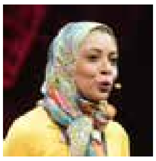
MAY 2017

NEWSLETTER 35

Italian National Institute for Nuclear Physics

INTERVIEW



NEWS

FOCUS

» INTERVIEW

A NEW LIGHT IN THE MIDDLE EAST IS ON

Interview with Gihan Kamel, researcher at the international laboratory SESAME, Jordan

Palestinian National Authority, Cyprus, Egypt, Iran, Israel, Jordan, Pakistan and Turkey met on May the 16th in Allan, Jordan, to inaugurate SESAME (Synchrotron Light for Experimental Science and Applications in Middle East), the multidisciplinary international laboratory that they have founded and built as a common project. In addition to the members of SESAME, the ceremony was attended by the Observatory Countries - Brazil, Canada, China, European Union, France, Germany, Greece, Italy, Japan, Kuwait, Portugal, Russia, Spain, Sweden, Switzerland, United Kingdom and the United States - including Italy, which stands out for being the only one that devoted an ad hoc contribution to the project, which has been allocated through the Ministry of Education, University and Research (MIUR) and managed by INFN. The Italian contribution was used to realize the four radio frequency chambers, which are fundamental parts of the electron accelerator, and the detector for one of the machine's light lines. This was possible thanks to the collaboration of INFN and Elettra Sincrotrone Trieste. Thanks to the national contribution, moreover, the reception and supporting facilities for scientists are being finalized.
At the opening ceremony we met Gihan Kamel, a SESAME researcher of Egyptian origins, who completed her training in Italy, first at Sapienza University in Rome and then at the INFN National Laboratories of Frascati (LNF), where she worked at the Dafne Sincrotron. Today Gihan Kamel is responsible for the SESAME's infrared light line.

What's SESAME?
SESAME is the 3rd generation accelerator of the Middle East built in Jordan following the model of CERN. This unique facility is approaching the completion after a long journey that started in 1997 when SESAME was founded. The project aims to not only foster the scientific capabilities and excellence in the Middle East and the neighbouring regions and reverse the brain-drain

» INTERVIEW

issue for many countries in the region, but also to build bridges between people living in this hot zone. As any other Synchrotron-light sources, SESAME is a super microscope allowing different experimental techniques, thanks to beamlines, powerful enough to reveal vital details about physics, chemistry, biology, pharmaceuticals and biomedicine, as well as, materials science, archaeology and cultural heritage. Being in the Middle East, SESAME has to be competent enough to attract the scientists to come back to the region. The accelerator scientific value is so high that it has stimulated conflicting Members to collaborate in producing science for the benefit of their societies.

Whom does SESAME represent a resource for? And Why?
SESAME is a wonderful opportunity for the scientists of the Middle East and also of the neighbouring regions, since it gives them the chance to advance their professional career, at the same time that it allows them to stay in or close to their home countries. Having it this way, an important fraction of the brain-drain problem can be solved, bringing us back for the benefit of our home countries. This in turn, will foster the collaboration between different scientific groups in the region, and will definitely strengthen the relationships between societies. Moreover, this may also create some space for the European or elsewhere scientists. Nevertheless, the interaction between all the scientists should be always maintained and coming back to the Middle East should not, by any means, lead to segregation or cutting the links with the rest of the world, because this is what will keep us moving on the right way. When nations rely on diplomatic relations to overcome their economic or political issues, scientists and academics can contribute in their own way to decision-making and can create a more peaceful and equal world. SESAME is a good start and a huge source of motivation for us, the scientists, to contribute effectively in solving various problems facing our region through a high-level scientific research. At a certain level of our scientific career, we need to feel that we are really participating and offering practical solutions to our societies, in the different fields. This is because synchrotron radiation is opening up new scientific opportunities that have a direct influence on public health issues - including pollution, food and agriculture, not only focusing on the present and the future, but also helping us to understand the historical past of the region, shedding light on the archaeological and the cultural heritage treasures, for instance.
In addition to that, we should always keep fighting for women rights in the region to have a better education and a remarkable future. SESAME proved to be a major push for female scientists to enhance their professions. We can not deny that the overall situation is much better than years ago, but we have also to admit that it is not the best yet. We have to face our problems in order to be able to solve them. While female Arab scientists are bravely fighting for their dreams, many are still constrained as, unfortunately, they cannot travel abroad or they can only travel to Arab countries. I experienced this in some cases and this is why I strongly believe that SESAME

» INTERVIEW

will open the door for them and for many other women, giving them a priceless opportunity to accomplish their goals and to serve their societies with an equal and hard capacity.

Who will be the future SESAME users?
SESAME is open not only for the Middle East and neighbouring regions' scientists, but also to European scientists through basic collaboration schemes or the facility call for proposals. So far, collaborations are presented either as individual researchers' category or as national teams of researchers. However, because of the complementarities between the different research groups in the region that appear because of the mutual discussions of the SESAME annual Users' Meetings, they are foreseen to set joint project. Research areas constituting SESAME scientific programme are covering a wide range, from life to materials' sciences, biomedicine and diseases' diagnosis aided by drug design characterization, to archaeology, cultural heritage and environmental issues. Other users are also focusing on nanotechnology and electronics. The staff number is still limited, but with the operation that is ongoing, this number is expected to increase, as there is a growing need to cope with the upcoming stage of scheduled experiments. We had many users who were able to conduct many scientific projects in other synchrotron light sources via the coordination of SESAME. Many were also trained abroad, and the number is increasing according to the annual statistics.

How did you get involved in the project?
I visited SESAME in 2005 for the first time just to attend its annual Users' Meeting out of curiosity. Then, starting from that time, I had a passion about SESAME that was mixed with a doubt, just like anyone who follows the news every day! In the following years, it was worthy to see where the scepticism would take me, but eventually, year-by-year, I saw that wonderful things could happen in the region by having such a facility. In 2012, I was nominated by the Egyptian Academy of Scientific Research and Technology to represent Egypt in the SESAME Users' Committee. In 2014 I was appointed as a researcher for one year on the Infrared beamline at Dafne synchrotron facility, at the INFN National laboratories of Frascati, where I was exposed to the practical uses of the synchrotron radiation and mastered the handling of the infrared microspectroscopy technique. This opportunity was my gate to apply for the infrared beamline position at SESAME, and I was selected to start the job in late 2015. On the scientific level, I loved the fact that with this unique radiation, it is possible to do almost anything: you can jump from medical applications to electronic devices, to plants studies to Egyptian papyri or Iranian parchments, something that gives you an exciting motivation and feeds your curiosity!

What do you work on at SESAME?
I am responsible for the construction and operation of the Infrared beamline, that is the first

» INTERVIEW

completely new beamline at SESAME in collaboration with the French Synchrotron, SOLEIL. I also assist SESAME users to conduct their experimental projects using the infrared micro-spectroscopy technique starting from the measurements' stage and ending up with the data analysis and interpretation.
In parallel, launching and coordinating some regional long and short-term projects as well as different in house research activities.

Which are SESAME next steps?
SESAME is undergoing the commissioning stage. It will start with two beamlines: the infrared micro-spectroscopy beamline (IR), dealing with life and materials sciences together with cultural heritage experiments, and the X-ray Spectroscopic based beamline (XAFS/XRF), with a research program focusing on material science and environmental studies. The installation of the beamlines is progressing significantly with expected operation in 2017 upon coupling with synchrotron radiation. The scientific programme with the synchrotron radiation is to start by the end of 2017 with full operation of those two beamlines.

How does the collaboration on such a project involve people coming from many countries and different cultures?
Science in its essence should level up our beliefs, it should unite us and it should take us to a common destination for the benefit of others and ourselves. It is challenging to work at SESAME, but if we think of SESAME as an international scientific research facility, things will move on in the right direction. Who cares about the nationality or the religion of Galileo, Newton, Einstein, Fermi, Raman, Abdus Salam, Ibn Al Haytham? I hope no one does! Inside SESAME, there are no borders. You can see differences, nevertheless you don't really feel them, unless you intend to do so. Something brings us together. We, scientists, engineers, technicians, administrators, are all working everyday for our facility, and we are waiting impatiently to make it operating. We have no time and no space for contrasts. ■

INTERNATIONAL AGREEMENTS
DARK MATTER: INFN AND IHEP SIGN AGREEMENT FOR THE NEW SPACE TELESCOPE HERD

The cooperation between Italy and China for dark matter research is confirmed and strengthened. During the bilateral meeting of May 9th between INFN and IHEP (Institute for High Energy Physics) of Beijing, the two Institutes signed the letter of interest to participate in the HERD (High Energy Cosmic Radiation Detection) experiment.

HERD is one of the main science projects of the Chinese Space Station, which involves the construction of a new powerful space telescope. The scientific objectives of HERD, whose launch is planned for 2020, are dark matter particle detection, cosmic ray composition analysis and high energy gamma ray observation. The main characteristics of the future detector are its total weight, which will be less than 2 tons, and its total energy consumption, which will be less than 2 kilowatts. To achieve its scientific objectives, HERD must be able to measure with great accuracy the energy and direction of origin of electrons and gamma rays, i.e. high energy photons (from tens of GeV up to 10 TeV), and the energy of cosmic rays, also determining their charge (up to the PeV scale). HERD will be able to detect high energy gamma rays, electrons and cosmic rays with a higher resolution compared to current telescopes: this implies that the experiment has great potential in contributing in an innovative manner to the understanding of the origin and propagation of high energy cosmic rays, and to the identification of possible "signatures" left by dark matter particles, but also to new discoveries in the field of so-called "high energy gamma-ray astronomy". ■

INTERNATIONAL AGREEMENTS
ASTROPARTICLE PHYSICS: AGREEMENT SIGNED IN ARGENTINA IN THE PRESENCE OF PRESIDENT MATTARELLA

It's called ANDES and will be a large underground research infrastructure, like the INFN Gran Sasso National Laboratories, the largest underground laboratories in the world dedicated to astroparticle physics. The only difference with respect to this last is that instead of being under the massif of the Apennines it will be built in the Agua Negra tunnel in the Andes. This is the main project included in the agreement that was signed on May 10th, in San Carlos de Bariloche in Argentina, in the presence of the President of the Italian Republic, Sergio Mattarella, the President of INFN, Fernando Ferroni, and the President of CNEA (Comisión Nacional de Energica Atomica), Osvaldo Calzetta Larrieu. The new agreement, which specifically regards research in astroparticle physics, is part of the Memorandum of Understanding signed by the two scientific institutes in 2015 and concerns, in particular, three international projects: the ANDES Laboratory, the Pierre Auger Observatory and the QUBIC (Q-U Bolometric Interferometer for Cosmology) Observatory. Within the scope of ANDES, INFN will provide an important contribution to the construction of the new underground laboratory, thanks to the thirty years of experience acquired by the Gran Sasso National Laboratories. INFN will thus provide its knowledge and skills acquired in training people and in the design and construction of experimental prototypes. For the Pierre Auger Observatory project, INFN will be responsible for the surface scintillators, while for the QUBIC Observatory for its cryostat.

INFN and CNEA will subsequently develop a more generally coordinated and joint action in the field of research in astroparticle physics: this action will cover everything related to the training of graduate students and technicians, basic and applied research, technology development and deployment of new equipment, techniques and methodologies. ■

RESEARCH
XENON1T IS THE MOST SENSITIVE DETECTOR FOR THE DIRECT SEARCH FOR DARK MATTER

The highest sensitivity ever achieved in the direct search for dark matter: this is the record set by XENON1T, the data acquisition experiment at the Gran Sasso National Laboratories (LNGS) of INFN, the largest underground laboratories in the world dedicated to astroparticle physics.

The results, obtained with a short run of 30 days and presented on May 18th to the scientific community, make XENON1T the most sensitive experiment in the world for searching for so-called WIMPs (Weakly Interacting Massive Particles), which are among the candidates to constitute dark matter particles.

Many astrophysical observations have strengthened the hypothesis of the existence of dark matter, leading to a global effort to try to directly observe its interactions with ordinary matter particles, thanks to very high sensitivity detectors. These interactions, nevertheless, are so rare and weak to have so far impeded their direct detection, prompting scientists to build increasingly large and sensitive detectors.

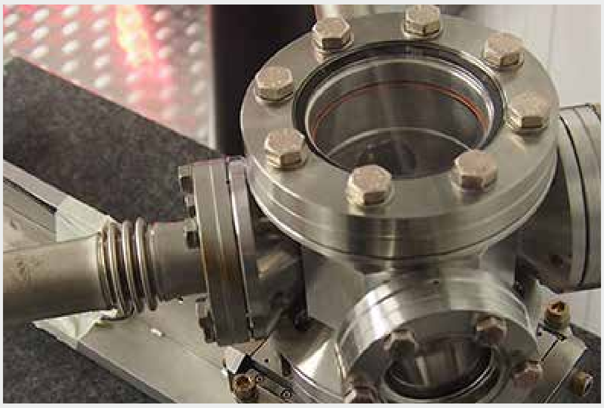
The recent results of XENON1T show that the detector has the lowest level of radioactivity ever achieved, by many orders of magnitude less than that of the materials surrounding it on Earth. With a total mass of approximately 3,200 kg, the detector is also the largest of its kind ever built. The combination of the significant increase in mass with a lower background contamination of the possible dark matter interaction signal provides an excellent chance of discovery in the years to come.

The XENON scientific collaboration consists of 135 researchers from USA, Germany, Italy, Switzerland, Portugal, France, Netherlands, Israel, Sweden and the United Arab Emirates. ■

INTERNATIONAL EVENTS
THE INFN AT THE ITALY-AUSTRALIA FORUM OF SCIENCES AND INNOVATION

On 15 May 2017, the first Italo-Australian science and innovation forum was held, organised by the Italian Embassy and the Australian Department of Industry, Innovation and Science. The event was attended by about a hundred Italian and Australian researchers from INFN, represented by the Vice President Antonio Masiero, from EGO, represented by the Director Federico Ferrini, and from ASI, INAF, ENEA, CNAO and OGS. Many were the topics addressed, from the detection of dark matter to gravitational waves and space technologies; much interest has also been placed in hadron therapy for the treatment of cancer and marine sciences.
Italy is today the eighth scientific partner of Australia and there are 190 bilateral agreements in place between universities and research institutes of the two countries which have enabled a significant increase in the number of joint scientific publications over the past 10 years, currently standing at 8,000. The future projects discussed include Ska, ET, the development of an Australian research programme on gravitational waves, part of a global infrastructure project with LIGO-Virgo in the northern hemisphere and the launch of an underground laboratory (the first in the southern hemisphere) in close cooperation with the Gran Sasso laboratory.
Thanks to this forum, it was possible to complete the bilateral agreement for cooperation in science and technology between Australia and Italy signed a few days later, on May 22nd, by the Italian Ambassador in Canberra, Pier Francesco Zazo, and the Australian Minister for Industry, Innovation and Science, Arthur Sinodinos. ■

» FOCUS



GINGERINO: THE MOST SENSITIVE METER OF THE EARTH'S ROTATION IS AT THE GRAN SASSO LABORATORIES

In the bowels of the Gran Sasso, under 1,400 metres of rock, in addition to the big experiments for dark matter and neutrinos research, the INFN National Laboratories are home to the world's most sensitive instrument for measuring the Earth's rotation. We are speaking of Gingerino (Gyroscopes in General Relativity), a device whose unique features will enable researchers to test a particular aspect of General Relativity: the Lens-Thirring effect. The phenomenon, one of the consequence of Einstein's Theory, predicts that in its rotational motion, the Earth deforms the spacetime grid, twisting it in the direction of its movement. The effect has never been comprehensively verified experimentally because it has virtually unperceivable implications. As a consequence of the spacetime torsion, in fact, a change in the speed of Earth's rotation of less than one billionth of a degree per second is expected: a change so small as to require measuring instruments with extremely high accuracy.
A prototype of what will be the most powerful and sophisticated final experiment (GINGER), Gingerino consists of a laser gyroscope, a kind of ring of light that can measure the tiniest variation in the rotation of the planet. The instrument uses two laser beams that run along the perimeter of a 3.6 x 3.6 metre square, guided by a set of perfectly smooth mirrors. Moreover, to protect the electronics of the instrument against humidity, Gingerino is enclosed in a sort of thermal cradle, a sealed chamber heated with infrared lamps. The spacetime distortion due to the rotation of the Earth influences – as predicted by General Theory of Relativity - the path of the laser beam which runs in the direction of the rotation, slightly increasing its extension and thus giving rise to a difference in the path of the two beams. A difference which, although equal to only a few billionths of a metre, is sufficient to change the frequency of the photons by a measurable quantity.
Although the accuracy needed to confirm the effect has not yet been reached, the optimisation of the Gingerino prototype is an excellent result and an absolute record: ensuring unprecedented levels of sensitivity and robustness, it allows the instrument to work continuously for months without the need

» FOCUS

for intervention and to detect the slightest alteration in the Earth's speed of rotation.
An initial confirmation of the Lens-Thirring effect, still with quite a large margin of error (5%), came in 2016 thanks to the Lageos and Lares satellites, launched by NASA and the Italian Space Agency (ASI). The previous result, obtained in 2011 by the Stanford Gyroscope Experiment, Gravity Probe B (GPB), produced an agreement with the predictions of the General Theory of Relativity with a margin of error of 19%. The expected accuracy of GINGER in measuring the Earth's drag would reduce the margin of error to 1%, thus allowing the phenomenon predicted by Einstein's GTR to be confirmed. To reach this result, GINGER's experimental data will be also compared with data collected independently by IERS (International Earth Rotation and Reference Systems).
The data coming from Gingerino, and in the future from GINGER, will also be useful in many areas. Besides proving the spacetime distortion caused by the Earth's rotation, the instrument will, for example, be able to measure the solid tides caused by the gravitational attraction of the Moon and the rotation transmitted to the ground by seismic waves, a hitherto little studied aspect of earthquakes which, thanks to Gingerino, has already been monitored and measured during the earthquake that struck central Italy. ■

ITALIAN NATIONAL INSTITUTE FOR NUCLEAR PHYSICS

CONTACTS

Communications Office
comunicazione@presid.infn.it
+ 39 06 6868162

Cover
SESAME, the 3rd generation accelerator of the Middle East, in Jordan