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Communication
project by
Gaetano Ferretti

Revolutionary discoveries

After Higgs boson, it's gravity waves' turn. Italy is actively participating in international studies and research activities.

Speech by the Nobel **John C. Mather**

Foretold by Albert Einstein in 1916, gravitational waves, so long awaited for over 20 years, were finally observed by the two Ligo antennae, in the United States, on 14 September 2015, precisely at 11.51 hours. The recorded activity only lasted for two tenths of a second, but marks the birth of gravitational astronomy, a revolutionary way to listen and sound the Universe. With the fusion of two black holes, 36 and 29 times the mass of our sun respectively, located in a far distant galaxy at 1.3 billion light years from the Earth, the gravitational wave, called GW15.09.14., made the two Ligo antennae's vibrate, like an immense cosmic diapason. Let us see together how. After almost five months of prudent verification, on last February, 11 this clamorous discovery was announced by the international group operating in the two Ligo laboratories, at Livingston, Louisiana, and at Hanford, Washington, to the whole world. The Italian-French team at the Virgo laboratory, created in 2003 at Cascina, near Pisa, also cooperates with processing the data produced by the passage of this incredible wave. Until now light has always been our principal messenger for understanding the Universe. Today gravitational waves afford a new and promising instrument to understand it. These audible frequencies – of a different nature to light – could have the ability to reveal the various unresolved enigmas of the Universe, comprising its aspect upon birth, and to finally trace back to the famous Big Bang. We should remember that the first 380,000 years of life of the Cosmos are still entirely obscure for us, because they came before light was formed. So let us follow the course of the wave, like a sports commentary: the GW15.09.14 arrives in the sky of the southern hemisphere on 14 September 2015 and crosses Earth. Both the United States Ligo antennae's pick up its passage in an extraordinary manner. The gravitational wave originated from the fusion of two black holes, located at about 1.3 billion light years from Earth, orbiting the one around the other at 200,000 km/second, before merging together. The signal observed corresponds to the seven last circles of this ritual dance. The wave propagates in the Universe at the speed of light, dilating and contracting outer space, thus making the distances vary. The presence of gravitational waves is observed by measuring the small perturbations produced by the waves at their passage in space-time. The Ligo antenna in Louisiana was the first to pick up the signal. Thanks to the characteristics of this recording, the team succeeded in deducing the mass of celestial bodies at the origin of the signal.

3,000 kilometres away, the other Ligo station at Hanford, in the State of Washington, registered the same signal exactly seven thousand seconds afterwards. If it had been travelling at the speed of light this signal should have arrived in ten thousand seconds. This difference indicates the provenance of the gravitational wave to us. Our Virgo antennae, in Toscana, did not register the signal, but the international team is taking part in the complex data processing. We must remember that these gravitational waves had been foreseen by Einstein in his article published in 1916 (Gravitationswellen) and their existence had been demonstrated in the 70's and 80's by Joseph Taylor, Jr. and by his colleagues, as being possible, when a powerful cosmic activity deforms space/time. And this is the case of the two black holes on 14 September 2015. But what are these invisible celestial bodies? Black holes are what remain of big stars, after their explosion in supernovae at the end of their life cycle. In short, black hole it becomes, it is not born. Ligo's discovery is very special also because picking up this gravitational wave is the first tangible evidence of the real existence of black holes. It is moreover the tangible proof of Einstein's Theory of Relativity, occurring at a distance of 1.3 billion light years from Earth. Many consider that the Ligo team should be awarded the Nobel Prize. ■

-P.Antolini-

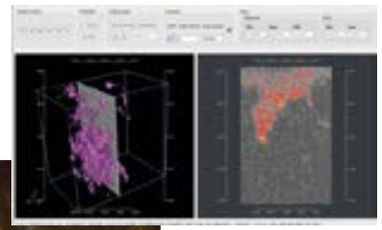
PH: ESA - CHRISTOPHE CARREAU

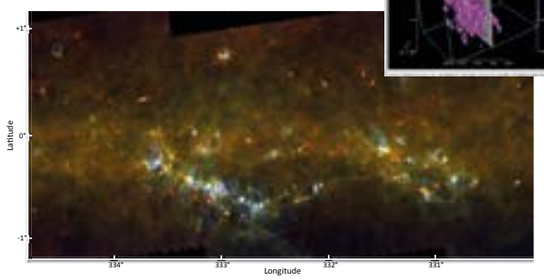
LISA Pathfinder Esa in outer space

The recipe for the formation of stars

The Vialactea Project reconstructs the map of our galaxy

The Milky Way – our home in the cosmos – is a complex ecosystem where a cyclic process of transformation brings together diffused matter to form clouds and compact filamentary structures. These then fragment, due to the action of gravity and of turbulence, to produce dense star embryos which in turn form new masses of stars which then, at the end of their lives, give back to the galaxy material that is chemically enriched with new elements which are essential for life. The Vialactea Project was designed to achieve in-depth understanding of how our galaxy functions to form stars. It shows the relationships between the differing physical agents responsible for triggering the start up and the regulation of the formation of stars. The final goal is to define a true "recipe for the formation of stars" as a cornerstone on which to build our ability to trace the history of star formation in the universe. To make this goal come true, Vialactea is organizing and using, in a coordinated and homogeneous way, a knowledge base with all of the main data bases that have been accumulated on our galaxy in the last 20 years of observation, both terrestrial and from space, from infrared wave length to radio waves, reconstructing the complete three dimensional distribution of all the star nurseries through the use of new 3D image instruments and integrated scientific analysis.



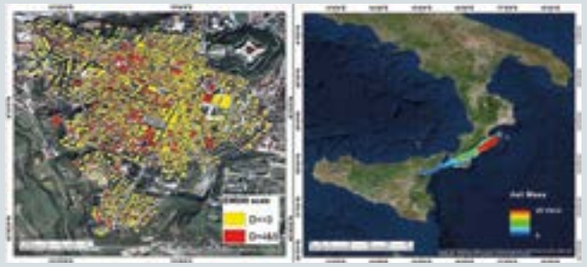


VIALACTEA IS A PROJECT FINANCED BY THE SEVENTH FRAMEWORK PROGRAMME OF THE EUROPEAN UNION WITH CONTRACT #607380

Volcanos and earthquakes

Predicting them to be able to preserve our habitat, and human and economic activities

Aphorism (Advanced procedures for volcanic and seismic monitoring) is a project financed by the European Community under the Frame Programme 7 (Fp7) in the "Space" category, headed by the Istituto Nazionale di Geofisica e Vulcanologia (Ingv). Aphorism aims at supplying reliable answers to Europe regarding the safety of human habitat, economic activities and the improvement of actions to mitigate the risks due to natural disasters such as earthquakes and volcanic eruptions, in certain key areas (for example, civil aviation safety and earthquake management). Aphorism is part of the European strategy to improve the Space industry over the long term. The project is developing innovative methods based on the integration of sensors and data collected from the ground and orbiting satellites, to support the management of seismic and volcanic emergencies. The objective is to prove that "remote" and ground data collection, if properly managed and integrated, can provide better performance in accuracy and quality of information. The methods and products made by Aphorism are tested in certain areas which are prone to a high seismic or volcanic risk. The multidisciplinary approaches put forward in Aphorism imply the use of a range of satellite and sensory platforms never used before, so as to supply an abundance of information from multi-source and multi-frequency data. This variety and abundance of data will allow us to make a significant step forward in the characterisation of investigated and measured parameters. Aphorism is contributing to the supply to end users and decision-making bodies relevant products for their activities. Lastly, Aphorism will be the basis for the next H2020 projects of Earth Observation.



Exploring the universe with X-rays

European satellites and instruments for galaxies, Smes and schools

High energy astrophysics is the science that explores the chaotic and energy-rich universe. Ahead (Integrating Activities in High Energy Astrophysics Domain) is the benchmark project designed to enhance its community within Europe. It is funded by the European Union within the framework of the multi-year programme Horizon 2020, with the aim of strengthening research infrastructure in Europe. The Ahead consortium, spearhead of high energy astrophysics for the European Union, includes representatives from 26 European institutions, including a company in the space sector. It was set up in September 2015 and will continue until February 2019. The project, coordinated by Professor Luigi Piro, director of research at the Institute of Astrophysics and Space Planetology in Roma (Inaf) will develop technologies and associated research infrastructure for high energy astrophysics. Professor Piro explains: "The construction of space satellites with sophisticated instruments is our daily bread and we must join forces to optimise the technology, the methods for testing future instruments and understand how to make the most of the data supplied by high-level observers already present in space". Ahead's milestone is the Athena mission, the massive X-ray space observatory that will be launched by Esa in 2028. Why are X-rays essential for understanding the universe? "Because - explains Professor Piro - about 50% of the ordinary matter within the universe, or rather the same atoms and protons that make up our system, is not stars or galaxies as we see them, but scolding hot gas, millions of degrees in temperature, which permeates the universe in a structure similar to a spider web, and that gives rise to galaxies. At such high temperatures, this gas is seen only with X-rays. But that is not it. Thanks to innovative X-ray detectors we can also study the symbiosis between blacks holes and galaxies and investigate the formation of the first stars of distant universe some 13 billion years ago. In fact, X-rays perform tomography of the atmosphere present at the beginnings of the universe". For this reason, the Ahead project is developing ultra-sensitive cryogenic detectors to observe X-rays and measure with extreme precision the energy of each photon X. Ahead also supports studies to explore new applications for its cutting-edge technologies, such as diagnostics of materials and biological samples in a low-dose system. This gives scientists and aerospace engineers of research institutes, as well as small and medium enterprises, free access to the best analysis and calibration experimental equipment in order to promote their technological advancement. Ahead also supports training projects on data analysis, programmes for scientists and spreading awareness to schools. On the website ahead.iaps.inaf.it you can find full details on programmes and membership opportunities for scientific institutes and private companies.

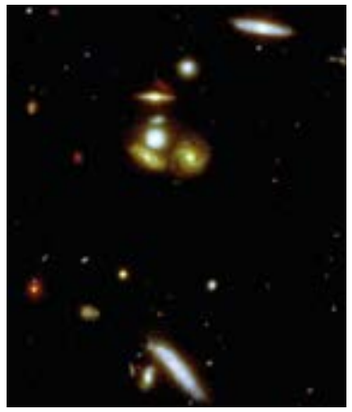
Luigi Piro

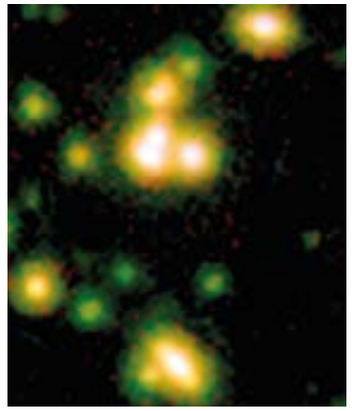
From the space come the answers on the future

Astrodeep, the power of deep images

It is said that a picture is worth a thousand words. This is also true in astrophysics: images from telescopes tell us the most important history of all, that of the entire universe. By observing objects that are further and further away - whose light comes from billions of years ago - you can rebuild history, back in time almost to the moment of the Big Bang. The images that allow this, in astronomy slang are called "deep" images. The Astrodeep project was started with an ambitious goal: to put European astrophysics in a position of leadership in the use of these deep images. In order to do this, researchers developed new technology for the analysis of the images, to then apply them to the data from the best Esa and Nasa satellites, and telescopes on the Earth. The main problem they faced can be seen in the photographs accompanying this article. These show a small part of a deep image, a tiny slice of a piece of sky the size of one ten-thousandth of the moon, taken by the Hubble Space Telescope. The objects that can be seen are galaxies, of various size and shape, from 3 to 12 billion light years away from earth. This is data that tells us how the progenitors of the Milky Way and other nearby galaxies were. To study them better, we have to match them with those from other telescopes on earth and in space, like those on Nasa's Spitzer satellite, as shown in the figure. Unfortunately, as these images were obtained with a different wavelength from Hst, the images have the same quality, but a lower resolution. Astrodeep has tackled this problem by developing new techniques of "deconvolution" on the images to recover hidden information in the more confusing ones. The principle is to use the best images as the main information which is used to bind in a statistically rigorous manner the analysis of the lower resolution images. To obtain these results, they formed an international team including young researchers from many European and non-European countries. They combined their know-how and mathematical image analysis techniques, statistics and astrophysics. Thanks to Astrodeep's results, researchers can rebuild the history of the galaxies with a never-before achieved precision. The future effects of these developments are important.

Adriano Fontana





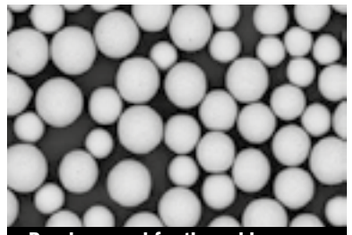
Primordial galaxies

The technology developed by Astrodeep has been adopted by the Esa for the analysis of satellite Euclid, which will be launched in 2020, to resolve the mystery of "dark matter" and "dark energy". In the meantime they are also studying how to extend their image analysis techniques into other areas of research, including medical applications like the automatic recognition of skin lesions which could turn into cancer. The adventures in deep space have only just begun...

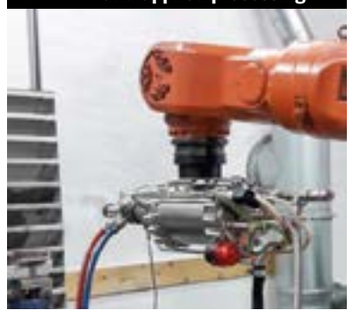
Prolong aeroplane's life with a new surfacing

Corsair studies the possibility of extending aeroplane's service life with cold spray

The current aeronautical situation is marked, if you will for the changed economical picture or for problems of environmental impact, by the tendency to use aeroplanes for longer than the time estimated at the project stage: this can only be done by establishing and applying repair and maintenance techniques for parts damaged during service, for wear or unforeseen incident phenomena, which must be sustainable from an economic and environmental point of view. The Cold Spray Radical Solutions for Aeronautic Improved Repairs (Corsair) research programme, coordinated by Professor Mario Guagliano, Department of Mechanics at the Politecnico School in Milano, with the participation of 12 partners (comprising Airbus, GE Avio, Iberia, Impact Innovations and Twi) funded by the European Union's 7th Framework Programme (FP7), studies the applicability of cold spray to this end. Cold spray is a new solid state surfacing based on the ability of powders, shot against a surface at supersonic speed, to adhere to the impacted surface. The energy required is far less than the standard heat surfacing techniques. Not only, cold spray is free from toxic waste typical of the other techniques used to this end. Corsair studies the microstructural and mechanical characteristics of materials repaired in this way, the definition of applicative protocols and development of a portable unit able to repair on site, saving even further on costs, time and impact with each job.



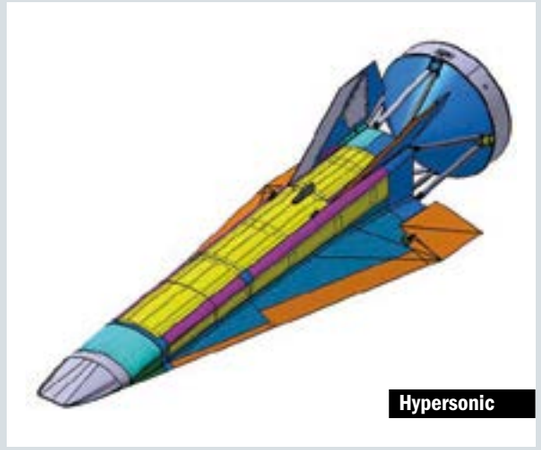
Powders used for the cold spray and applied processing



High speed flight test

Hexafly: the UE-ESA project for the development of the future aircraft

Travelling at speeds eight times higher than current commercial transport aircraft seems an achievable goal thanks to the extensive research in this area. In a not too distant future, it will be possible to reach Tokyo from Europe in just two hours or a roundtrip to Australia in one day. Europe is at the forefront of the development of fast transportation system thanks to the joint effort of the European Space Agency and the European Commission, which funded the project Hexafly whose purpose is to develop a flying demonstrator able to reach eight times the speed of sound. Not only Hexafly will use technologies developed in Europe, but Italy, through the Italian Aerospace Research Centre, has the leadership role of designing the aircraft. Thanks to its experience in the field of hypersonic flight, CIRA has been entrusted, in fact, the task of defining the innovative configuration of the hypersonic aircraft, its aerodynamics and thermal loads resulting from the high temperatures generated at high speed. C.I.R.A. will also host the integration and final assembly of the demonstrator. The European partnership is made up of 18 partners including three SMEs from Campania Region. In addition, Russia and Australia are also supporting the project. The project will end with the demonstration flight in 2018.



Hypersonic

Pure hydrogen from organic waste

This is the goal of the BioRobur Project which has already been tested on a big-sized plant

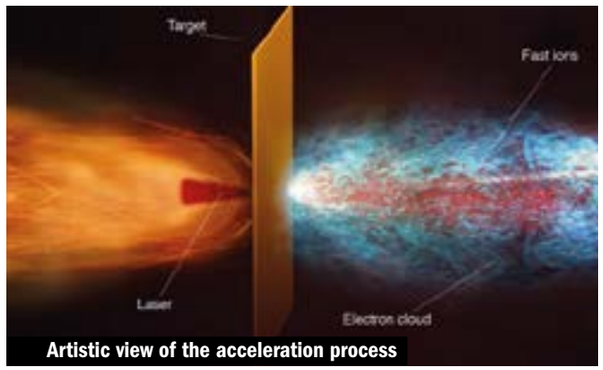
Just a few weeks are left till the end of the BioRobur European Project coordinated by Debora Fino, a professor of Chemical Systems at the Torino Polytechnic, and the enthusiasm is making itself felt. "The project will reach its conclusion at the end of August, and the final meeting is planned for the end of July right here in Torino – explains Fino -. I am very proud of this because, after three years of work, I can say that we have reached 90% of the objectives that were set, and in the weeks that are left I think we will reach all of them, 100%". A result which was not to be taken for granted, also because the goal of the work group – eight European partners, among which were universities, research centers, and small to medium-sized companies – was decidedly complex, and namely, to produce hydrogen with an elevated level of purity, starting from the direct reforming of the gas produced by anaerobic digestion of organic waste. In other words, this meant finding the modes and the reactors necessary to obtain pure hydrogen from organic waste, a result that was stimulating both in terms of research as in its immediate practical environment also at production levels. "The main original aspect of our project was this – Fino goes on – because normally during the reforming process carbon dioxide is eliminated to convert only methane as the synthesized gas. We, instead, started with everything to then obtain hydrogen and carbon monoxide using the process of auto-thermal reforming". Their goal, moreover, had two objectives – it was not intended to just produce hydrogen with a high grade of purity, but also to design a demonstration plant which would process the biogas "without using commercial catalysts with a high content of noble metals, but rather by using more economical systems which benefit the process and its cost. We used new materials both from the support point of view and for the catalysts for the reforming process". And this is precisely the aspect where the project is achieving big results. Having started off by testing powdered catalysts, the work team took an almost two times greater leap in scale. From powders for a reactor structured to be the size of a small half liter water bottle, they were then able to confirm the process on systems selected from among the most performing even on a big scale, resulting in 50 Nm3/h (100 Kg/day) of hydrogen produced. "And this system, in a demonstrative scale – which is testing stronger and better performing catalyst material – is producing better results compared to the smaller scale, as was expected. The whole month of August is still left to carry out tests of longer duration, but the results obtained up till now already open up great prospects. In spite of the fact that ours is a big plant at research level, the results obtained can already be commercialized in the near future. Certainly, now it would be necessary for a big industrial company to produce these catalysts as a mission, and invest in the concept, and make it more solid. We have made an innovative plant which was financed by the European Community, which has become a reality which only desires to be put to work".

Fuel processor

The aim is to...accelerate

A project of the Politecnico di Milano explores new techniques of particle acceleration

Is it possible to bring together, in one single research team, plasma physics, relativity, nuclear physics and engineering, nanostructured material science and the technology to create superintense ultrashort laser pulses? The Ensure project, funded by the European Research Council (Erc-2014-CoG No. 647554) with 1.9 million euros at Politecnico di Milano, tries to give a positive answer, by exploring new techniques of particle acceleration. "High-energy particle beams are exploited in various scientific and technological fields, both for research and applications, for example in nuclear medicine or radiotherapy", explains Matteo Passoni, associate professor in Theoretical Physics of Matter and head of the project. "But conventional techniques have certain limits: a completely new approach is possible, thanks to the developments in high power, ultrashort laser technology". Interacting with matter, these pulses produce the most intense electric fields ever made in a lab environment (thousands of billions of volts per meter) and to accelerate charged particles (protons and other ions) up to high energies, within very small space regions. The acceleration process can be controlled and enhanced by creating suitable nanostructured materials, with properties impossible to be obtained in conventional materials. "The project allows therefore to investigate, at the theoretical and experimental level, both fundamental physical processes, like the collective behavior of matter in the relativistic regime, and potential applications of interest for the society".



Artistic view of the acceleration process

The leading edge in energy

Research on fuel cells has now reached maturity

Fuel cells are tools allowing for the direct conversion of hydrogen in electricity, with a large reduction in emissions compared to combustion reactions. This is not a new technological solution but one that only in the last few years has received a strong push, both in power, but mostly in mobility: two big companies, Toyota and Hyundai already sell cars based on fuel cells, and it has been predicted that by 2030 they will be producing at least 300 thousand vehicles a year running on hydrogen. Now that the technology has reached maturity the problem is guaranteeing functionality comparable to other systems on the market. A sector of research in which the laboratory ePro-Lab in the University of Salerno has had a primary role for many years. Professor Cesare Pianese explains "We concentrate on the aspects tied to control, technology and software which allow the system to work at optimal performance, even through diagnostics". The campus is among the founders of a European association that brings together researchers in the industry: "We made available - notes Pianese - knowledge that was borderline, then bringing it to full-blown innovation". So much so the University of Salerno ha received financing on seven different projects for a total of nearly one and a half million euros: "which allows us to involve all the students in the university in this research, and the ability to issue various scholarships and on the job training which is important for them".

Cesare Pianese

Nanotechnology the key to growth in Europe

This is where Italia is at the top in terms of competitiveness and technologies

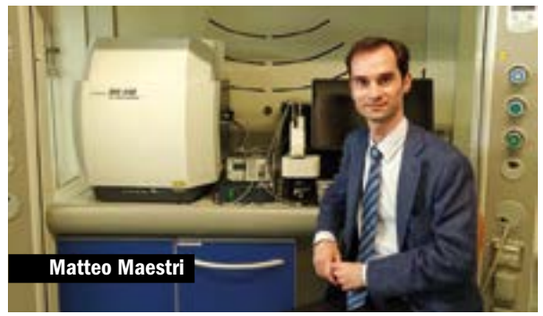
Nanotechnologies are pervasive-enabling technologies that have opened new horizons and made it possible to produce materials and devices with performance which would not be possible otherwise. They are based on fundamental scientific knowledge that has developed along with the ability to manipulate and characterise materials to the scale of a billionth of a metre (nanometre), as well as the rapid transfer into technologies for industrial production. And now, thanks to interdisciplinarity, physicists, chemists, engineers and technologists design, manipulate and control the architecture of materials from a nanoscale to the upper scales for industry. The paradigm of design is now reversed: no longer choosing a material which best meets the needs of the project, but the creation of material designed specifically to achieve the desired set of properties. The group of Science and Technology of Materials (Stm) of Roma Tre, thanks to the Interdepartmental Laboratory of Electron Microscopy (Lime), has always been committed to the development of solutions for the reliability and durability of the performance of mechanical components, even miniaturised and with electronic functionalities for different industrial sectors (transport, energy, construction, bioengineering ...). Founded by Professor Fabio Carassiti and now directed by professor Edward Bemporad, the group has established itself internationally in the field of advanced techniques of nano-mechanical and microstructural characterisation of materials and nano-structured thin coatings, as well as in the development of industrial scale-up methodologies. An example: the European project Istress (Fp7-2014, www. Istress.eu), whose central coordinator is Professor Marco Sebastiani, senior researcher of the Stm group and winner of a Fulbright Scholarship in 2013. The project is geared towards developing methods for analysis on a nanometre scale of internal stresses in materials and components whose content of knowledge creates a significant technological gap compared to that of mass production, typical of non-European countries. In particular, new nanostructured thin films were developed for a major increase in performance of the injectors of diesel engines, as well as microelectromechanical devices (which regulate, for example, our mobiles and video game consoles), with significantly improved performance. The European Commission - aware of the benefits offered from the ability to design and manufacture products whose performances derive from the multi-scale control of material architecture - has developed dedicated networks. The European Materials Characterisation Council (Emcc - www.characterisation.eu) is a European initiative to form a cluster of excellence in the field of material characterisation techniques, where Professor Sebastiani is a member of the Organisational Management Board. The Emcc, recently launched and promoted by the European programme of Industrial Technologies, under the initiative of Dr. Sophia Fantechi, scientific official of the Directorate General for Research and Innovation of the European Commission, already has the joint participation of 16 major European projects, and has the goal of creating a more favourable environment for the innovation of new materials and to facilitate the adoption by European industry.


The team

Towards the nano-engineering of the catalytic processes

The Shape project fine-tunes a theoretical and experimental methodology

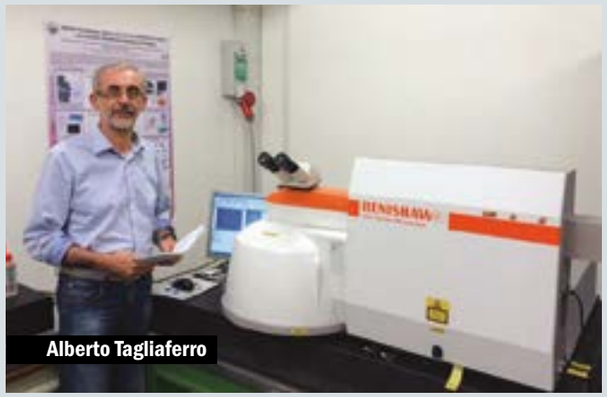
Heterogeneous catalysis plays a crucial role both in the production of important chemicals (for instance, ammonia, the basis for production of fertilizers), energy applications (for example, fuel production) and environmental protection (for example, pollution abatement from vehicles). Peculiar to heterogeneous catalysis is the interaction between the reactants and specific functional materials ("the catalysts"), which allows for the selective enhancement of the rate of elementary reactions. The Shape project, funded by the European Research Council for the period 2016-2021 and coordinated by Prof. Matteo Maestri (Politecnico di Milano, Italy), aims at establishing an experimental and theoretical methodology for the development of structure-dependent microkinetic models. This allows prediction of structural changes of the catalyst during reaction by achieving an atomistic-level description of the structure-activity relation. The potential contribution of Shape on catalysis science and technology is very high by making possible the engineering of the chemical transformation at the atomic level. The possibility to predict the catalyst structure under reacting conditions has a direct impact on the fundamental analysis and design of the structure-activity relation, thus paving the way towards the nano-engineering of the catalyst structure and composition to tailoring activity and selectivity for advanced process intensification in applications of technological relevance.


Matteo Maestri

Zero-emissions hydrogen

Credit due to photocatalytic materials and solar sources

Sunlight, source of life and energy, has been exploited for a long time - for example through photovoltaic cells – to satisfy at least a part of humanity's need for energy. Photocatalysis is one of the most promising from amongst the latest methods of exploitation. Photocatalytic materials can in fact exploit sources of light to accelerate chemical reactions. For example they can accelerate reactions that disassociate pollutants and contaminants of various kinds, transforming them into substances harmless for man and environment. Photocatalytic materials can also be applied to self-cleaning windows and in water repellent paints. The target of the European Phocscleen 'Photocatalytic systems for clean energy and environment applications' project, coordinated by Torino Polytechnics school and conducted together with Canadian (Uoit), Mexican (Unam) and French (Upjv) universities, is on the one side to develop more efficient photocatalysts and on the other to use them in new fields of application such as polluted water treatment and water splitting processes (that is extracting hydrogen from water). These new materials developed make it possible to exploit a greater part of the solar spectrum and to remove colouring from water polluted by colouring agents, more rapidly. This is particularly interesting for treating waste water from clothing industries.


Alberto Tagliaferro

Sustainable logistics

A project that aims at providing models applicable to various production sectors

Environmental sustainability is an increasingly felt and transversal subject. Also on a production level as, for several years now, more forward-thinking companies have designed their strategies with this topic in mind. It comes as no surprise then that a three-year project, proposed by Professor Eleonora from the Bottani University of Parma, has been financed as part of the Sir calls. Its aim is to study sustainability in logistics: a subject still poorly studied academically, at least in Italia. "Logistics sustainability - or that of the so-called supply chain - considers three aspects: economic, environmental, and social. My project mainly covers the first two: I don't just base my studies on a single sector, instead I try to contextualise the research in different areas - explains Bottani -. And the different case studies that I have included and intend to include in my work plan, which I will be actually working on in the upcoming months together with the pool of experts I coordinate, represent standards which I hope will become applicable to any sector". Beginning with some tangible examples verifiable within the Emilia region or neighbouring areas (such as the food chain or cold logistics), the project aims to provide a modelling of the problem that can then be transferred to all other areas of production: perhaps - making the right adaptations - also in global geographical contexts, or rather in other parts of the world…


Eleonora Bottani

Laser monitoring of gas

The Safetypack system uses spectroscopy to for the precise measurement of gas in food containers


Luca Poletto

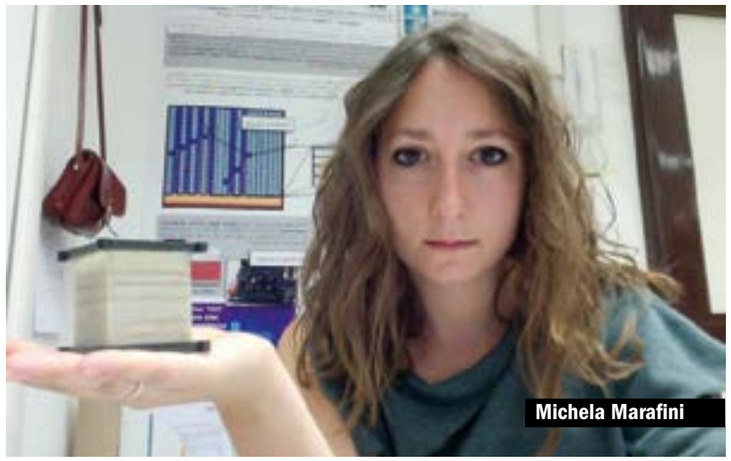
Safetypack: innovative application on laser monitoring of food package internal gas composition. The precise measurement and control of the gas composition of packaging in modified atmosphere (MAP) represent a requirement in the food industries in order to control ripening, prevent spoilage, assure shelf life and food safety for consumers. Safetypack aims at the realization of new contactless non-intrusive gas sensors using laser spectroscopy for real-time control of the internal gas composition on a wide range of sealed food packages (containers, bags, cups). The sensors are applied on packaging lines to control the full production inline. The technology is interesting for packaging industries and food manufacturers that need to assure high standards when using MAP technique in products such as fresh pasta, meat, bread, milk, dairy and vegetables. Companies can join in-field demonstration sessions at Santa Maria, a Swedish bakery facility, and at Latteria di Soligo, a dairy producer in Italy, where two Safetypack systems have been installed and are fully operative for inline validation. The Safetypack final conference is going to be held on Friday, Oct 14, 2016 in Pieve di Soligo (Tv), Italy.

SAFETYPACK IS COORDINATED BY CNR-INSTITUTE OF PHOTONICS AND NANOTECHNOLOGIES, ITALY, DR. LUCA POLETTO
THE RESEARCH LEADING TO THESE RESULTS HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S SEVENTH FRAMEWORK PROGRAMME FOR RESEARCH, TECHNOLOGICAL DEVELOPMENT AND DEMONSTRATION UNDER GRANT AGREEMENT N° 613795

The secret of the neutrons

An applied physics project to cure tumors, which will create a new particle detector

You can fall in love with physics as an adolescent and dedicate your entire profession life to the search for particles which are so small and "neutral" that they are considered invisible. But instead, if those particles are known, you can study them to give very important answers and maybe even help defeat certain tumors. This is what Michela Marafini is doing. Following the passion for physics she acquired in school, after receiving a university degree in Physics from Roma Tre University, she dealt with particles at the University of Paris, where she worked on the photo-detection of neutrons, i.e. making them visible by measuring the light produced by a particular effect on water. Today, at age 34, she is back in Roma, working at the Sbai Department at the Sapienza (Roma's prestigious university) in an interdisciplinary group – half physics and half engineering – financed by various projects at the Historical Museum of Physics and the Enrico Fermi Center for Studies and Research. She heads a Sir project which aims at monitoring neutron behavior in hadrotherapy. The Fermi Center has made interdisciplinary work its workhorse, and already in past years has financed other monitoring projects which were in the hadrotherapy setting, in addition to many other projects in which physics mixes with engineering and technology. "This is why – explains Marafini – it is the ideal place to develop my project, which is a variation on radiotherapy using a relatively new technique which can give very important results for curing tumors". In this technique the band of particles which is used on the patient is very concentrated, but only on the cancerous part. This increases the possibility of being affected by the cure, but makes it essential for the margin of error to be reduced to the minimum possible in order to avoid damaging healthy tissue. "Once the radiation is in contact with the patient, it becomes absolutely necessary to monitor the behavior of the secondary particles produced by the contact between the band and the patient himself – the photons, protons, and neutrons. They are difficult to measure. This is also because they can interact in areas that are far from the operation. But when they interact, they emit a lot of energy, and the goal is to measure this, because neutrons hold much more information about their prime origins than protons". The project aims at creating an ad hoc neutron tracer, an instrument which up to now does not exist, but which could make particle therapy useable for a greater number of patients and also make diagnosis easier. A fundamental part of the work is being done with the Bruno Kessler Foundation in Trento, which has been given the job of developing the necessary electronics for this project. "The detector will be made of sparkling fibers - Marafini continues -. It is to be a compact object, as big as say a shoe box, in order for it to be used in a easy way in the various treatment rooms. It will be composed of very thin 250 micron fibers that are 10 centimeter long that cross each other as in a grid. The shiny material, when it passes a particle, produces a light which then goes to where we can read it. We will be using this innovative new detector to see the interaction of the neutrons with the material of the fibers. Once we have monitored the movements of the particles, we can then recover all the information we need". The research group has already identified where the first practical application should be carried out – at the Cnao in Pavia, which is the first Italian center for ion-carbon treatment. "When we will have constructed the detector, then we will be able to do real monitoring – concludes Marafini – but I am satisfied. A piece of the detector already exists, thanks also to the National Institute of Nuclear Physics which financed the first prototype, but above all thanks to the Sir at the Fermi Center, and I am now able to see the project proceed from beginning to end".


Michela Marafini

The central banks during a time of crisis

A comparative study on the behaviour of the BCE, FED and Bank of England. Soon a book

Hundreds of experts have studied the behaviour of monetary institutions since the world economic crisis began. Yet the analysis that Manuela Moschella - associated professor of International Economic Policy at the Normale di Pisa, together with her colleague Domenico Lombardi, director of the Global Economy Program at the Center for International Governance Innovation (Cigi) - has made is decisively uncensored, and is promising interesting developments: it is not by chance that their project won the SIR competition at the Miur. Moschella and Lombardi are studying the behaviour of the main central banks during the crisis: the Bce, the American Fed and the Bank of England. "The three institutions - explains Moschella - had to face new challenges both compared to traditional economic policy, and to political power, seeing the financial implications of certain monetary policy interventions. We are still looking for the common behaviour characteristics of the central banks to understand the determiners of non-conventional policy, keeping in mind the risks that these policies have for the independence of monetary authorities". The research hypothesis - based on the analysis of official speeches held by central bankers - brings together two aspects: how thinking has changed from the beginning of the crisis, and how the relationship with political authorities has developed, both explicit and implicit. A book will soon be published at the end of the project, which could be very useful in interpreting the financial policy of these dark years.


Manuela Moschella


Domenico Lombardi

The social side of brain in action

How the brain control complex interactive movements

Consider your hand: It gives us a glimpse into how the brain creates the grace of human motion. If you put a five year-old child's dexterity against the best robots of today, the child wins easily. At the Cognitive Neuroscience Center of Padova, Luisa Sartori is studying the complexity of human motion during social interactions from an evolutive perspective that entails human and non-human subjects. As she says, "I believe that humans are shaped to socially interact". Indeed, people (even newborn) imitate other people. The subliminal activation of the motor system - and of the imitative response - while observing actions performed by others is ubiquitous. The discovery of mirror neurons confirmed this evidence. But complementary action (from Latin complementum; i.e., that fills up) are still a puzzle. Complementary actions refer to forms of social interaction wherein individuals coordinate and mutually complete their incongruent actions, rather than performing imitative behaviors. Understanding how the brain evolved to control complex interactive movements it's a challenge. But it is relevant for diagnosis, rehabilitation and robotic technology. Taking this viewpoint, and adopting a multi-methodological approach involving neuroimaging techniques and 3-D motion analysis, Luisa Sartori and her colleagues investigate the social side of brain in action.


Luisa Sartori

Financial fragility and the macroeconomy

The Finimpmacro studies the complex interactions responsible for the crises

If an economy plunges into a recession, its financial system comes under stress. At the same time, however, shocks originating from the financial system, e.g., banking crises, widely affect the economy: recessions following financial crisis are typically larger and more persistent. This mutual interaction can lead to a vicious circle (a process of so-called "financial acceleration") which can exert a large impact on economic activity. Against this backdrop, this research project studies the following key question: how can an economy move abruptly from normal periods of moderate business cycles to periods of large and prolonged slumps? The answer, according to our perspective, is: because of financial fragility. Financial fragility arises in an economy where many agents reach a condition of excess accumulation of private debt, and are close to their borrowing constraint. In such a context, the economy is easily prone to phenomena of debt deleverage. Meaning, a shock of typical size (e.g., a normal slowdown in the housing market), can make that constraint suddenly binding, and force the agents to reduce their debt. This can be achieved by a sudden contraction in their consumption and investment spending, which can precipitate the economy into a recession. An interesting aspect of this dynamic is that shocks of typical size can trigger radically different effects on economic activity depending on the current level of indebtedness. In other words, in a state of financial fragility (i.e., high accumulated leverage), it is not necessary to assume "large shocks" to engineer large recessions. This is a new perspective on a key question in macroeconomics: is it realistic that great recessions are simply caused by large exogenous shocks, as if they were simply the result of "bad luck"? We show instead that great recessions (like in 2008) can be the result of normal disturbances, whose effect can be amplified by an underlying state of financial fragility, possibly built up during tranquil periods of economic expansion (between 2000 and 2008). Finimpmacro (Financial Imperfections in Macroeconomics) is a 4-year project sponsored by the ERC which studies the complex interaction between the financial conditions of the economy and the likelihood of economic crisis. This perspective is particularly relevant, e.g., in light of the recent events observed in the Eurozone. In the last decade many countries of the so-called Euro periphery have experienced booms in credit and asset prices, often associated with widening current account imbalances and loss of competitiveness, due to an excessive appreciation of their real exchange rate vis a vis the rest of the union. Should financially-driven real exchange rate misalignments be of more serious concern for countries belonging to a currency area? This question has been high on the agenda of Eurozone policymakers in the last few years. However, it requires new tools of analysis, at the heart of this research project, that precisely emphasize the aforementioned interaction between the financial structure and the macroeconomy.

Tommaso Monacelli

Emotions in social web

EmoQuest project is dedicated to collaborative knowledge building

Nowadays people are increasingly likely to search for information in social media, including online Question and Answer (Q&A) sites. For example, Stack Overflow is a popular community of code developers, with 5.5 million users providing 19M answers to 12M questions. In Stack Overflow the knowledge building is based on collaboration among the community members and questions, answers and users are subject to a reputation award process. In the true spirit of gamification, the reputation system motivates users to generate high quality contents thus turning Stack Overflow in the most authoritative source of knowledge for software developers. One of the biggest drawbacks of communication through social media is to appropriately convey sentiment through text. Web users are not necessarily prepared for effectively dealing with the social media barriers to non-verbal communication. Thus, the design of systems to support the emotional awareness between communicators is an important technical and social challenge for research related to computer-supported collaboration. Understanding the role of emotions in online Q&A sites is the main goal of EmoQuest, a three-year project funded by the Italian Ministry of University and Research under the program "Scientific Independence of young Researchers" (SIR 2014). The project is coordinated by Nicole Novielli, researcher at the University of Bari 'Aldo Moro' and member of the Collaborative Development Research Group. EmoQuest aims at shedding new light on how emotion expression facilitates or impairs effective knowledge sharing, that is how the emotional style of questions and answers incentives contributions, determines the perceived quality of the information provided, and affects the reputation of users in Q&A sites. The research domain of EmoQuest is Computer Supported Cooperative Work (CSCW), a multi-disciplinary field emerged in the 80s and recently boosted by the rise of the Social Web. The research will produce an advancement of the state of the art for some of the disciplines which guide and contribute to CSCW and in which the team members have a strong research expertise, namely Software Engineering, Human-Computer Interaction, Linguistics and Psychology. The team will combine emotion modelling with affective computing and natural language processing techniques to build large-scale, robust approaches for sentiment detection in interactions on Q&A sites. Empirical studies will be performed, exploiting data from Stack Exchange, a growing network of over 150 Q&A sites about a broad range of diverse topics, which includes Stack Overflow. Among the expected outputs of EmoQuest there is a user-driven netiquette for Q&A to incorporate emotion awareness in social media interaction. Thanks to the empirical studies, it will be possible to build new psycho-linguistic models about emotion and sentiment expression through language, upon which to build new affect recognition techniques and sentiment analysis tools.


The Collab

The language of the brain

A pioneering project to understand the complexity of neuronal electrical signals

How is the perception of the world around us generated in the brain? With what language do neurons encode and represent sensory stimuli coming from the outside world? These are questions, for now, without a clear answer: "We are able to read the signals that the brain produces in response to external stimuli, but we do not know what kind of information they represent, and we do not understand the mechanisms which produce them. We'd need a sort of Rosetta stone to decode such signals". Tommaso Fellin, graduated in physics from the University of Padova, today at the Italian Institute of Technology, has been awarded funding from the European Research Council (Erc) and the National Institute of Health (Nih) to develop a new technology that is capable of reading and modifying the electrical signals of the brain. Five years of work forecast, an interdisciplinary pool composed of physicists, biologists and engineers, for an experimental project that has many long-term implications. "First of all - says Fellin - our work will have an impact from a technological point of view: we will develop optical microscopes to modify the electrical activity in neurons with spatio-temporal resolution never achieved before. These technologies will then be used to shed light on one of the main unresolved questions of modern neuroscience: what language is used by the brain to interpret and process information from the outside world. Unravelling these fundamental properties of the functioning of the brain may represent the first step for a better understanding of the mechanisms of the onset of numerous still puzzling neurological diseases such as, for example, Alzheimer's disease, Autism and Schizophrenia.


The team

Against chronic pain

New medicines are under study with long-term analgesic mechanisms

An illness is normally generated by specific causes; if the treatment eliminates these causes then the illness ceases to be. Chronic pain is a different case, because it creates hypersensitivity in the pain system for a longer time than the causes that had generated it: that is to say it is not suffice to fight the causes to eliminate an illness. And pharmacological solutions are currently insufficient. This is the subject of the Paincage project research, with nine European partners involved and coordinated by professor Antonino Cattaneo, neuroscientist at the Scuola Normale Superiore in Pisa. The purpose is to formulate a more efficient generation of medicines against the illness. "Each medicine is a molecule that hits the target, which is often a protein that must either be activated or inhibited by said medicine – explains Cattaneo -. In this case we have neurotrophins (in particular Ngf) or endocannabinoids. Chronic pain can be treated by inhibiting these molecules, but there are many potential side effects: selectors are needed to hit the Ngf system but which must be more selective than the current ones. The multidisciplinary nature of the partners enables us to hit in many different points, continually interacting". Now half way through the work, the project has already fostered a potential result. "Several of the medicines we chose to study imply long term analgesic mechanisms, reflecting on the chronic pain. That is: I administer them for a certain period, but the analgesia lasts far longer. It's a new phenomenon: we are studying the epigenetic modulation mechanisms they could have, if we succeed it would open up important horizons".


Antonino Cattaneo

Target therapy for aggressive pituitary tumors and carcinomas

From Naples the hope of individualized treatments for patients with pituitary malignancies

Pituitary tumors are generally non-invasive, benign, slow-growing lesions, but some display local invasion, high recurrence rate and resistance to multi-modal therapy, and are in fact defined aggressive or carcinomas in presence of metastases. Prognosis is poor as both aggressive tumors and carcinomas commonly relapse after surgical excision with scarce response to radio- or chemotherapy, and specific therapies are still lacking. Out of Naples comes a new research supported by a SIR 2014 (MIUR) project, under the leadership of Dr. Renata S. Auriemma, a researcher at the Dipartimento di Medicina Clinica e Chirurgia, Sezione di Endocrinologia, of University "Federico II". The projects aims at investigating novel therapeutic approaches for these severe and disabling, albeit rare, tumors. Doctor Auriemma explains: "A cross-talk between fine deregulation of intracellular pathways and complex micro-environmental factors can be implicated in pituitary tumorigenesis, and alterations upon node molecules can lead to aberrant proliferation. We believe that new treatment strategies, targeting signaling pathways of growth, angiogenesis and hormonal secretion, may impact tumor progression, hormonal excess, systemic complications and quality of life in patients with aggressive pituitary tumors and carcinomas", says Auriemma. "The results of this study might also lead to the identification of molecular predictors of responsiveness to treatment, driving endocrinologists in the choice of individualized adjuvant therapy in patients with pituitary malignancies".


Renata Simona Auriemma

Changes in Dna as the key to interpret hereditary anaemia

As new technologies are changing diagnosis and research

Hereditary anaemia is a genetic disease caused by alterations in the Dna sequence of specific genes. Knowing these changes is critical for the proper diagnosis and adequate treatment of patients. The achievement of the Human Genome Project in 2000 and subsequently the development of new technologies in the study of Dna, such as next-generation sequencing (Ngs), have brought about the beginning of a new era of clinical research. Thanks to the complete mapping of human genes, now we have the possibility to analyse the entire genome or parts of it in a matter of days and understand the genetic differences between individuals. Recently, the Scientific Independence of Young Researchers (Sir) programme of the Italian Ministry of University and Research has funded Sphera, a 3-year project with geneticist Roberta Russo as principal investigator, researcher at the Department of Molecular Medicine and Medical Biotechnology at the University Federico II of Naples. Doctor Russo is a member of the group of international reference, for genetics of rare anaemia led by Professor Achille Iolascon, at Ceinge Advanced Biotechnology. The project aims to obtain a global vision of the genome of patients with rare anaemia. It will enable the identification of genetic factors responsible for the most severe forms, expanding the knowledge of the Pathophysiology of these disorders and improving the clinical management of patients.


Roberta Russo

Neapolitan research, worldwide hope

On the way to experimenting on a vaccine against hepatic tumours

Liver cancer is the fifth most common in the world, at least in males: but is unfortunately second for mortality, after lung cancer. It is particularly widespread in certain areas of the world: in Indochina it is the most lethal of all, but also in the southern areas of our country. And yet, paradoxically, the development of immunotherapy for liver cancer is not well addressed. This is why the European project, "HepaVac", coordinated by professor Luigi Buonaguro of the Istituto Nazionale Tumori "Fondazione Pascale" in Napoli is particularly important: its objective is to develop a vaccine which will trigger off an immune response capable of fighting, restraining and destroying the illness. "In theory, it is a simple objective", explains Buonaguro, who, in the past worked for many years on vaccines against Hiv, as part of the staff of professor Robert Gallo. "The therapeutic approaches available today, both surgical and pharmaceutical are not able to efficiently fight this tumour: this is why we thought to develop an immunotherapy approach, based on a vaccine to administer to patients who already have the disease". Over the first three years, the project has reached its first objective: to identify the antigens, meaning the specific molecules displayed on liver tumour cells. A fundamental step to then develop a vaccine capable of inducing the immune system able to recognise these specific molecules and kill the cells. "Now we are in the next phase - says Buonaguro -: we are producing the vaccine according to pharmaceutical standards and, if everything goes according to plan, by the end of 2016 we should be ready enroll our first patient for testing". Project funding ends at the end of 2018: by that date conclusive data on the efficiency against the illness will not be available. Indeed, the objective of this phase is to obtain data on vaccine's safety (meaning a lack of collateral effects) and on the immunity response induced in the patients. "We will test 40 patients who have liver cancer, and are expecting an immunity response very quickly: with each administration of the vaccine, we will evaluate the response of the immune response through a peripheral blood test". The professor, who heads a pool of nine partners from six different European countries - is optimistic... "Let's just say I believe in what I am doing, and I hope the results will be positive. We are on the front line: if the clinical results will be significant, we could be playing a main role on a global scale and make a decisive improvement in the therapeutic prospects of these patients". It is not by chance that in the last few weeks Buonaguro was invited to Vietnam and South Korea to present an update on his studies: if all goes well, the vaccine could be brought to these countries where liver cancer is a high unmet medical need. "Lastly, I would like to underline that the close collaboration for 5 years with important European partners is providing a great opportunity for technical and scientific growth to our research group at the Institute in Naples. All of this is an invaluable investment which will remain and will bear fruit over the long run".


Luigi Buonaguro and his staff

The epigenetic basis of Lymphoma in dog

An innovative molecular biology project starting from canine medicine translating into human medicine

The project is intended to study the epigenetic modifications of the most common lymphoma in dog – Diffuse large B-cell Lymphoma (Dlbcl) - and to predict the clinical behavior of this tumor according to the perturbations of methylation. It is a momentous goal in veterinary medicine that could even get major relevance in human medicine in future: this lymphoma histotype is considered a good model for Dlbcl, which occurs in humans. This is the major objective of the research project developed by Luca Aresu, associate professor at the Department of Comparative Biomedicine and Food of the University of Padua: one of the winning projects of the 150 selected from the call SIR 2015 reserved for researchers under the age of 40. Luca Aresu graduated in Veterinary Medicine in Turin, then a three years PhD experience in immunopathology was first developed in Turin and then in Geneva; he moved to Padua in 2007, after gaining a researcher place. Here, he expanded his project idea and, since last September, a small pool of collaborators is contributing to the success of the grant. "The project is divided into multiple tasks - explains Aresu - and after only having been operative for few months, today we have already completed the work intended to be done in the first year of the three forecasted". The preliminary experimental phase was carried out on 70 samples of Dlbcl where analysis of the transcriptome has been associated to changes of the methylation profiles of the tumor. The study hypothesis is based on the concept that the clinical variability that this tumor shows in dog might bassociated to different molecular profiles that are not identified with routinary clinical procedures. From here on we will also determine this correlating the experimental data with the clinical and pathological aspects of the group of dogs analyzed. "My idea is that there are epigenetic modications able to influence both the development of Dlbcl in dog and the clinical variability, as well as the response to therapy. Methylation of Dna is a gene transcription regulatory mechanism and changes in Dna methylation are associated with unplanned gene silencing, particularly in tumor suppressor genes. We work on a spontaneous tumor model, without any induced experimentation: in fact dogs share the same environment and the same risk of tumour development as humans". Then, the project will include a phase of validation of these results in other lymphoma histotypes. In the project's contest, Professor Aresu's collaborators will work on an in vitro system to evaluate the effect of the main mole- cules with hypomethylating activity to investigate if it is possible to alter the tumor methylation. "The expected end result is threefold - states Aresu -. Firstly, to identify a set of genes associated with the clinical behavior of the tumor, to predict the behavior of the lymphoma, secondly to identify new therapeutic targets and validate the use of hypomethylating drugs in this subtype and finally, to step into the functional mechanisms of some genes more involved in Dlbcl in dog". The last is the most revolutionary aspect of the project. "Epigenetics is an innovative area in human medicine: in veterinary and above all in canine oncology field, the analysis of methylome is unprecedented".


Luca Aresu

A microscopic "Trojan horse" against malaria

The use of symbionts in the control of mosquito-borne diseases

Mosquitoes are the deadliest animals in the world and kill millions of people every year due to numerous diseases including malaria, filariasis, dengue and many viral encephalitis. Malaria is one of the most devastating disease and causes every year hundreds thousands deaths. It is currently widespread in tropical regions and the absence of vaccines and resistance to drugs and insecticides with the complicity of climate change, could cause its spread to other areas of the planet. The SymbioVec project proposes an innovative and revolutionary strategy that overcomes the obstacles of resistance and use of chemicals by using symbionts of mosquitoes as a "Trojan horse" to release anti-malarial substances in the gut of mosquito itself, making it unable to transmit malaria. This research, coordinated by Irene Ricci at the School of Biosciences and Veterinary Medicine of University of Camerino, is funded by the European Commission by 1.5 million euro (http://d7.unicam.it/symbiovec/). SymbioVec promises the use of symbionts based biopesticides to prevent diseases transmitted by many pathogenic insects. At this purpose it has been launched "BioVecBlock", a spin-off involved in the development of new methods for the biological control of vectors, run entirely by the youngest members of the Unicam team of Parasitology.


Irene Ricci

Medicine for children

The Music (Medicines Use and Safety Investigations in Children) study in the Centro Regionale di Farmacovigilanza of the Seconda Università di Napoli

The prescription of medications in paediatrics is a complex aspect of pharmaceutical management in illness as it is often based on safety and efficiency data which is incomplete or absent for children. It is well known that the efficiency and safety of most medicines used in clinical trials is evaluated mainly on adult patients. Therefore, the lack of clinical studies made specifically for children, leads to an inappropriate use of medicines, which essentially leads to an off-label use, meaning doses, information and formulations which have not been specifically tested for on children. In absence of data from specific clinical studies, medicines are often administered to children in lower doses compared to those used for adults. This common practice exposes the patient to a series of risks. The evaluation of the benefit/risk factors in paediatric use is therefore transferred to post-marketing clinical research. As shown in the work of Dr. Carmen Ferrajolo, there are many sources of data regarding the use and safety of medicines in daily clinical practice that can be used for scientific purposes. These sources of data can be classified in two macro-categories: a system for the collection of adverse reactions in a national database, and health registries, which allow for the collection of personal, clinical and diagnostic data by the Gp/Paediatrician together with information on medical spending from pharmacies and hospitals. The Music project (financed by Miur under Sir), is a cooperative effort between the Seconda Università degli Studi di Napoli, other national and international institutes, like the Erasmus Mc University in Rotterdam (Netherlands), and the Agenzia Italiana del Farmaco (Aifa), and has the objective of increasing the evidence on the use and risk of medicines for paediatric use through a combination of different existing data sources and the application of innovative methods to manage and analyse them.

Target: change the fate of Fap

The studies on Duchenne muscular dystrophy (Dmd)

Duchenne muscular dystrophy (Dmd) is a rare genetic disease affecting 1:3.000/6.000 boys per year and for which there is still no available cure. The affected boys have weaker muscles that progressively lose their function due to the absence of a protein called dystrophin. One of the most negative consequences of the disease is the progressive loss of muscle tissue, which is replaced by fat and fibrotic scars. Our lab has recently demonstrated that a population of stem cells residing in the muscle, called fibro-adipogenic progenitors (Fap) is able to either support the formation of new muscle tissue, in the first stages of the disease, but also to give rise to fibrotic and fat cells at later stages. Thus, understanding how to change Fap's behavior, inducing them to support new muscle tissue instead of forming fat and fibrotic scars, is crucial to conceive strategies aimed to slow-down disease progression. The aim of our project, funded by Miur in the context of the "S.I.R. (Scientific Independence of young Researchers)" program, is indeed to study if gene silencing machineries, such as the Prdm16/G9a/Glp proteins, might be involved in maintaining Fap's ability to promote formation of skeletal muscle. The results gains by our studies will allow us to understand if Prdm16/G9a/Glp might be future pharmacological targets for therapies aimed to block the loss of muscle tissue and to prevent the fibro-adipogenic degeneration of dystrophic muscles.


Chiara Mozzetta

The true color of atmospheric particulate matter

A Marie Sklodowska-Curie action coordinated by the Italian CNR on brown carbon aerosol

Anthropogenic activities inject large amounts of particles into the atmosphere, some of which absorb the solar radiation and contribute to atmospheric warming. Macroscopically, such atmospheric particulate matter look grey-black and it is chemically characterized by the presence of amorphous carbon named "black carbon". Such aerosols exist in thick layers extending for hundreds of kilometers in certain areas of the world, like South-East Asia, where they exert a potential significant impact on the regional climate and on the climate of mountain areas. Previous studies in these areas suggested that the true color of such aerosols is not purely black but partly brown: with a stronger light absorption at the short wavelengths, probably due to the presence of organic pigments. The project "Himalayan Brown Carbon", coordinated by Cnr-Isac (National Research Council of Italy, Institute of Atmospheric Sciences and Climate), is a Marie Sklodowska-Curie Individual Fellowship aiming to determine atmospheric brown carbon in one of the most important global climate hotspots: the area of Himalayan glaciers. The fellow, Dr. Elena Kirillova, has measured brown carbon on PM10 samples previously collected by CNR and EvK2-CNR technicians at the NCO-P observatory (5079 m a.s.l.) in Nepal. The results of this research are a step forward understanding the true color and the true nature of climate-forcing atmospheric aerosols.


Elena Kirillova

Learning Professionalism

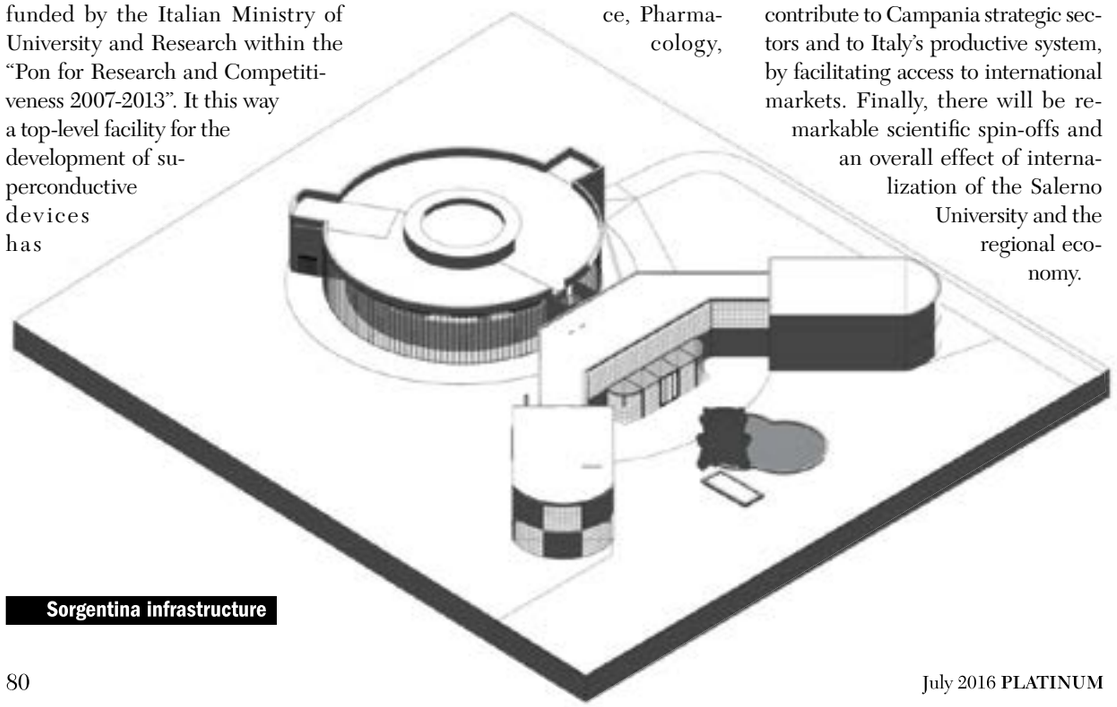
Providing IT engineers with all the skills for the global market

Information technology is an industry that moves at lightning speed: what today is at the forefront, in a few years will have already been surpassed. At the same time, the computer engineer is becoming increasingly in demand, as they are essential in the creation of complex applications and systems. The job of those who have to create young engineers in this field is challenging: something Diem- the Department of Electrical and Information Engineering and Applied Mathematics of the University of Salerno- knows very well. For many years now it has been at the forefront of training future professionals. "The speed with which the market is evolving is clear for everyone to see - says Professor Mario Vento, head of the department -: ten years ago many of the current technologies were still in their infancy, there were no social networks ... We have to satisfy the needs of the market, training professionals also including the so-called soft skills (from languages for internationalisation, to the ability to work in teams, communication and presentation of results). On the other hand, students who come from our high schools know very little about the future world of work and professions or employment opportunities in emerging areas such as robotics, bioinformatics, e-health, renewable energy, broadband telecommunications and the Internet of Things (IoT) ". Therefore Diem's goal: to transform students with sound theoretical abilities into professionals with all the necessary skills for a global market. "To achieve it we need a dynamic program of studies, characterised by training activities conducted directly designing applications and systems, through constant interaction with our 14 research laboratories and industry leaders". Diem, to mould these new skills, set up two paths: one aimed at creating computer engineering expertise for cyber security, computer vision, the Semantic Web and the Internet of the future; the other for Industrial Engineering, to meet the growing needs of the renewable energy, robotics and broadband telecommunications sectors. Just recently a double degree programme has been established with the Ecole Nationale Supérieure d'Ingénieurs of Caen, one of the most prestigious French engineering schools: the pupils study one year in Italia and one in France, and at the end they obtain a degree recognised in both countries. "Still on the subject of internationalisation - continues Vento - periodically we send all of our students around Europe (we have agreements with 30 foreign universities) to carry out the final thesis, with a dual aim: enhancing their curriculum with an international experience increasing job opportunities and completing the development of soft skills by working in multicultural teams". With outstanding results: after graduating from Diem, it takes about two months on average for the young engineers to enter the world of work (source-Almalaurea). And if all this is not enough, Diem does even more, by searching for future professionals while they are still at high school. "We want highly motivated individuals: we lent some robots to twenty schools, in Campania and neighbouring regions, creating a kind of 'competition' to select the most passionate youngsters, and taking them to visit our laboratories directly". Thanks also to the superb organisation of the University of Salerno, not surprisingly deemed the top University of Southern Italia in the 2014/2015 ranking of the best Italian universities compiled by the Italian financial-economic newspaper Sole 24 Ore: a modern campus, a real citadel of studies, with modern spaces for teaching and research, but also for leisure and cultural and sports activities, where students on track with their exams do not pay taxes!

A project with positive effects

Sorgentina: a great opportunity to build an international research infrastructure in Campania with relevant industrial spillovers

At the international level, scientific and technological development need large research infrastructures such as the particle accelerator Large Hadron Collider (Lhc) at Cern, the Isis neutron source in Oxfordshire or the Elettra Sincroton Lightsource in Trieste. Within European research institutions it is well recognized the need for new neutron sources at national level which would improve the expertise of local scientific communities and the access to European neutron sources such as European Spallation Source (Ess) currently under construction in Sweden. In the past 20 years, unlike most advanced countries, Italy has not kept pace with new research infrastructures and it has not fully used its resources from EU Structural Funds to this purpose. However, there were success stories. An example is the "Nafassy" project, funded by the Italian Ministry of University and Research within the "Pon for Research and Competitiveness 2007-2013". It this way a top-level facility for the development of superconductive devices has been built at the University of Salerno, thanks to synergies with the main Italian research organizations (Enea, Infn and Cnr). Following this experience and on the basis of Enea's idea regarding a new neutron source, called Sorgentina, this new research infrastructure could be created at the University of Salerno using U.E. Structural Funds. Other public research organizations (Infn and Cnr) could contribute, and several University Departments (Physics, Chemistry, Engineering and Materials Science) as well as the Italian and European Neutron Spectroscopy Society could participate in the realization of the infrastructure. Sorgentina would provide public and private users, both national and European, with scientific and technological services in different sectors such as Materials and Engineering Science, Aerospace, Pharmacology, Medicine, Biology, Cultural heritage, and Agribusiness. In particular, Sorgentina will be a test facility for the materials used in the "fusion" project which is the most ambitious international project ever proposed, aimed to generate a clean and inexhaustible source of energy. Sorgentina is expected to cost about 150 million euro, while its functioning costs could be covered by the services provided by the facility, in particular through the production of the radiopharmaceutical based on molibdenum- tecnetium 99. There will be positive spillovers from the construction of the facility and connected to its functioning (70 employees and 5,000 man-days per year), and it is likely that an infrastructure which produces the basic material for radiopharmaceuticals will also attract pharmaceutical companies. Moreover, Sorgentina will positively contribute to Campania strategic sectors and to Italy's productive system, by facilitating access to international markets. Finally, there will be remarkable scientific spin-offs and an overall effect of internalization of the Salerno University and the regional economy.



Sorgentina infrastructure

A network to develop advanced biotechnologies

The University of Palermo focuses on research with the ATeN Center

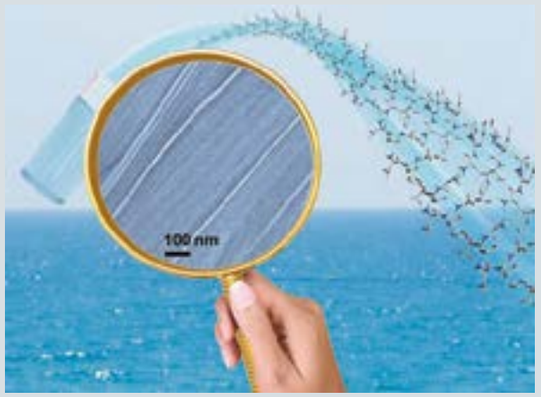
A research centre able to provide excellent services to both public and private sectors; biologists, biotechnologists, chemists, physicists, engineers, doctors, computer scientists who work together to generate valuable technical knowledge, and create competitive products for the domestic and international market. In short, the ATeN Center, Advanced Technologies Network Center, is a complex structure set up by the University of Palermo that will offer to the outside, among the few centres in the world, the possibility of a chain that goes from the synthesis of materials up to live testing. ATeN has two hubs: Chab and Cga. January 2016 saw the set up of the Chab Mediterranean Centre, a research structure in the field of Advanced Biotechnology for Human Health, characterised by interdisciplinary and convergent skills, different services and advanced technologies. Funded with about 30 million Euros by the European Community, Chab wants to be a benchmark for new design ideas and new technology transfer activities for researchers and companies from Sicily and other regions in the Mediterranean. The facility is able to attract the best international researchers, providing them with the tools and cutting-edge technologies to the produce and analyse advanced biotechnologies. In addition, the university has decided to also include as part of the system, in a more general University Service Centre the pre-existing Large Equipment Centre (Cga-Centro Grandi Attrezzature), in order to widen the range of services and expertise. ATeN Center - Advanced Technologies Network Center - is directed by Professor Maurizio Leone.

The headquarters

Self-assembly of molecules

A project to obtain new hydrogel biomaterials, for high impact in medicine

Chirality is the property of an object that is not superposable on its mirror image. In chemistry, this feature is crucial for bioactive molecules, and this is the basis for an articulated SIR project created by Dr. Silvia Marchesan at the Dscf of the University of Trieste that started a few months ago, and that is entitled Hot-Spot - HeterOchiral, shorT, Self-assembling Peptides fOr Therapy. This laboratory project uses amino acids (i.e., protein building blocks) with different chirality to obtain small, simple peptides that are able to self-assemble into bioactive "superstructures" that go far beyond the sizescale of the individual molecules. "The idea - says Marchesan - is to obtain smart, nano-structured, water-based biomaterials that are environmentally friendly, and that offer innovative therapeutic solutions. On the one hand, the purpose is to develop new antimicrobial hydrogels that do not suffer from the typical issue of resistance to current antibiotics. On the other hand, we want to modulate the self-assembly of these molecules to find innovative therapies for neural degenerative illnesses such as Alzheimer's." Marchesan, who has several years of research experience abroad, is the head of an international team of young researchers. "Financial support of this kind is key not only to promote the return to our country of Italian academics employed abroad, but also to attract foreign resources and talented staff", she concludes.



The Italian chemical industry being colored green

A new generation of additives for water and processes, which perform well while respecting the environment, designed by Celko Chemical

The Italian chemical industry takes the world's top place in terms of the development of innovative products that are also sustainable from an environmental point of view. These are slowly substituting those that are utilized today, which for the most part are very damaging for man and for the environment. This, what is called the chemical energy sector, is a highly competitive sector, where main players abound, each with their own inventions which have brought mutual benefits for the Earth's ecosystem and for the safety of those involved in it. Rossano Celani is one of these. Its winning experience forms a part of its professional history which is dotted with innovative discoveries seeking solutions, researching alternative substances, and bringing to life a variety of additives which are sustainable and which give excellent performance. Rossano Celani – a manager who looked ahead, with the great technical and scientific competence which he matured at the beginning of his career in an Italian company in this sector – decided in 1989 to set up on his own and found Celko Chemical Srl. Celko Chemical is today brilliantly involved in the production, selling, and application of auxiliary chemical products for industry, designed for energy savings, the protection of industrial plants, and the preservation of the environment. And so began a production of elevated technological content which has permitted Celko Chemical to carry out its strategy of growth and to project itself, with extraordinary results, at international level. Thanks to the company's perfect organization, both flexible and dynamic, it is among the most qualified in the sector, in particular in the processes of desalination, intended as the distillation of sea water, and in membrane processes, starting from those of reverse osmosis. In this field the company has developed very competitive products which have had great success on the global market. Today Celko is a "gem" of the Italian chemical industry. It has a range of products and of application technologies that give elevated performance, and a range of skills and competences whose value is constantly being added to, thanks to experience in the field. "A hyper-specialized service company which is able to resolve, with solutions studied ad hoc in its labs, any problem in any context, even the most difficult ones – explains Rossano Celani -. What has always distinguished us from our competitors is in fact the immediateness with which we intervene, thereby guaranteeing and ensuring an efficient assistance service and the monitoring of each single plant. This has allowed the company to transmit the feeling of security to its clients (which range from the giants in the energy sector – like, Enel, Alstom Power, and EdF – to petro-chemical multinationals like Dow and to small and medium-sized companies). This is concretized in their certainty to be able to set up plants and systems that are safe and reliable over time. And this is dues to the additives signed off by Celko". So we are speaking of a production sector that is in constant evolution. Where the investment in Research&Development is high. And whose goal is to implement and develop technologies that are oriented to the production of a new generation of products, what has been called "green chemicals", which, when applied, bring visible improvements in many diverse fields – from the chemical treatment of cooling water (corrosion inhibitors, anti-scalant agents, anti-fouling agents) to desalinization/reverse osmosis; from the chemical treatment of furnace water and the water thermal cycles/vapor (de-oxidizing, conditioning, corrosion inhibitors) to the auxiliaries of the sugar and paper industrial processes. "We are involved on a daily basis in taking our sector back to its origins – affirms the company founder – that is to applied technologies and science. This is why chemical technologies and 'fine chemicals' which are fine-tuned and applied by us, are born of the long and qualified work of specialized technicians and are the final synthesis of studies and experiments in the lab, with applied experience in systems and plants". The final point of arrival for every project Celko develops, is always to improve on the sustainable technologies designed to reduce environmental impact and to improve chemical and energy efficiency. "Our primary goal is not just to sell chemical products – adds Stefano Celani, the son of the founder, who for several years now has an operational role, along with his sister Alessia – but to supply, in equal measure, a scientific support which makes us true technological partners and not just suppliers for our clients, in accordance with the revised concept of Quality Insurance which confers primary importance on the complete satisfaction of the above". Today the market recognizes the credibility and competence given by this company from the Region of Campania, and so the management is determined to continue to research and develop alternative products. But the effort to do so is demanding. To continue to grow – the founder confides in us – we are also evaluating the hypothesis of identifying an industrial or financial partner, be they private or governmental, in order to write, together, another special chapter in the history of "green" chemicals in Italy.

Today Celko is a gem for Italian chemistry

Rossano Celani with his children, Stefano and Alessia