show clear-cut analogies. For instance, nuclear fission and fission of charged metal clusters are strikingly similar processes and can be understood with similar models. Also, dynamical behaviours of atomic clusters and clusters of galaxies turn out to be alike (after the huge differences in time and mass scales are accounted for). Yet not only phenomena occurring in clusters are similar, but the theoretical approaches to describe these phenomena derive from the same mathematical basis.

Thus it seems promising to compare clusters of the various components and of all sizes in search for further analogies. Resulting advances in understanding the behaviour of clusters may lead to concrete applications: For instance, by manipulating clusters, material with specific desired properties can be created.

Yet there is a more universal, appealing question behind these comparisons: Are there fundamental laws governing all cluster systems? Can the interdisciplinary study of clusters reveal a key design principle of nature and provide new insight into the self-organization of matter?

Clusters are an essential concept in numerous areas of science, such as nanoscience, physics, astrophysics, chemistry, molecular biology. Also in engineering, computer science, social science as well as in the research of neural networks, clustering phenomena are addressed.

Experts from these diverse “cluster” sciences will talk about “their” clusters in this genuinely interdisciplinary session. And tell us more about the necessity to look high up to the stars in order to understand matter deep down.

For more information on this scientific session, please click [here](#).

Written by Barbara Schwerdtfeger

Of curiosity, lasers and insulin: Small science, big results

Many big things had small and unpredictable beginnings, hidden away, unnoticed by most people. This can hardly be truer in the case of inventions and progress in science. Numerous key developments have been made by small groups, or even by individuals, driven solely by the curiosity to solve basic questions. An example of such small-scale research is Einstein’s



This feature is kindly supported by



work on the theory of quantum optics, which paved the way for the invention of the laser, an indispensable device found in many of the electronic appliances that we use every day. Another is restriction enzymes, discovered by Werner Arber, Daniel Nathans and Hamilton O. Smith. These enzymatic "molecular scissors", which cut DNA at very specific sequences, laid the foundations for molecular biology, the age of genetic engineering, and biotechnology itself.

However today, eager to generate innovative technologies, and ever more concentrated on applications and large-scale research, we run the risk of neglecting small-scale fundamental research, argues session chair Andrew Moore from the European Molecular Biology Organization in Heidelberg, Germany. Individual researchers, or small teams working on scientific questions with no direct application, are often regarded by the public as too eccentric and impractical to deserve the support they need. Instead, consumers tend to sympathise more with projects that seek to produce concretely applicable results to a given timetable. Applied research done by large groups is a highly attractive candidate in the funding race.

Considering the often huge (though unpredictable) economic and social benefits of curiosity driven research, several panellist will argue, we should think more carefully about the balance of funding distribution between small, fundamental, research and large projects.

This appeal to bear in mind basic research is, at least in part, directed to the European Commission, which largely finances large-scale applied research. However, on the side of small research there are developments afoot in science funding at the European level: Will the recently founded European Research Council (ERC) significantly improve the situation of basic research?

A session dedicated to fundamental research – with an, so the session chair admits, "unashamed bias towards emphasising the 'hidden' value and significance of fundamental research."

For more information on this scientific session, please click [here](#).

Written by Barbara Schwerdtfeger

ESOF2006 NEWS

View the programme and register now!

The programme for the Euroscience Open Forum 2006 is online! Through the programme planner (which you can find on the ESOF2006 website by clicking on 'Programme'), potential participants can put together their personal timetable from over 70 seminars, workshops and key-note lectures.

Would you like to take part in the 2nd pan-European general science meeting? Then click on 'Registration and Rates' and register online. Participants not entitled to a reduced fee (please check the table under 'Registration and Rates') receive **20% off** when registering before **April 30th 2006!**



This feature is kindly supported by



Sign-up for the exciting social events!

Numerous social and networking events have been planned around the scientific programme, offering participants the chance to interact but also enjoy the scenery and local cuisine of the host city. All social events (except the one reserved for the press) are open to participants. There are, however, two social for which pre-registration is required:

1) The joint Opening Ceremony ESOF2006/Wissenschaftssommer 2006

A joint ceremony will mark the beginning of ESOF2006 and the Wissenschaftssommer 2006 (German National Science Week). The organisers are happy to announce that the President of the Federal Republic of Germany, Horst Köhler, will be participating in this event. The ceremony will be followed by a reception at the hotel "Bayerischer Hof" located in the heart of Munich. Please note that the number of seats is limited, therefore the organisers encourage to register early. Seats will be allocated on a first come-first serve basis.

2) Evening reception at the "Flugwerft Schleißheim"

One of the most attractive branches of the Deutsches Museum is the "Flugwerft Schleißheim" (aerodrome). This is the site of the historic airfield which was built between 1912 and 1919. In the early nineties it was restored and enlarged with a new exhibition hall. Today, the Flugwerft hosts one of the largest aerospace exhibitions in Germany with more than 50 historical aeroplanes, helicopters and gliders. ESOF2006 will take you on a trip back to the first hours of manned aviation by welcoming you to a reception in these historical surroundings. Please make sure to pre-register for this event. Participation costs €20 per person and includes return transportation in modern buses, buffet dinner and drinks, and entertainment.