2014 international year of crystallography

United Nations Educational, Scientific and Cultural Organization

International Union of Crystallography

Partners for the International Year of Crystallography 2014

Launch of the

International Year of Crystallography

Opening Ceremony

UNESCO House, Paris
20–21 January 2014

Programme

www.iycr2014.org

Acknowledgments

The organizers acknowledge with thanks the vital sponsorship of the opening ceremony by the Governments of India and South Africa.

They also wish to thank the following sponsors of this event:

Cover photo: Loperamid Crystal

International Year of Crystallography

Opening ceremony

Room I
20–21 January 2014

There is an exhibition on **Journey into the Crystal**
in front of Room I and in an adjoining room,
organized by the French Crystallographic Association.

Message from the Director-General of UNESCO
Irina Bokova

The year 2014 has been proclaimed the International Year of Crystallography. Exactly a century ago, it was discovered that X-rays could be used to 'see' the structure of matter in a non-intrusive manner. Today, X-ray crystallography has become the leading technique for studying the structure of matter at the atomic or molecular level.

Crystallography has shaped the history of the 20th century. It has made a vital contribution to our understanding of the very basis of life itself, notably through the work of Francis Crick and James Watson, who, with a valuable contribution from the crystallographer Rosalind Franklin, revealed some 60 years ago that the structure of DNA was a double helix. In the past 50 years, the structures of more than 90,000 biological molecules have been revealed by crystallographers, with great ramifications for health care.

Today, crystallography underpins all the sciences. It forms the backbone of a wide range of industries, including pharmaceuticals, agrifoodstuffs, aeronautics, computing, mining and space sciences. It is essential for the development of almost all new materials.

Yet many countries still lack expertise in this field. This is why UNESCO and the International Union of Crystallography are joining forces to shine the spotlight on crystallography in 2014.

Every country must invest in this field and our message is that they can – crystallography is accessible to all and can be performed in a university setting, with relatively inexpensive equipment, without sophisticated infrastructure. All countries can enjoy considerable social and economic benefits from modest investments – and the International Year of Crystallography will demonstrate how.

Throughout the year, UNESCO and the International Union of Crystallography will be providing interested governments with guidance on curricular and research development. We shall be organizing a number of open laboratories in developing countries, in order to show how crystallography works, in partnership with private companies. The first labs will be equipped and ready by early 2014 in Argentina, Côte d'Ivoire, Morocco, South Africa and Uruguay.

In conclusion, I wish to invite all governments to join us in raising the flag for crystallography throughout 2014 and beyond.

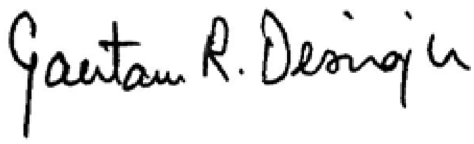
Message from the President of the International Union of Crystallography Gautam R. Desiraju

The International Union of Crystallography is delighted to partner with UNESCO in celebrating the International Year of Crystallography in 2014.

Crystallography is a science that studies crystals. One of its biggest achievements is an imaging technique that enables scientists to look at matter at the atomic and molecular level. Accordingly, it has the widest of applications in biology, chemistry and physics. No branch of structural science is untouched by it. The benefits to humankind have been enormous and range from the discovery of medicines and drugs to materials that make the quality of life better for all.

While crystallography is a high-level scientific subject, its applications are easy to enjoy and appreciated by all. The International Union of Crystallography and UNESCO have undertaken a wide-ranging programme of activities, from crystal-growing experiments for school children to summit meetings for researchers and science administrators. An ambitious programme of open laboratories in at least 20 countries worldwide has been launched. The International Union of Crystallography is committed to the spread of crystallography to all parts of the world because it is only through such a global initiative that all-round material progress will be obtained and the quality of life will improve for all.

I invite all crystallographers to celebrate IYCr2014 in a befitting manner.



20 January 2014

10:00 am ● Welcoming remarks

This session will be moderated by Neil Ford.

Ban Ki-moon, Secretary-General of the United Nations, by video message

Irina Bokova, Director-General of UNESCO

Gautam R. Desiraju, President of International Union of Crystallography (IUCr)

Soumaia Benkhaldoun, Vice-Minister of Higher Education and Research of Morocco

Alain Fuchs, President of French Centre national de la recherche scientifique (CNRS)

Nicole Moreau, past president of the International Union of Pure and Applied Chemistry, chair of the Organizing Committee of International Year of Chemistry 2011: From the International Year of Chemistry to the International Year of Crystallography

John Dudley, President of European Physical Society, Chair of Steering Committee of International Year of Light 2015: From the International Year of Crystallography to the International Year of Light

Walter Maresch, President of International Mineralogical Association

Gregory Petsko, President of International Union of Biochemistry and Molecular Biology

Claude Lecomte, Vice-President of International Union of Crystallography: From the Africa Initiative to the IUCr–UNESCO Open Labs

10:55 am ● Lecture on milestones in crystallography and future perspectives

Introduction by **Christian Brönnimann**

Crystallography: past, present and future
Jenny Glusker

11:30 am ● Coffee break

12:00 pm ● Session 1: Talented young crystallographers of the world

This session will be moderated by Philip Ball.

Africa: Yvon Bibila (Côte d'Ivoire), Delia Haynes (South Africa)

Arab States: Mohamed Eddaoudi (Saudi Arabia)

Asia: Rumana Akther Jahan (Bangladesh), Ji-Joon Song (Republic of Korea)

Latin America: Adriana Serquis (Argentina)

Eastern Europe: Marcin Nowotny (Poland)

Western Europe and North America: Anders Ø. Madsen (Denmark)

Other talented young crystallographers from around the world will participate in the question and answer portion of this session, namely: Rahul Banerjee, El-Eulmi Bendeif, Malla Reddy and Andrew Torelli

1:10 pm ● Lunch break

2:50 pm ● Nobel laureate lecture

Introduction by **Jules Tenon**

Structural insights into G-protein coupled receptor signalling
Brian K. Kobilka

Summary remarks by **Judith Howard**

3:30 pm ● Session 2: Crystallography in emerging nations: success stories and the role for development in the BRICS countries

This session will be moderated by Neil Ford.

Hao Ping, President of 37th session of the General Conference of UNESCO

Irina Bokova, Director-General of UNESCO

Vinay Sheel Oberoi, Ambassador, Permanent Delegate of India to UNESCO

Thirumalachari Ramasami, Secretary, Department of Science and Technology, Government of India

Glaucius Oliva, President of Brazilian National Council for Scientific and Technological Development (CNPq)

Thomas Auf der Heyde, Deputy Director-General of South African national Department of Science and Technology, and **Catherine Esterhuysen**, President of South African Crystallographic Society

Mikhail Kovalchuk, Director of the Kurchatov Institute and Chair of the National Russian Crystallography Committee

Gao Song, President of Chinese Crystallographic Association

6:00 pm ● End of first day

21 January 2014

9:00 am ● Session 3: Crystallography for society and the future

Introduction by **Johannes Friso van der Veen**

From X-ray tubes to X-ray lasers
John Spence

Crystallography in our daily lives
Martijn Fransen

Crystallographic research in the developing world
Juliette Pradon

Introduction by **Sunday Asuquo Thomas**

Crystallography in the study of the Universe
David Bish and David Blake

A short history of crystallographic technology
Frank Burgäzy

Introduction by **Diego Lamas**

Crystallography in the study of art and historical artefacts
Philippe Walter

11:30 am ● Session 4: Crystallography, symmetry and art

This session will be chaired by Hocine Merazig

Symmetry in art and architecture of the western Islamic Golden Age
Abdelmalek Thalal

Highlights of Eastern Islamic ornamental arts as seen through crystallographers' eyes
Emil Makovicky

Modern math in medieval Islamic architecture
Peter J. Lu

12:30 pm ● Session 5: Crystallography and peace

IUCrJ and crystallography working across nations
Samar Hasnain

SESAME: Fostering science, building bridges
Chris Llewellyn Smith

1:05 pm ● Closing remarks

Maciej Nalecz, Director, Executive Secretary of UNESCO's International Basic Sciences Programme

1:15 pm ● Opening ceremony ends

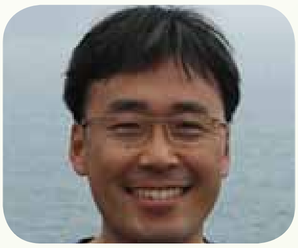
Talented young crystallographers of the world


Yvon Bibila


Delia Haynes


Mohamed Eddaoudi


Rumana Akther Jahan


Ji-Joon Song


Adriana Serquis


Marcin Nowotny

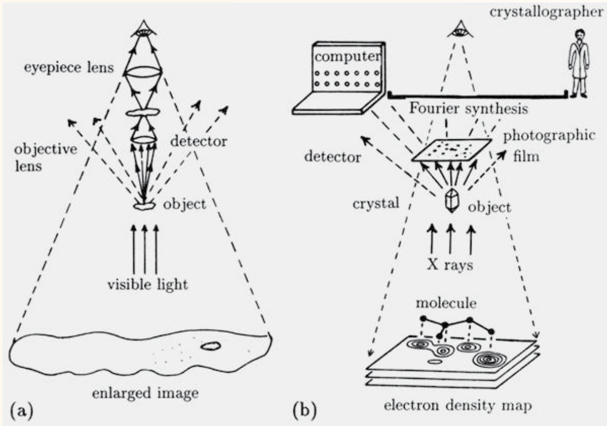

Anders Ø. Madsen

Crystallography: past, present and future

Jenny Glusker

Our celebration here of the International Year of Crystallography is concentrated on the changes in our understanding of the three-dimensional structure of matter since the published report of the determination of the first crystal structure, that of sodium chloride, in 1914 by W.H. and W.L. Bragg.

My talk will concentrate on our understanding of the internal structures of crystals through the years up to 1914, the X-ray diffraction patterns obtained in 1912 by von Laue and co-workers, and the inspirational mathematical and technological studies through the years up to the present (2014) that have enabled us to interpret the X-ray (and later neutron) diffraction pattern of any crystal in terms of a three-dimensional arrangement of atoms within the repeat unit of the crystal. X-ray crystallographers can now work with high precision with molecules as large as viruses, with crystals with less than perfect order to give results with the correct identification of atoms and the absolute configuration of the atomic arrangement. Some impacts of the structural results on various branches of science will then be described with indications of future studies.



Structural insights into G-protein-coupled receptor signalling

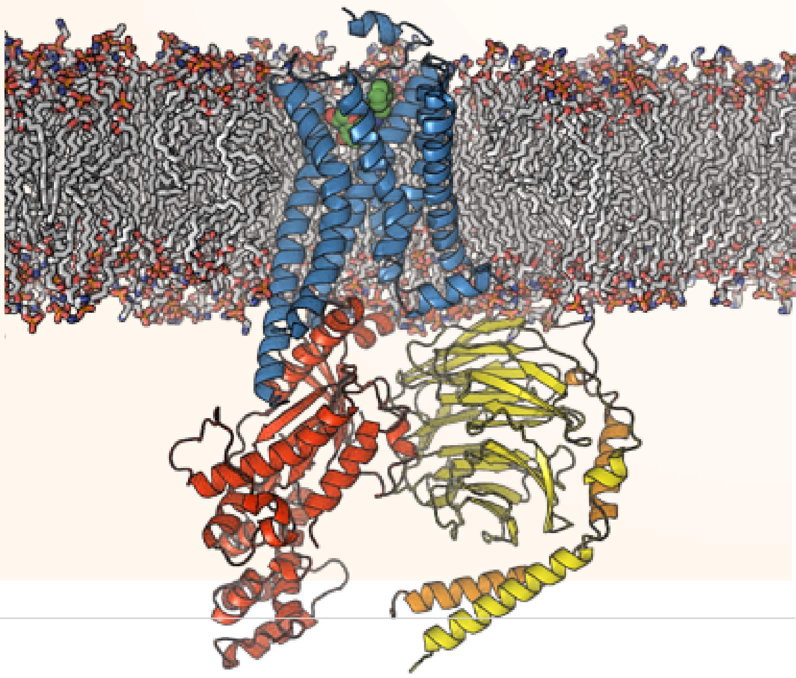
Brian Kobilka

G-protein coupled receptors (GPCRs) conduct the majority of transmembrane responses to hormones and neurotransmitters, and mediate the senses of sight, smell and taste. The β_2 adrenergic receptor (β_2AR) and the M2 muscarinic receptors are prototypical Family A GPCRs that mediates physiologic responses to autonomic nervous system activity. We have obtained three-dimensional structures of the β_2AR and the M2 muscarinic receptor in inactive and active conformations, as well as a structure of the β_2AR in complex with the G protein Gs. We have also used fluorescence, EPR and NMR spectroscopy to study the dynamic properties of the β_2AR, and to map ligand-specific conformational changes. I will discuss what these studies have taught us about allosteric regulation of GPCR structure by G proteins and ligands.

Note: What are G-protein-coupled receptors?

When you are afraid, your heart beats faster, your blood pressure rises, and you breathe more heavily. This is partly the result of adrenaline forming in your body, which causes your heart rate to accelerate. Adrenaline is a hormone, a substance that manages communication between the cells in your body. Each cell has a small receiver known as a receptor, which is able to receive hormones.

What these receptors look like and how they work remained a mystery for many years. In order to track these receptors, in 1968 Robert Lefkowitz attached a radioactive isotope of the element iodine to different hormones. By tracking the radiation emitted by the isotope, he succeeded in finding a receptor for adrenaline, which allowed him to build an understanding of how it functions. In the 1980s, Brian Kobilka successfully identified the gene that regulates the formation of this receptor. The two researchers also discovered that the receptor was similar to receptors located in the eye that capture light. It was later discovered that there is an entire family of receptors that look and act in similar ways – known as G-protein-coupled receptors. Approximately half of all medications used today make use of this kind of receptor (source: www.nobelprize.org).



Recent advances of Brazilian science and crystallography in particular

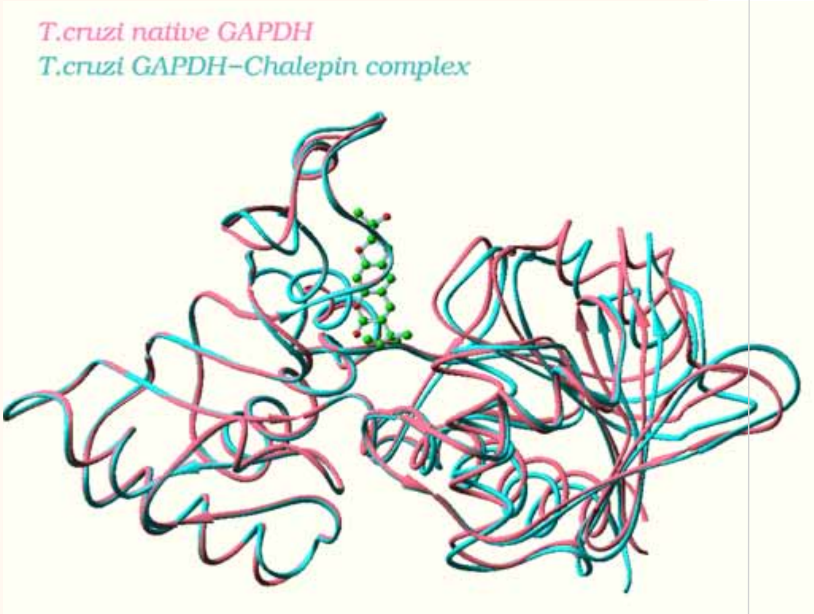
Glaucius Oliva

Brazilian science is still very young. The first higher education institutions, press and libraries were only allowed to be established in the country after the Portuguese Royal Family arrived in Brazil in 1808. The 19th century saw just a few medical and law schools being founded and the first universities were established only in the early 20th century. Science was restricted to some specialized research institutes dedicated to public health with the leadership of pioneers such as Oswaldo Cruz and Carlos Chagas.

The Brazilian Academy of Sciences (ABC) was created in 1916 and the Brazilian Society for the Advancement of Science (SBPC) in 1948; they played a fundamental role in the inclusion of science in the national agenda.

In 1951, the National Research Council (CNPq) was created with the mission to promote the development of science and technology in the country. Nevertheless, despite its short history, Brazil has already achieved important advances in science and technology, with significant impacts on our economy.

Crystallographic research was established in Brazil and originally affiliated to mineralogy. In the 1960s, Prof Y. P. Mascarenhas pioneered the introduction of structural studies of small molecules with single crystals, as well as powder diffraction. Protein crystallography only started in the 1990s, boosted by the establishment of the first synchrotron radiation source in the southern hemisphere – LNLS – in 1997. The Brazilian Association of Crystallography was created in 1972 and the scientific production in this field has grown strongly during this century, with 14,400 publications in international peer-reviewed journals having Brazil as the country of institutional affiliation of at least one author, in the period 2000–2013. Other indicators will be presented, as well as future perspectives for Brazilian science and crystallography in particular.



Crystallography in South Africa

Thomas Auf der Heyde and Catherine Esterhuysen

Crystallography in South Africa was given a solid foundation by the arrival of RW James, a close personal friend and collaborator of WL Bragg, at the University of Cape Town in 1937. In this presentation the development of crystallography in South Africa from this starting point to the current thriving, active community will be described. A short message of support from the South African Department of Science and Technology will also be provided.

Crystallography in the Russian Federation

Mikhail Kovalchuk

The 20th century was the age of ordered materials: crystals, high-ordered structures and X-ray diffraction as a method for studying and monitoring them.

Currently, we pass to irregular and disordered materials – hybrid and biomaterials first, which are constructed as a rule using convergent nano-, bio-, info- and cognitive (NBIC) sciences and technologies.

Modern crystallography is mostly based on megascience installations, such as synchrotron radiation and neutron sources. Future possibilities for a new crystallography given by an X-ray free electron laser and fourth generation synchrotron radiation will transform classical 3D crystallography into 4D crystallography (+ time-dimension) and open up the way for X-ray holography.

In this context, crystallography, with its interdisciplinary essence, offers a methodological base for the development of convergent sciences in the 21st century.

Crystallography in China

Song Gao

I present crystallography in China (mainland), its past, present and future. The study of crystallography had a difficult time before the 1970s, due to the environment and the poor available conditions for research. However, the pioneers successfully founded laboratories and organizations, trained students and researchers, and determined the crystal structure of insulin in high resolution, the greatest achievement during that period.

The last 20 years of the 20th century witnessed rapid development of crystallography in China, which covered wide research fields. Chinese scientists were able to contribute series of nonlinear optical crystals like BBO and LBO to the world; they developed the theory and applications of dielectric superlattices, helped to confirm the existence of quasi-crystals and developed direct methods. Synchrotron radiation facilities and neutron sources were under construction during this time.

Since 2000, the development and improvement of laboratory instrumentation and the availability of domestic synchrotron radiation facilities (Beijing and Shanghai) have allowed Chinese crystallographers to study various systems, from macromolecules to superconductors. Chinese structural biologists have revealed the structures and functions of proteins or protein complexes related to human diseases such as SARS, HIV and avian influenza, as well as structures and functions of light-harvesting complexes, the mechanism behind apoptosis and so on. For small molecules, Chinese chemists and crystallographers have explored a great variety of functional (magnetic, porous, optical, dielectric, etc.) molecule-based materials and their crystal engineering, with these studies making a significant contribution to CCDC. China has developed KBBF, another important and practical nonlinear optical crystal used for producing deep ultra-violet laser. Powder X-ray diffraction has been used to characterize new superconductors, minerals and to solve structures of complicated zeolites. Electron microscopy has been used to study the structures of biological macromolecular complexes, as well as oxides, intermetallic compounds and zeolites. Drug crystallography has started to develop in China. The future of crystallography in China looks bright. Today, the Chinese Crystallographic Society counts 1500 members.

From X-ray tubes to X-ray lasers

John Spence

This talk will briefly review the history of X-ray crystallography, from the early work of Roentgen, von Laue, Bragg and others, through the synchrotron era to the recent invention of the hard X-ray laser (XFEL). I will show how the discovery of the XFEL "diffract-then-destroy" effect has led to the invention of a new method of protein crystallography, which paradoxically offers a solution to the problem of radiation damage. Using very brief but highly intense X-ray pulses, it allows snapshot images of biological molecules to be obtained before the intense illumination needed to see such fine detail destroys the sample. By using such a fast "shutter speed", instead of freezing samples to avoid damage, this approach allows images of molecules to be recorded at room temperature in their native liquid environment. In addition, this high speed imaging in a stroboscopic mode offers a new approach to the making of "molecular movies" in which we hope to record images of molecular machines at work. I'll describe recent advances along these lines, drawn from work with many collaborators, applied to several important protein molecules.

These include those involved in photosynthesis (which, in all green plants, splits water to make the oxygen we breathe), an enzyme which is an important drug target for sleeping sickness, and a human 'GPCR' protein, also important for drug delivery.

Crystallography in our daily lives

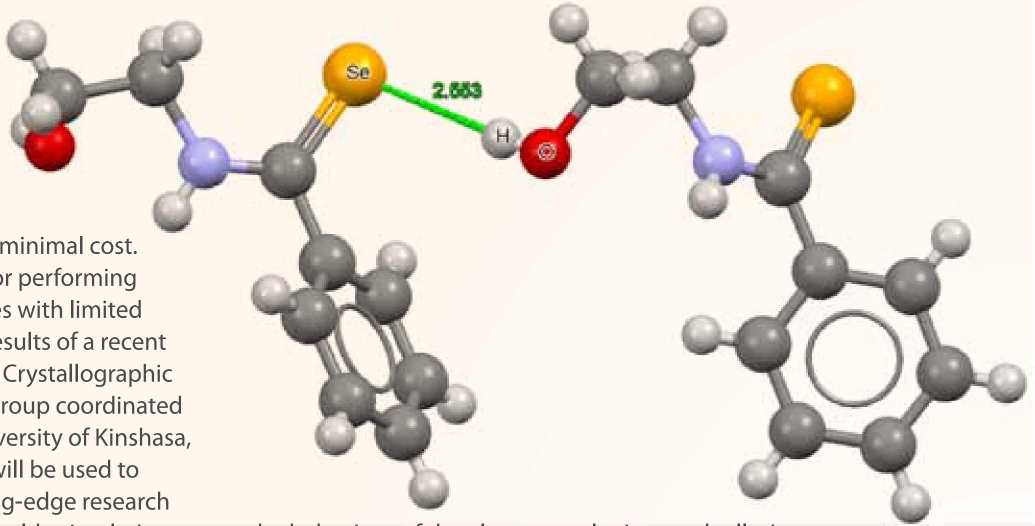
Martijn Fransen

Crystallography is everywhere in the world around us, in our daily lives. In fact, often the crystallographic properties of the products around us determine their performance. Without the knowledge of crystallography, we would not have been able to create the world around us. Crystallographic knowledge helps us to make the world a better place.

In this presentation, we will show a few examples of the importance of crystallography in our daily lives, by zooming in on a few products we all use and need on a regular basis, and explaining why crystallography determines their performance.

Crystallographic research in the developing world

Juliette Pardon



Crystallographic databases, which embody the world's molecular and solid state structural knowledge, are easy to access and can be searched and analysed via software at minimal cost. They are therefore well-suited to use for performing high-quality research in those countries with limited financial possibilities. In this talk, the results of a recent collaboration between the Cambridge Crystallographic Data Centre (CCDC) and the research group coordinated by Professor Zéphirin G. Yav of the University of Kinshasa, Democratic Republic of Congo (DRC) will be used to show that valuable, publishable, cutting-edge research can be performed in the developing world, stimulating local development. Two students, one studying for an MSc and the other for a PhD degree, are working with the Cambridge Structural Database (CSD) System and other computational chemistry resources to investigate the behaviour of the elements selenium and tellurium in intermolecular interactions, and thereby gain a greater understanding of their effects in biological, environmental and other critical systems.

The first X-ray diffraction results from another planet

David Bish

The Mars Science Laboratory (MSL) began its journey to Mars in November 2011, landing in Gale Crater on the night of 5 August 2012. Gale Crater is occupied by Mt Sharp at the center, three times higher than the Grand Canyon (USA) is deep.

MSL carries ten instruments on, or inside, the Curiosity rover, including CheMin, a miniature X-ray diffraction (XRD) and fluorescence (XRF) instrument. XRD is a well-established technique on Earth, using much larger laboratory instruments. It can provide more accurate identifications of minerals than any method previously used on the Red Planet. Curiosity delivered sieved (150 µm) samples of soil to the shoebox-size CheMin and the first XRD data were successfully measured on Mars in October 2012, coinciding with the 100th anniversary year of the discovery of XRD by von Laue.

The CheMin instrument first analysed a sample of Martian soil/dust from a dune and found that it is very similar to soils on the flanks of Mauna Kea volcano in Hawaii, containing minerals commonly found in basalts, along with amorphous or glassy material. No clay minerals were discovered in the soil, suggesting an absence of interaction with liquid water.

Subsequent XRD analyses of drilled rocks revealed the presence of clay minerals, in addition to minerals found in basalt. The level of mineralogical detail provided by CheMin was previously unobtainable and provides information on rock formation conditions. Clay minerals are consistent with formation in water. Moreover, the age of these rocks shows that Mars hosted wet environments more recently than previously thought. In addition, the particular minerals found in the drilled rocks are compatible with an environment that was potentially habitable to life, with near-neutral pH and moderate temperatures.

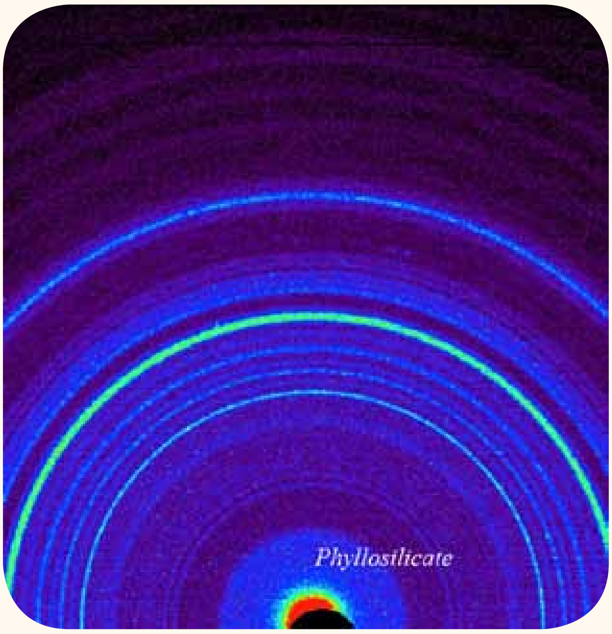
The importance of crystals in the formation and evolution of the first biogenic compounds, in their delivery to habitable zones and in the energetics of early life

David Blake

The formation of the first abiotic organic compounds in cold molecular clouds is moderated by water ice structure at every stage of star and planet formation. The local collapse of the gas, dust and water ice coated grains in these clouds formed stellar discs, the birthplace of stars and planets.

During this process, prebiotic materials were delivered to the inner rocky planets as complex organics and as organic compounds trapped in amorphous and polycrystalline ices and high-melting point clathrate hydrates.

In the near-surface environment of planets in the habitable zone, such as the Earth and Mars, the interaction of mantle minerals such as olivine with water and CO_2 also produces simple prebiotic organic compounds through Fischer-Tropsch reactions. H_2 liberated in these water-rock reactions can act as an energy source for early chemolithotrophic life. The natural oxidation of Fe in olivine to produce magnetite plus serpentine ('serpentinization') is one of a number of mineral-based redox reactions utilized by primitive organisms, the products of which can be identified and assessed by X-ray diffraction.



First X-ray diffraction pattern from another planet, 2012

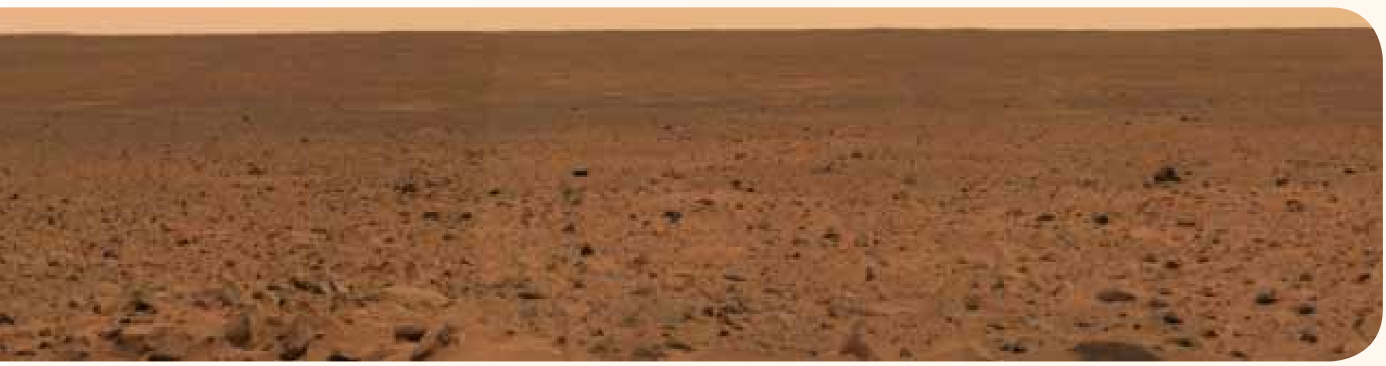
The CheMin XRD/XRF instrument on the MSL rover Curiosity was designed and built over a 20-year period to identify 'habitable environments' on Mars on the basis of the mineralogy of ancient rocks. CheMin has been actively analysing the mineralogy of rocks and soil in Gale Crater on Mars, since August 2012; this will be described in detail by my colleague David Bish (see previous abstract). On Earth, commercial portable and battery-powered 'spinoffs' of the CheMin instrument are being used in mineral, oil and gas exploration, as well as in art and antiquities conservation. They also show promise for the identification of counterfeit pharmaceuticals in developing nations.

A short history of crystallographic technology

Frank Burgäzy

From the pioneering work of Laue and Bragg to the latest synchrotron experiments of today, the technology and methods available to crystallographers have advanced tremendously over the past 100 years.

The historical developments in sources, optics, detectors and software techniques are described along with some of the key scientific discoveries that have been achieved with each new generation of technology.



Crystallography in the study of art and historical artefacts

Philippe Walter

The study of cultural heritage requires advanced techniques to shed light on ancient technologies and help in their preservation. The implementation of new analytical tools, including mobile laboratories or large-scale facilities such as synchrotron radiation and neutron sources, allows a deep insight into archaeological and artistic materials, from the millimeter to the nanometer scales.

During this lecture, I will show different applications and potential needs of crystallographic studies to characterize the nature and the mode of preparation of different pigments: origin of the minerals, chemical synthesis of new compounds, crushing of crystals, mixing of matters, etc..

The precious character of the most famous works of art and their uniqueness imply particular caution and require X-ray diffraction instruments which may give the maximum information directly on the artefacts, both in situ in a museum or at an archaeological site.

Symmetry in art and architecture of the western Islamic Golden Age

Abdelmalek Thalal

The history of the Maghreb was closely linked to that of Andalusia from the time of the conquest of Andalusia by the Arab-Berber Muslims and the establishment of the Umayyad Caliphate in the 8th century until the fall of Granada in the 15th century.

The mixture of populations of different ethnic origin gave birth to a civilization that radiated its science and culture worldwide. This brilliant civilization particularly favoured the development of an original, rich and varied art that integrated geometry into the construction of complex patterns that appear in architectural ornamentation. This highly stylized form of Moorish art has evolved over centuries from simple drawings to complex geometrical patterns involving a high degree of symmetry.

The Great Mosque of Cordoba, the madrassas of Fez and the Alhambra Palace and the Moorish architectural wonder are just some examples of historic buildings that reflect the development of art and architecture during the golden age of the western Islamic world.

Highlights of Eastern Islamic ornamental art as seen through crystallographers' eyes

Emil Makovicky

Islamic ornamental art is perhaps the richest ornamental art ever created. Although there are differences between the Eastern and Western schools, it transcended both the state boundaries and the language and national confines. We shall concentrate upon the Eastern branch of the Islamic world but we shall repeatedly compare their approach with that of Western Islam.

The glory of Islamic geometric patterns made of unglazed bricks is connected with the rule of Turcoman Seljuks in Central Asia and Iran. They adorned tomb towers and minarets. The advent of light and dark blue glaze helped to perfect these creations. In Anatolia, geology impressed upon artists another means of expression: carved ornamentation in basalt rock. Interlaced patterns are common, leading us beyond the usual plane groups of symmetry. The art of Mughal India was influenced by the availability of fine sandstones.

In Eastern Islam, artisans managed to free themselves from the world of periodic patterns for the first time at the end of the 12th century. In 1991, we described a decagonal quasiperiodic pattern adorning a Seljuk funeral tower in Maragha (Iran). Modifications from the following centuries are known today at several places in Esfahan, Konya (Turkey) and in more fragmentary form elsewhere. The depth of the artists' geometric understanding is astounding. Comparisons with quasi-periodic decagonal and octagonal patterns discovered in the west of the Islamic world are very interesting.

The discoveries of perfect-coloured glazes eliminated much of the original virtuoso geometric art in Iran. Patterns became painted on square tiles, rather than composed of brick elements. One blossoming branch of richly glazed tiling art, however, concerned the Iznik tiles from West Turkey. Detailed studies show for the first time the symmetry of tilings instead that of individual tiles and a fascinating world of application and especially misapplication of tile symmetry during the tile-laying process.

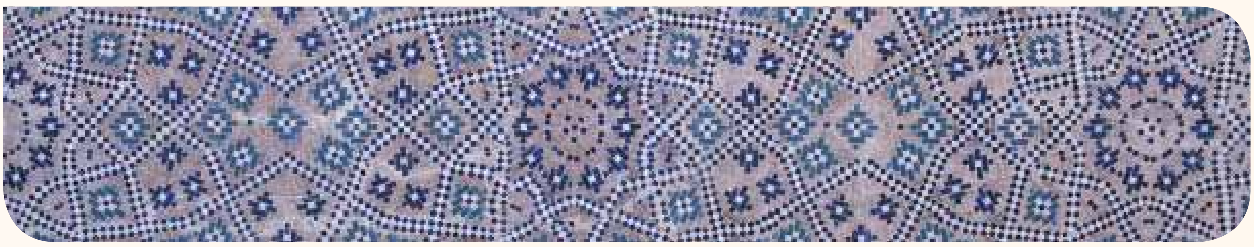
Modern math in medieval Islamic architecture

Peter J. Lu

The conventional view holds that girih (geometric star-and-polygon) patterns in medieval Islamic architecture were conceived by their designers as a network of zigzagging lines and drafted directly with a straightedge and a compass.

I will describe recent findings that, by 1200 CE, a conceptual breakthrough occurred in which girih patterns were reconceived as tessellations of a special set of equilateral polygons (girih tiles) decorated with lines.

These girih tiles enabled the creation of increasingly complex periodic girih patterns, and by the 15th century, the tessellation approach was combined with self-similar transformations to construct nearly-perfect quasicrystalline patterns. Quasicrystal patterns have remarkable properties: they do not repeat periodically, and have special symmetry and were not understood in the West until the 1970s. I will discuss some of the properties of Islamic quasicrystalline tilings, and their relation to the Penrose tiling, perhaps the best known quasicrystal pattern.



IUCrJ and crystallography working across nations

Samar Hasnain

The establishment of the International Union of Crystallography (IUCr) and its first journal *Acta Crystallographica* is a clear demonstration of nations working together. Lawrence Bragg and Max von Laue were the first elected President and Honorary Presidents of the IUCr, respectively, with Paul Ewald as the founding editor of *Acta Cryst*. A century after the first Nobel prize in Crystallography, IUCr has launched the 'all inclusive' science journal *IUCrJ*.

I will also briefly highlight two relatively modern examples of nations working together, synchrotron radiation sources and Collaborative Computational Project 4.

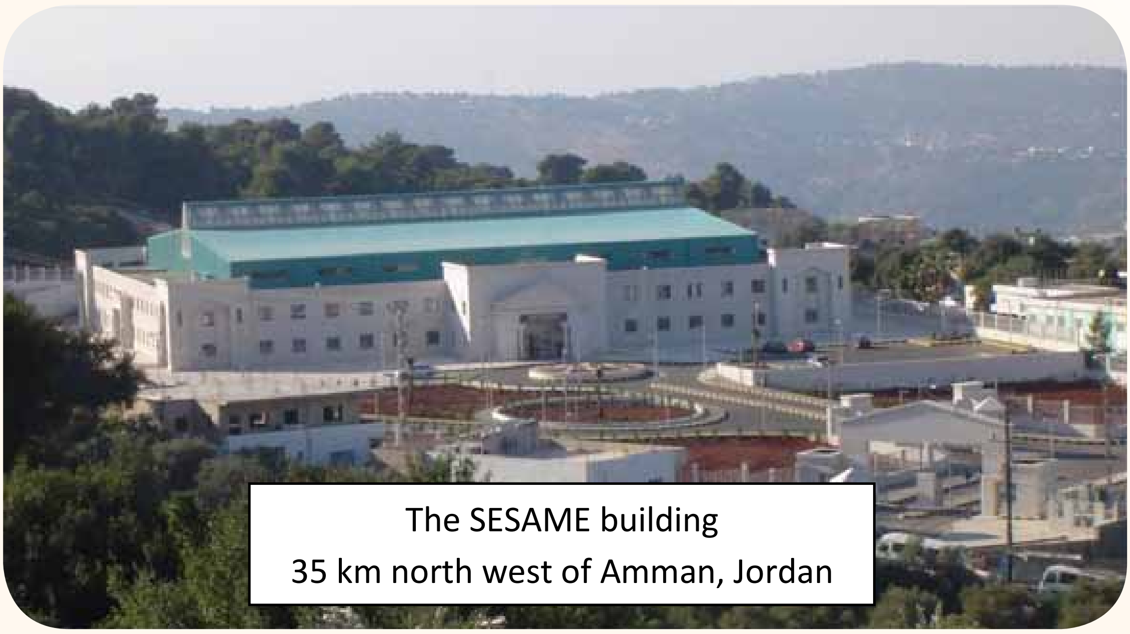
SESAME: Fostering science, building bridges

Chris Llewellyn Smith

SESAME (**S**ynchrotron-light for **E**xperimental **S**cience and **A**pplications in the **M**iddle **E**ast) is a 2.5 GeV third generation synchrotron light source under construction in Jordan. The Members are currently Bahrain, Cyprus, Egypt, Iran, Israel, Jordan, Pakistan, the Palestinian Authority and Turkey. SESAME will:

- foster world-class scientific research in the Middle East and neighbouring countries, in fields ranging from medicine and biology, through materials science, physics and chemistry, to the environment, agriculture and archaeology;
- build cross-border collaboration, dialogue and understanding between scientists with diverse cultural, political and religious backgrounds; and, it is hoped,
- reverse the brain drain that is holding back science education and research.

SESAME was created 'bottom-up' by scientists, who persuaded their governments to join. It is modelled on CERN and was set up under the auspices of UNESCO. SESAME is on track for commissioning to begin in late 2015 or early 2016, although challenges remain. After outlining the origins of SESAME, I will describe the project's status and the initial experimental programme.



The SESAME building
35 km north west of Amman, Jordan

International Basic Sciences Programme of UNESCO

Maciej Nalecz

All UNESCO's activities in the basic sciences are conducted under the umbrella of the International Basic Sciences Programme, including the preparation, coordination and monitoring of relevant international years. The International Year of Crystallography follows the Year of Mathematics (1999), the Year of Physics (2005) and the Year of Chemistry (2011) and precedes the International Year of Light (2015).

The International Year of Crystallography therefore adds another brick to the edifice of advocacy for the basic sciences. The aim is to raise awareness of science and demonstrate the benefits that science can bring society. Advocacy may take the form of science education, the popularization of scientific achievements, linking advances in the basic sciences to technological progress, or shining the spotlight on the key role that science and the resulting technologies play in sustainable development.

International years are not simply a one-year celebration of a given discipline. Rather, they produce many long-term, sustainable activities that continue well beyond the year. Take the example of the International Year of Physics (2005), which led to the introduction of a training programme at UNESCO on Active Learning in Optics and Photonics.

This programme continues to this very day within the International Basic Sciences Programme, in close collaboration with the Abdus Salam International Centre for Theoretical Physics and with funding from the International Society for Optics and Photonics (SPIE).

Similarly, the International Year of Chemistry gave birth to the Global Water Experiment, which involved school pupils from around the world in measuring the purity of water using disposable micro-analytical kits. This experiment has since been incorporated in the chemistry curriculum of secondary schools in many countries. The International Year of Chemistry has also spawned the Green Chemistry for Life programme, implemented by the International Basic Sciences Programme, in close collaboration with the International Union of Pure and Applied Chemistry and financed by the Russian fertilizer producer PhosAgro.

The International Year of Crystallography will be no exception. For instance, the open laboratories being initiated by UNESCO and the International Union of Crystallography in 2014 are intended to operate long after the year is over, in the form of training hubs in crystallography for developing countries.

Biological crystals

Moderators

Neil Ford has 30 years of professional experience, roughly divided into three parts: as an award-winning broadcast journalist in Canada, reporting on economic development and cultural identity; as a grass-roots activist in the developing world, designing partnership and governance strategies to give marginalized people a voice in their own development; and, thirdly, as a media and communication specialist in the United Nations system. He designs and delivers communication and partnership strategies that support freedom of expression, emphasize gender equality and enable young people to claim rights and participate effectively in decision-making.

Philip Ball is a freelance writer. He previously worked for over 20 years as an editor for *Nature*. He has authored many books on the interactions of the sciences, the arts and wider culture, including *The Self-Made Tapestry*: *Pattern Formation in Nature*; *Bright Earth: the Invention of Colour*; *Critical Mass* and; *The Music Instinct.*

Speakers

Welcoming remarks, 20 January 2014

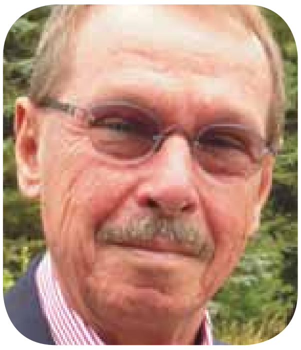
Irina Bokova has been Director-General of the United Nations Educational, Scientific and Cultural Organization (UNESCO) since 2009. She was elected to a second four-year term in 2013. Ms Bokova is a former Minister for Foreign Affairs of Bulgaria and Coordinator of Bulgaria–European Union relations (1995–1997). She is also a former Ambassador to France and to UNESCO.

Gautam Desiraju is Professor of Chemistry at the Indian Institute of Science in Bangalore and President of the International Union of Crystallography (2011–2014). He has published around 375 papers and is one of the highest-cited Indian scientists. He is a member of the editorial advisory boards of the *Journal of the American Chemical Society*, Angewandte Chemie and Chemical Communications, and is one of the main editors of the IUCr's new open-access journal, IUCrJ. He has been awarded the Humboldt Forschungspreis and the TWAS award in chemistry.

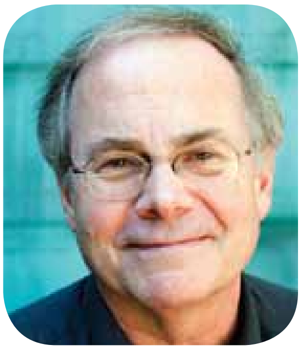
Alain Fuchs was appointed President of the French Centre national de recherche scientifique (CNRS) in January 2010. He had previously been Director of the Ecole nationale supérieure de chimie de Paris since 2006. He is also past president of the Physical Chemistry Division of the Société française de chimie and the Société française de physique (2002 to 2005). Prof. Fuchs is a Knight of the French Legion of Honour (2010). He is also a member of the Academia Europaea and a Fellow of the Royal Society of Chemistry.

Nicole Moreau is past president of the International Union of Pure and Applied Chemistry. Since 2005, she has been Secretary of the Maison de la chimie Foundation International Prize Committee. She was Director of Research at the French Centre national de recherche scientifique (CNRS) until 1993, when she was appointed Full Professor at Pierre and Marie Curie University (Paris 6). Six years later, she took up a post as Professor at the Ecole nationale supérieure de chimie de Paris (ENSCP), where she joined the CNRS Lab on Selective Organic Syntheses and Natural Products.

Born and educated in New Zealand, **John Dudley** carries out research at the CNRS research institute Franche-Comté Electronique, Mécanique, Thermique et Optique – Sciences et Technologies (FEMTO-ST) and the University of Franche-Comté in Besançon, France. He studies various areas of optics and nonlinear physics and is currently co-laureate of a European Research Council Advanced Grant for studying extreme events. He is Fellow of the Institute of Electrical and Electronics Engineers (IEEE), the European Optical Society and the Optical Society of America. He is involved in science education via a number of professional societies worldwide and is currently President of the European Physical Society.



Walter V. Maresch is President of the International Mineralogical Association (2011–2014). He was born in Europe, grew up in Canada and received degrees in geology and geophysics, as well as in mineralogy, from the University of Toronto, Princeton University and the Ruhr-Universität Bochum. He has been a Research Scientist in experimental petrology, Associate Professor of Petrography and Economic Geology, and Chair of Petrology at the Universities of Bochum and Münster in Germany. His main interests lie in the crystal chemistry of rock-forming minerals and in the petrology of high-pressure rock and fluid-rock systems. His methodology is both laboratory- and field-oriented.



Gregory A. Petsko is an American biochemist and member of the National Academy of Sciences. He is the Gyula and Katica Tauber Professor of Biochemistry and Chemistry at Brandeis University. He is past president of the American Society for Biochemistry and Molecular Biology. In April 2010, he was elected to the American Philosophical Society. Prof. Petsko's research interests lie in protein crystallography. He is co-author with Dagmar Ringe of Protein Structure and Function. He is also the author of a monthly column in Genome Biology modelled after an amusing column in *Current Biology* penned by Sydney Brenner.

Claude Lecomte is Professor of Physics and Crystallography and Emeritus Professor since 2013. Past president of the French Crystallographic Association (1997-2002), he is currently Vice-President of the International Union of Crystallography, where he is in charge of the Crystallography in Africa Initiative and the IUCr contribution to the Open Lab project with UNESCO. He is the founder of the CNRS–Université de Lorraine CRM2 laboratory in Cristallographie, resonance magnetique et modélisations, which he directed from 1995 to 2013. Past president of the European Crystallographic Association (2000–2003), he is the laureate of the 2010 Max Perutz Prize awarded by this association. His research concerns advanced crystallography for electron density analysis and application.

Milestones in crystallography and future perspectives

Christian Brönnimann is founder and CEO of Dectris Ltd, the world's leading company for detectors for X-ray diffraction. He obtained his PhD in High Energy Physics from the Paul Scherrer Institut in Villigen (Switzerland). In 1997, he began developing hybrid pixel detectors for the Swiss Light Source. After the breakthrough with the first large area Pilatus detector in 2005, he decided to commercialize its development. In 2006, he founded Dectris together with three partners. The business of supplying fast, large area and reliable detectors for synchrotron applications grew very rapidly. By the end of 2013, Dectris had more than 50 highly qualified employees. Currently, 650 detector systems are used at synchrotrons and in lab sources around the world, the vast majority of them for challenging diffraction experiments.

Jenny Pickworth Glusker studied at Oxford University, working with Dorothy Crowfoot Hodgkin on the crystal structure of a derivative of vitamin B_{12}. This helped lead to the chemical formula of that vitamin. After working on peptide structures at Caltech under Robert Corey and Linus Pauling she went to Philadelphia to work with Lindo Patterson at Fox Chase Cancer Center. She has remained there and worked on crystal structures of biochemical interest, including antitumor agents and carcinogens and their possible interactions with DNA, several enzyme mechanisms, and the X-ray and neutron structures of the enzyme xylose isomerase.

Nobel laureate lecture by Brian K. Kobilka

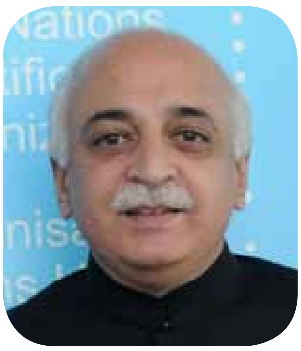
Jules Tenon has been Professor of Physics at the Félix Houphouet-Boigny University since 1986 and currently directs the Crystallography and Molecular Physics Laboratory. He teaches quantum mechanics, atomic physics and molecular modeling. His research currently focuses on the structural determination of compounds derived from benzimidazole and molecular modelling. He is in charge of the IUCr–UNESCO Open Lab to be implemented in Côte d'Ivoire.

Judith Ann Kathleen Howard CBE, FRS, is a distinguished British chemist, crystallographer and Professor at Durham University, where she leads the Single Crystal X-ray crystallography group. Her research focus is on materials and structural chemistry; this spans a wide range of activities but pivotal is the elucidation of molecular structure by diffraction techniques. In the laboratory this means by X-ray diffraction using single crystal or powder techniques.

Brian Kobilka graduated from Yale University School of Medicine (USA) in 1981, before completing residency training in Internal Medicine at the Barnes Hospital at the Washington University School of Medicine in St Louis, Missouri. From 1984 to 1989, he was a postdoctoral fellow in the laboratory of Robert Lefkowitz at Duke University. In 1990, he joined the faculty of Medicine and Molecular and Cellular Physiology at Stanford University.
Prof Kobilka was awarded the Nobel Prize in 2012 'for studies of G-protein-coupled receptors', the subject of his lecture at the opening ceremony.

Crystallography in emerging nations: success stories and the role for development in the BRICS countries

Hao Ping has served as Vice-Minister of Education. He is a Full Professor at Peking University and holds a PhD in international relations. He is currently President of the 37th General Conference of UNESCO.



Vinay Sheel Oberoi is Ambassador and Permanent Delegate of India to UNESCO.

Thirumalachari Ramasami has been Science and Technology Secretary of India since 2006. Prior to this assignment, he served as the Director of the Central Leather Research Institute in Chennai. He is a distinguished researcher and leather scientist. In 2001, he was awarded India's National Civilian Honour, the Padma Shri, for excellence in science and engineering. In 1993, he was awarded the Shanti Swarup Bhatnagar Award, the highest award for science in India, for notable and outstanding research in chemical sciences.

Glaucius Oliva is Full Professor at the Institute of Physics of São Carlos within the University of São Paulo, where he also directs the Center for Research and Innovation on Drug Discovery. He is President of the Brazilian National Council for Scientific and Technological Development (CNPq). Since obtaining his PhD in Protein Crystallography from the University of London in 1988, his main research interests have been structural biology and its application to drug design and discovery, with a particular focus on parasitic infectious tropical diseases that affect the population of Brazil and other developing countries.

Thomas Auf der Heyde is currently Deputy Director-General of the South African national Department of Science and Technology. In the past, he has held teaching, research and executive management posts at the Universities of Johannesburg, the Western Cape, Cape Town, Berne, Cambridge and Princeton. He trained as a crystallographer and structural chemist with Luigi Nassimbeni, Hans-Beat Buergi, Frank Allen and Kurt Mislow.

Catherine Esterhuysen is President of the South African Crystallographic Society. She joined the University of Stellenbosch as a lecturer in 2000 and was co-editor of Acta Crystallographica E from 2006 to 2012. During her studies at the Rand Afrikaans University in Johannesburg, she developed an interest in computational chemistry. Today, her main focus is the study of intermolecular interactions, combining her knowledge of crystallography with computational chemistry to explain unusual interactions.

Mikhail Kovalchuk is Director of the Kurchatov Institute, a national research centre in the Russian Federation. A Doctor of Physical and Mathematical Sciences, he is Member of the Russian Academy of Sciences, Member of the Council for Science and Education under the President of the Russian Federation, Chair of the National Russian Crystallography Committee (Russian Crystallographic Association) and Editor-in-Chief of the *Crystallography Report*.

Gao Song is President of the Chinese Crystallographic Society. He was a Humboldt Research Fellow in TH Aachen in 1995–1997. He has been Cheung Kong Professor in College of Chemistry and Molecular Engineering at Peking University since 2002 and served as Dean of this college between 2006 and 2010. He is currently Vice-President and Provost of Peking University. He was elected a member of the Chinese Academy of Sciences in 2007 and a TWAS Fellow in 2013. He is currently Editor-in-Chief of *Inorganic Chemistry Frontiers*. His research interests lie in molecular magnetism, molecular and crystal engineering.

Crystallography for society and the future, 21 January 2014

Johannes Friso van der Veen was appointed Full Professor of Experimental Physics at ETH-Zürich in May 2000. He is head of the Research Department of Synchrotron Radiation and Nanotechnology at the Paul Scherrer Institute and Deputy-Director of the same institute. Born in The Netherlands, he graduated from the University of Utrecht before holding positions at the FOM-Institute for Atomic and Molecular Physics and the University of Amsterdam. His passion is to promote synchrotron radiation science and instrumentation at the Swiss Light Source and elsewhere.

John Spence is Director of Science for BioXFEL, the US National Science Foundation's Science and Technology Center for application of X-ray lasers to Biology, a consortium of six Universities in the USA. He teaches Condensed Matter Physics at Arizona State University, with a joint appointment at Lawrence Berkeley Laboratory. John was recently awarded the Burger Medal of the American Crystallographic Society and the IFSEM Cowley Medal in electron microscopy. He completed a PhD in Physics in Melbourne and postdoc at Oxford, UK. He a Main Editor of IUCrJ, fellow of Churchill College, APS and AAAS. He is the author of texts on electron microscopy and about 470 papers; his group currently focusses research on sample-delivery and data analysis techniques for time-resolved diffraction at EXFELs.

Martijn Fransen works for PANalytical, the only Dutch company supplying X-ray diffraction equipment for analysing the crystallographic properties of matter for materials research and production control purposes to virtually all countries in the world. He holds a PhD in Applied Physics from the Technical University of Delft (Netherlands) and has been involved in the development of scientific instruments for more than 20 years. In his current role, he is responsible for the worldwide product management and strategy of PANalytical's X-ray diffraction product portfolio.

Juliette Pradon is a Research and Applications Scientist at the Cambridge Crystallographic Data Centre (CCDC), Cambridge (UK). Upon completing her PhD in Molecular Modelling at the University of Bristol in 2009, she spent two years studying pharmacophore methods at Eli Lilly pharmaceutical research centre at Windlesham (UK), before joining the CCDC in 2011. Dr Pradon has twice visited Kinshasa so far to provide training in the use of the CSD System. She acts as the students' co-supervisor with Professor Zéphirin G. Yav of the University of Kinshasa (Democratic Republic of Congo).

Sunday Asuquo Thomas is Director-General of the Sheda Science and Technology Complex of the Federal Ministry of Science and Technology, in Abuja (Nigeria), where he coordinates research and development activities at a multidisciplinary centre. He holds a Doctor of Philosophy degree from the School of Molecular Sciences at Sussex University in Brighton (UK), which he obtained following work on X-ray diffraction studies of both some inorganic and organic molecules, under the supervision of Ron Mason. His research interests have been mainly tied to single crystal and powder diffraction studies of materials and the structure/activity relationship.

David Bish is the Haydn Murray Professor of Mineralogy at Indiana University (USA). He previously worked at the Los Alamos National Laboratory from 1980 to 2003. David has received several awards for his research in clay mineralogy and has been president of several mineralogical scientific societies. He is the author of numerous publications on mineralogy and the application of X-ray powder diffraction to geological and mineralogical problems. His Mars X-ray diffraction work began in 1991 through collaboration with David Vaniman and David Blake.

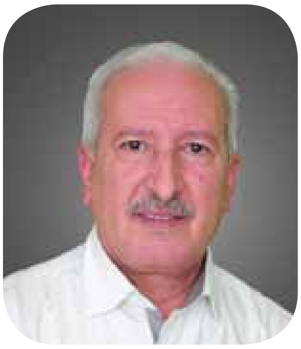
David Blake holds a PhD in Mineralogy from the University of Michigan (USA). As a NASA scientist, he studies the biogenic elements from their origin in stars to their incorporation into prebiotic compounds and early life. He received NASA's Exceptional Scientific Achievement medal in 1998 for his work on astrophysical ices and the origin of biogenic compounds. He is the Principal Investigator of the CheMin XRD/XRF instrument on the Mars Science Laboratory rover Curiosity. He received NASA's Outstanding Leadership Medal in 2013 for his 22-year development of the CheMin instrument, which resulted in the first quantitative mineralogy of the Mars surface and discovery of the first habitable environment on Mars.

Frank Burgäzy received his PhD degree from the Max-Planck-Institute for Metal Research in Stuttgart, Germany, for his studies of the electronic structure of high temperature super-conductors. He has over 24 years' experience in the development of advanced analytical X-ray technologies at Siemens and Bruker. He currently serves as President of Bruker AXS, one of the world's leading manufacturers of laboratory X-ray equipment.

Diego Lamas has been President of the Argentinian Association of Crystallography since 2011 and is Coordinator of the X-ray National System of the Ministry of Science, Technology and Productive Innovation. An Independent Researcher for the Argentinian National Council for Scientific and Technical Research (CONICET), he is Associate Professor at the National University of Comahue in Neuquén, Argentina. He received his PhD from the University of Buenos Aires in 1999. He was head of the Solid-Oxide Fuel Cells group at this centre from 2001 to 2010 and leader in the fields of nanomaterials and synchrotron radiation techniques.

Philippe Walter is Director of the Laboratory of Molecular and Structural Archaeology (CNRS/UPMC) in Paris. This year, he is also holder of the chair in technological innovation at the Collège de France. He is currently developing new analytical tools adapted to the study of ancient materials, using synchrotron radiation and home-made portable instruments. His main research interests focus on the use of pigments and the elaboration of new painting materials through time. He holds a PhD in Geochemistry from Paul Sabatier University in Toulouse (France). In 2010, he was awarded the Franklin-Lavoisier prize in Philadelphia (USA).

Crystallography, symmetry and art



Hocine Merazig is Professor of Inorganic Chemistry and Crystallography. He is Head of the Division Chemistry of Materials and X-ray Diffraction within the research unit Environmental and Structural Molecular Chemistry (CHEMS) at the Faculty of Science of the University of Constantine 1 (Algeria). He is Director of the Centre of X-ray Diffraction of the research unit CHEMS and Vice-President of the eastern branch of the Algerian Association of Crystallography. His research focuses on the synthesis of inorganic, organometallic and hybrid materials and X-ray diffraction and crystal structure resolution.

Emil Makovicky received his PhD in 1970 from McGill University in Montreal (Canada). He was appointed Associate Professor in Mineralogy and Crystallography at the University of Copenhagen (Denmark) in 1972 and Professor in 1995. He studies mineral sulfides, important for metallurgy and solid-state science. His specialities are modular crystal structures and syntheses in sulfide phase systems important for mineral deposits. Outside the mineral realm, he has performed symmetrological studies of ornamental art, especially Islamic art: Hispano-Islamic art in Andalusia and Morocco and the art of Iran and Turkey, especially quasiperiodic patterns.

Abdelmalek Thalal is Professor at the Deparment of Physics at Cadi Ayyad University in Marrakech (Morocco). He obtained a PhD in Material Sciences from Pierre and Marie Curie University (Paris 6) in France. His research focuses mainly on powder ceramics, art and crystallography.

Peter J. Lu received his PhD in Physics in 2008 from Harvard University, where he is presently a postdoctoral research fellow. His main focus is on the physics of attractive colloids and the integration of high-performance imaging and analysis techniques. He has conducted a series of experiments aboard the International Space Station, examining phase-separation of colloid mixtures in the absence of gravity. He has also published his discoveries of modern quasicrystal geometry in medieval Islamic architectural tilings; the first precision compound machines, from ancient China; the first use of diamond, in prehistoric China; and the first quasicrystalline mineral found in nature.

Crystallography and peace

Samar Hasnain obtained his PhD in 1976 from the University of Manchester, working on the first generation synchrotron source, NINA. He then spent a year at DESY in Hamburg before joining the UK's team establishing the world's first dedicated synchrotron radiation source in 1979. During the early 1980s, he was fortunate to work with Max Perutz and Sir John Pendry, among others. In 1989, he established the Molecular Biophysics group at Daresbury, where he remained head until March 2008 when he moved to the University of Liverpool as Max Perutz Professor of Molecular Biophysics, establishing Barkla Laboratory of Biophysics in 2011, named after Liverpool's X-ray Nobel prize winner Charles Glover Barkla (1917). He is the founding Editor of the IUCr's *Journal of Synchrotron Radiation*. Since September 2012, he has been Editor-in-Chief of the IUCr journals.

Chris Llewellyn Smith is Director of Energy Research at Oxford University (UK) and President of the Council of SESAME. He has chaired the Council of the International Thermonuclear Experimental Reactor, directed the UK's fusion programme and served as Provost and President of University College London and Director General of CERN (1994–1998) at a time when the Large Hadron Collider was approved and construction started. He has written and spoken widely on science funding, international scientific collaboration and energy issues, and served on numerous advisory bodies. His scientific contributions to theoretical high energy physics and leadership have been recognized by awards and honours worldwide.

Closing remarks

Maciej Nalecz is a biochemist with over 200 scientific papers. An elected Member of the Polish Academy of Sciences and Letters (1998) and European Academy of Arts, Sciences and Humanities (2003), he is former Director of the Institute of Experimental Biology of the Polish Academy of Sciences (1990–2001) and former Chair of the Fellowships Committee for the Federation of European Biochemical Societies. He proposed and coordinated the creation of the International Institute of Molecular and Cell Biology (Warsaw), under the auspices of UNESCO (1995). As Director of UNESCO's Division for Basic and Engineering Sciences since 2001, he has played a crucial role in the development of a synchrotron light source in the Middle East, within the SESAME Project. He was also the architect of UNESCO's International Basic Sciences Programme, of which he is Executive Secretary.

Open Labs and Open Factories: a lasting legacy of the Year

The IUCr–UNESCO Open Labs are a network of operational crystallographic laboratories that will be based in different countries worldwide from 2014 onwards, many of them in Africa, South and Central America and South Asia.

These Open Labs are being planned in partnership with major equipment manufacturers. At the moment, the main partners are: Bruker, Panalytical, Agilent, STOE, Dectris, Xenocs and CCDC.

The purpose of the Open Lab project is manifold:

- in threshold countries, the idea is to encourage the purchase of advanced instrumentation;
- in hub countries, the idea is to increase the technological base and spark interest in youngsters;
- in less privileged countries, the idea is to start some crystallographic activity.

Different types of laboratory are planned:

Open Lab Type 1

These are new installations of crystallographic instrumentation, to allow the birth of new crystallographic research centres. These will act as hubs for hosting university students and researchers from neighbouring countries. Type 1 Open Labs are planned for 2014 in Côte d'Ivoire, Uruguay and, most likely, in Ghana.

Open Lab Type 2

These Open Labs are based in research centres where crystallographic instrumentation is already operational. These laboratories will host workshops, tutorials and hands-on experiments for students and young professors coming from the host and nearby countries. This is a provisional list of countries interested in hosting a Type 2 Open Lab in 2014: Algeria, Argentina, China (Hong Kong), Colombia, Republic of Congo, Ghana, India, Kazakhstan, Mexico, Pakistan, Uruguay Vietnam.

Travelling Lab

A portable instrument will move through different locations in a country and at each stop it will serve as the basis for a crystallographic school, including tutorials about the use of the instrument and related software. A travelling lab is being implemented in Morocco in 2014.

Open Factory

Workshops will be held in the factories of the diffractometer manufacturer companies. These workshops will be open to students and young professors who already have some background in crystallography. They will also focus on technical aspects and maintenance of crystallographic instrumentation.

Young scientists invited to apply for first Open Factory

The first Open Factory will take place from 10 to 19 September 2014. Participants will receive seven days of intensive training by STOE, DECTRIS and Xenocs staff and guest scientists, in cooperation with the IUCr. In Grenoble (France), delegates will spend a lot of time at the European Synchrotron Radiation Facility (ESRF) and will be trained in small-angle X-ray scattering at Xenocs' headquarters. In Darmstadt (Germany), participants will be trained in single-crystal and powder XRD at STOE's headquarters.

The programme is free of charge for delegates, as STOE, DECTRIS and Xenocs will cover round-trip flights from the delegates' home country, accommodation, food and transport costs.

Candidates should be young scientists who are already knowledgeable about crystallography but have, so far, less exposure to XRD.

Candidates should submit their written application, including a CV, letter of recommendation and declaration of motivation, before 30 March 2014.

For details, please visit www.iycr2014.org/openfactory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Maciej Nalecz, Director, Executive Secretary of IBSP – m.nalecz@unesco.org

Jean-Paul Ngome Abiaga, Assistant Programme Specialist – jj.ngome-abiaga@unesco.org

Ahmed Fahmi, Programme Specialist – a.fahmi@unesco.org

Francesco Glorioso, Consultant

Magalie Lebreton-Traoré, Programme Specialist

Lucy Hoareau, Programme Specialist

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Susan Schneegans, Editor

Blanca Gutierrez

Susanne Pote

IUCr

Gautam R Desiraju, Indian Institute of Science, Bangalore (India), President of the IUCr – desiraju@sscu.iis.ernet.in

Claude Lecomte, Université de Lorraine, Nancy (France), Vice President of the IUCr – claude.lecomte@crm2.uhp-nancy.fr

Michele Zema, University of Pavia (Italy), IUCr Project Manager for IYCr2014 – mz@iucr.org

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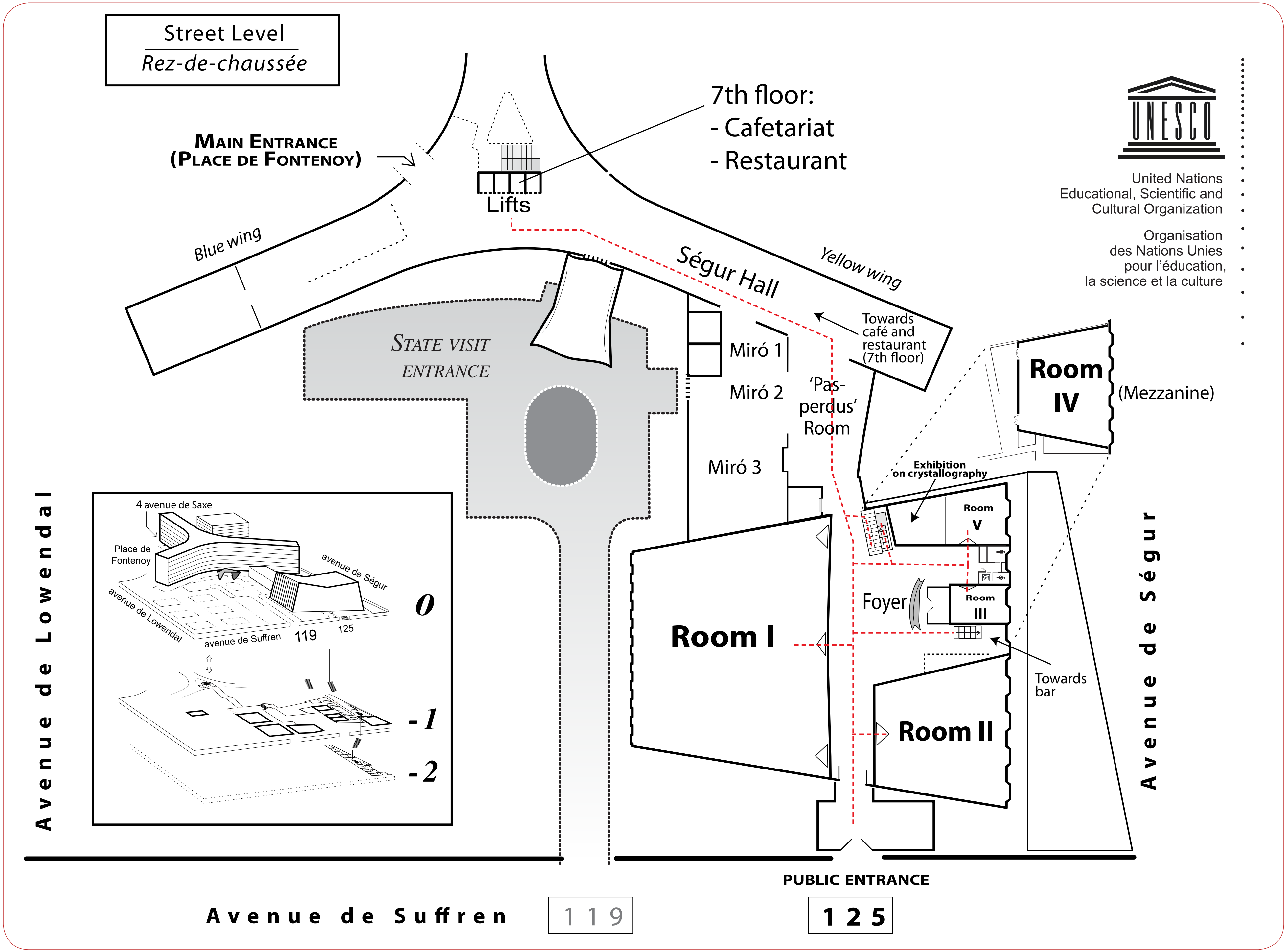
Street Level
Rez-de-chaussée
MAIN ENTRANCE
(PLACE DE FONTENOY)
Lifts
7th floor:
- Cafetariat
- Restaurant
United Nations
Educational, Scientific and
Cultural Organization
Organisation
des Nations Unies
pour l'éducation,
la science et la culture
Blue wing
Ségur Hall
Yellow wing
Towards
café and
restaurant
(7th floor)
STATE VISIT
ENTRANCE
Miró 1
Miró 2
Miró 3
'Pas-
perdus'
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IV
(Mezzanine)
Exhibition
on crystallography
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Foyer
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III
Room I
Room II
Towards
bar
4 avenue de Saxe
Place de
Fontenoy
avenue de Ségur
avenue de Lowendal
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PUBLIC ENTRANCE
125