KN-1

Very large complexes

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KN-2

Powder Diffraction at the Japanese Spallation Source

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KN-3

Protein interactions regulate ubiquitin and SUMO conjugation.

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Ubiquitin conjugation has emerged as a major signalling pathway that regulates critical cellular pathways such as DNA repair, transcription and cell cycle. In this process the small ubiquitin protein is covalently conjugated to a lysine on the target protein that is redirected for degradation, interaction or cellular localization.
Since ubiquitin itself has seven lysines, different ubiquitin chains can occur, with different cellular outcomes. The conjugation machinery consists of E1,E2,E3 cascades of enzymes that are balanced by a series of deubiquitinating enzymes or DUBs.
We study the modulation of E2 and E3 enzymes by the components of the system itself, using a combination of protein crystallography and protein interaction studies. Results will be presented on the question of target complexes, target selectivity, chain formation and selection of chain types as well as the asymmetry of E3 RING dimers.

KN-4

Can Nature do what Man can do? The Search for Natural Quasicrystals.

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The well ordered world of solid materials was forced to reassess its rules when an icosahedral phase of matter was first discovered in the laboratory [1] and the concept of quasicrystals was introduced to explain it [2]. Quasicrystals are solids whose diffraction patterns are composed of Bragg peaks, like periodic crystals, but with symmetries forbidden to crystals. Over the last twenty-five years, more than one hundred examples have been identified, but, until now, all have been produced in the laboratory under controlled conditions ranging from rapid to moderately slow. The search for a naturally-forming quasicrystal began soon after the concept of quasicrystals was introduced. For many years, the search was informal. However, beginning about a decade ago [3], a systematic search was developed that, through planning and much serendipity, led to the discovery this past year of a natural candidate embedded in a rock found in the Koryak Mountains, northern Kamchatka [4]. It should be noted that, when the concept of quasicrystals was first introduced, there was considerable skepticism [5] whether complex quasiperiodic structures could ever form, even under ideal laboratory conditions. Indeed, the first icosahedral phase, i-Al_6Mn, reported by Shechtman et al. [1] exhibited so much disorder that its identification as a quasicrystal was challenged and alternative structural models were proposed [5]. At the time, all known examples of icosahedral alloys were metastable, only obtainable by rapid quenching. Then, highly perfect and more stable quasicrystals, such as i-AlCuFe began to be discovered, showing that quasicrystals can be formed under highly controlled laboratory conditions. Nevertheless, one could not be sure of their long-term stability [6] because they could not be kept in equilibrium at low temperatures or annealed over eons. The discovery of natural quasicrystals could push back the age of the oldest known quasicrystal by orders of magnitude: for example, the host rocks in the Koryak mountain region date from the Triassic, roughly 200 to 250 million years ago. A natural sample would represent the first physical evidence that quasicrystals can form spontaneously under natural conditions, and can remain stable over geologic timescales. From the perspective of condensed matter physics, that the natural quasicrystal, embedded in a matrix of different minerals, remains distinct and so structurally perfect would lend support to the original proposal [2] suggesting that quasicrystals can be as stable as crystals, and, therefore, have equal footing as a stable form of solid matter. From a geological standpoint, the concept of what makes a mineral would have to be amended to include quasicrystalline structures, and the search for other natural candidates may provide a new avenue to discover new stable quasicrystals not yet observed in the laboratory.

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KN-5

The ribosome story.

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Research on protein synthesis or translation emerges during the 40-ties and 50-ties. 1941 it was noticed that high levels of RNA correlated with protein synthesis. Ribosomes were first isolated 1952 and identified as the site of protein synthesis 1957. The name ribosome started to be used 1958. The mRNA was discovered 1956. The need for tRNA was postulated 1956 by Crick in his adaptor hypothesis and shortly thereafter identified by M. Hoagland. From early times the structure with whatever means has been in focus. A dramatic step forwards was due to Ada Yonath 1980 when she managed to get the first crystals of ribosomal subunits. Numerous improvements of methodology and crystals led to the first structural results 1998. Year 2000 high resolution structures of both subunits became available and the year after a medium resolution structure of the whole ribosome. This has made the whole field flourish both biochemically and structurally like for all fields where the central molecules have been clarified by crystallography.

KN-6

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KN-7

From hot to cool and more for less: new developments for Structural Biology. Elspeth F.Garman, *Department of Biochemistry, University of Oxford, South Parks Road, OXFORD, OX1 3QU, U.K.*
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Structural biology relies on X-ray crystallography to provide much of the three dimensional information on macromolecules that informs biological function. To enable problems not previously accessible to structure solution to be tackled, improved methods must be developed. A notable example of this has been the progress in finding protocols to cryocool protein crystals prior to 100K data collection to reduce the rate of radiation damage by around a factor of 70 compared to that at room temperature (RT): from hot to cool and more for less. Radiation damage to the sample is an inherent problem when utilising ionising X-radiation in macromolecular crystallography (MX), and it is now known that radiation damage can also be a limiting factor for MX at 100K [1]. Following our measurement of 30 MGy (1 Gy =1 J/kg energy absorbed) for the experimental dose limit for 100K [2] protein crystals, we tried to determine a limit for RT samples. The unexpected discovery of an RT inverse dose rate effect over a limited dose rate range [3] led us to search for RT scavengers [4], which in turn has elucidated the radiation chemistry induced in protein crystals when irradiated at 100K. Current ongoing methods investigations that will be described include studies of 100K and RT radiation damage in macromolecular crystals in order to inform both our understanding and putative mitigation strategies, and the trace elemental analysis of liquid and crystalline proteins using microPIXE (particle induced X-ray emission), allowing determination of their stoichiometric ratio to an accuracy of between 10 and 20% [5].

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KN-8

Single Crystal Diffraction Studies at Multimegabar Pressures. Malcolm McMahon, *SUPA, School of Physics & Astronomy, and Centre for Science at Extreme Conditions, The University of Edinburgh, UK.*
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By the late 1990s, it was clear that the structural complexity induced in simple materials by compression was such that powder-diffraction methods were no longer able to solve complex structures being observed. While single-crystal techniques offer the ability to solve such structures, attaining the necessary high-quality samples at pressures above 20 GPa, perhaps after passing though one or more phase transitions, is extremely difficult. But the remarkable behaviour of the alkali metals Li and Na at extreme pressures, coupled with techniques developed at the SRS and ESRF synchrotrons, has enables us to push single-crystal techniques first to 100 GPa [1] and, most recently, to 145 GPa [2]. We have found previously unimagined structural complexity in both Na and Li [3], and have also been able to collect high-quality data from weakly scattering samples such oxygen [4] and nitrogen [5], including at both high- and low-temperature studies.
In this talk I will review both the new techniques, and the results we have obtained recently on these simple systems. I will also look to the future, and give some pointers as to the kind of crystallographic experiments that might be conducted on the next, “4^{th}”, generation of light sources.

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KN-9

Symmetry breaking in complex molecular assemblies. Jürg Hulliger, *Department of Chemistry and Biochemistry, University of Berne, Switzerland*
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A mechanism leading to effects of symmetry breaking in the solid state results from the fact that at the nutrient-crystal interface incoming building blocks interact under the influence of a lower symmetry [1] than in the bulk. In case the attachment state shows kinetic stability, symmetry breaking in particular growth sectors can occur. A process most investigated during the last ten years [2, 3] is 180° orientational disorder of incoming dipolar molecules. Because of selective recognition at growing surfaces, this kind of symmetry breaking can lead to polar property formation. The lecture is reviewing the field, including examples from supramolecular crystals, single component and solid solution molecular materials. Because of generality, the theory applies also to the formation of polar tissues [4].