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SPECIAL FEATURE

EXOPLANETS: THE HOPE OF LIFE BEYOND EARTH



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**POSITIVE
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**NOVEL 5G
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EDITORIAL

by the editorial team

FROM EXOPLANET TO HABITABLE WORLD: THE DEVIL IS IN THE DETAIL

Exoplanet researchers across the world are seething with excitement. As we were preparing this issue of the *research*eu results magazine*, NASA had just announced that Kepler had recently added an additional 1 284 hunting trophies to its bag — bringing the total number of Kepler-verified exoplanets to more than 2 000.

This is definitely one giant leap for mankind. Yet much work is still needed not only to better understand the dynamics of these planets, but also to identify which ones can definitely sustain life and, in a hypothetical and very distant future, be worth the journey from Earth.

First, by observing alien planets, Kepler and other space telescopes have challenged our ideas of how planets form and evolve. Last year for instance, a small star with a giant planet the size of Jupiter orbiting it very closely was found. While researchers

**'Much work is still
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said it must have formed further out and migrated in, they admitted that current theories couldn't explain how this had happened. More recently, in March 2016, the highly eccentric orbit of an exoplanet, also about the size of Jupiter, made scientists realise that not all Jupiter-sized planets had circular orbits. And these are just a few examples in a long list of brainteasing observations.

Meanwhile, a more popular quest to find the closest thing to an Earth-like planet is keeping space researchers busy. So far, 21 rocky, potentially habitable planets have been confirmed from Kepler's data. But as it takes more than a rocky ground and a decent amount of light and heat to create life, additional efforts are needed to study the atmosphere of these planets or verify the presence of liquid water on their surface.

This month's special feature focuses on EU-funded exoplanet research projects that hope to lift the veil on the mysteries of planet formation or provide more detailed information on their potential habitability.

It is followed by the usual eight sections providing insights into biology and medicine, social sciences and humanities, energy and transport, the environment and society, IT and telecommunications, industrial technologies, security and safety, and space, along with a list of upcoming events hosted by or involving EU-funded research projects.

We look forward to receiving your feedback. You can send questions or suggestions to:
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feeding humanity
while maintaining
nature's balance

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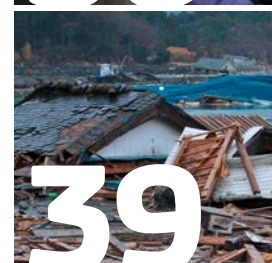
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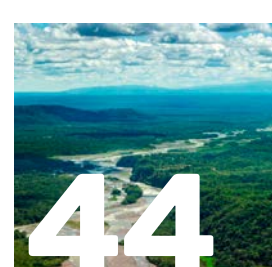
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"We do not really care if a planet has an orbital period of 12.1 or 12.2 days, but we should care whether a planetary system is real or not."

SPECIAL FEATURE **EXOPLANETS: THE HOPE OF LIFE BEYOND EARTH**

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INTERVIEW

PASTIS HELPS CONFIRM EXOPLANET EXISTENCE WITH NOVEL SOFTWARE

While the recent increase in the detection of exoplanets raises a distant hope of finding another habitable world, it also begs questions related to the accuracy of current detection software. Is there really an exoplanet where we thought there was one? The PASTIS project is coming up with new software to clear up these doubts.

New exoplanet detection instruments with improved capabilities are starting to be rolled out. But as highly performing as these technologies may be, the detection and characterisation of extrasolar low-mass planets is currently limited by various astrophysical and instrumental effects. The precise characterisation of the host star, the modelling of stellar jitter and the existence of false-positive scenarios are particularly challenging.

According to Prof. Alexandre Santerne, Marie Curie fellow from the Centre for Astrophysics at the University of Porto in Portugal and coordinator of the PASTIS (Planet Analysis and Small Transit Investigation Software) project, overcoming these obstacles to Earth-like planet detection will require major improvements in analysis software so as to take these limitations into account.

The two-year project aimed first at implementing such improvements into Prof. Santerne's state-of-the-art PASTIS software, after which he hoped to validate new small and low-mass planets among the CoRoT, Kepler and HARPS data using the freshly-improved PASTIS software.

★ **What would you say are the main limitations of current data analysis software?**

Prof. Alexandre Santerne: In the field of exoplanets — at the very least — the main limitation we face is the

current lack of knowledge of the host stars and in particular their variability (granulation, spots, magnetic cycles). Even for the Sun, recent high-precision observations showed that state-of-the-art analysis techniques would likely fail in finding or characterising inner solar system planets.

Because of this lack of understanding of stellar variability, analysis software is not able to disentangle variability signals from planetary signals. This means that a substantial fraction of small planets reported so far might not be there. As I always say during outreach talk, if we find an Earth-like planet in the habitable zone of the nearest star, we might try to build a (very expensive) mission to visit this planet. But what will happen if in the end there is no planet? It would clearly be a disaster!

★ **The PASTIS software existed before the actual project started. How does it compare to other state-of-the-art solutions?**

The PASTIS software is conceptually completely different from other solutions in Europe. While most state-of-the-art software has been designed to derive the most precise and accurate parameters for a planetary system, PASTIS has a different objective: it aims to estimate the probability of a given planetary system being real and not mimicked by something else, in most cases whatever the parameters



© ALEXANDRE SANTERNE

PROF. ALEXANDRE SANTERNE

are. To me, this is a fundamental difference. We do not really care if a planet has an orbital period of 12.1 or 12.2 days, but we should care whether a planetary system is real or not. This is exactly what PASTIS is doing.

★ **What kind of software improvements did you aim for?**

The initial goal was to include stellar models into PASTIS, to better validate small exoplanets and characterise them, in particular in the case of stellar variability.

★ **We are now only a few months away from the end of the project. Would you say that you are on track to meet your initial objectives?**

Not completely. Some of the initial objectives were tested but resulted in a substantial slowing down of the software, to a level that would make the validation of new planets within the duration of the project impossible.

Therefore, I searched for alternative solutions to meet the initial objectives, keeping the code relatively fast to run. I succeeded for the most part. The main objectives in terms of software improvement have now been implemented and validated.

★ **What was the nature of that problem?**

Well, the main difficulty was in improving the software in terms of complexity without increasing computing time. This was clearly the main challenge of this project and it required alternative solutions. As always in physics, when we are faced with an overly complex system, we try to find reasonable approximations.

★ **What about the validation of new planets, which was also one of your main objectives?**

New planets were indeed validated using PASTIS and published: K2-19 b & c (a system of two Neptune-size planets — Armstrong, Santerne et al., 2015) and WASP-121 b (an interesting hot Jupiter — Delrez, Santerne et al., 2016). More systems are currently being analysed, including Earth-size planets.

★ **What are your plans until and after the end of the project?**

Thanks to this Marie Curie fellowship, I just got a faculty position in France / Marseille, starting this fall. So, I will continue developing and using PASTIS to validate exoplanets and for the preparation of the ESA PLATO space mission. In particular, I plan to exploit the new data from the GAIA mission to improve the validation of planets with PASTIS. The improvement of the code, making it even faster, is also among my top priorities for the next few years.

PASTIS

- ★ Coordinated by the Centre for Astrophysics of the University of Porto in Portugal.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/188093>

CALIBRATING EXOPLANETARY ATMOSPHERES USING BENCHMARK BROWN DWARFS

An EU-funded researcher has developed an innovative new tool, furthering our understanding of giant planet atmospheres and, ultimately, how planets are formed.

Scientists are constantly trying to understand how planets are made, a task that requires them to observe exoplanets and measure their composition — which is easier said than done. Although over the last few years there have been a number of new instruments built on telescopes capable of taking direct images of planets and stars, the cloudy atmospheres of their targets make interpreting these observations tricky.

Through the EU-funded CALEXOPLAN project, Marie Curie Fellow Dr Ben

Burningham has developed a new code that allows for the interrogation of this data and the measuring of composition, temperature profile, surface gravity and cloud properties in cases where obscuring clouds are present. The tool has been tested on self-luminous brown dwarfs, with hopes of transitioning to exoplanets in the near future. 'Because we're dealing with cases where clouds are present and blocking the light from deeper in the atmosphere, it's crucial to calibrate and make sure our tools are working the way we expect,' explains Dr Burningham.

Testing model

Brown dwarfs are similar to giant planets, but are formed on their own rather than from discs around stars, which makes them easier to observe in many ways. 'They don't have the light of a bright star next to them, so we can get better data and start out with a better idea of what they're made of,' says Dr Burningham. 'We can use them as benchmarks, and right now we're at the stage of using them to calibrate our new remote sensing tool.'



'No one has done this in these kinds of objects where there are clouds, so the CALEXOPLAN project is running the first field tests on brown dwarfs where we have different types of clouds present,' adds Burningham.

Dr Burningham's tool uses a technique called atmospheric retrieval, a

technique common for people who study planets within our solar system, but not for those studying brown dwarfs and self-luminous giant planets. 'It's taking a tool that is used in solar system work and rewriting it for self-luminous planets outside of the solar system, young planets that shine

themselves rather than being visible through reflected star light,' he says.

End goal

In the immediate future, results will not be tangible for the general public, but this ability to observe brown dwarfs, even with cloud coverage, is an important technique for future studies of how planets are made and their habitability.

'For example, we may find that our understanding of the interaction of the atmospheric gases with light is not as good as we thought it was, and this feeds into a bigger picture for those who want to study biological signatures in the future,' concludes Dr Burningham. 'It's curiosity-driven science rather than industrial application, but these are questions that speak to our origins and that humans have been trying to answer for a long time.'

CALEXOPLAN

- ★ Coordinated by the University of Hertfordshire in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/186684>

WORLDS BEYOND OUR SOLAR SYSTEM

Astronomers have long suspected that other star systems in our galaxy and the Universe may have orbiting planets of their own. EU-funded scientists have now developed direct methods for actually acquiring an image of these extrasolar planets.

One of the main reasons why extrasolar planets are difficult to observe is because they are fainter than the stars they orbit. In addition, the host stars give off light that obscures them from direct observation. As a result, the first discovery was not made until 1992 when astronomers using the Arecibo Observatory in Puerto Rico observed several planets orbiting the pulsar PSR B1257+12.

Since then, some extrasolar planets have been directly observed with telescopes. However, the vast majority has

been detected through indirect methods such as the transit method. The EU-funded DICE (Direct imaging of extrasolar planets from LBT and VLT to E-ELT) project paved the way for new discoveries using the direct imaging

To increase the sensitivity of direct imaging of extrasolar planets, DICE scientists developed two new coronagraphs. These angular filters that suppress the halo around the bright host stars were used at the Very Large Telescope (VLT) in Chile and the Large Binocular Telescope (LBT) in the United States. Thanks to their improved design, it was possible to acquire images of the extrasolar planet β Pictoris b and a low-mass protoplanet.

Project scientists also developed new adaptive optics techniques that have led to new insight into how wide-field spectroscopy could be carried out on extremely large telescopes. A network of small telescopes distributed around an extremely large telescope can acquire images along multiple different lines of sight by looking in the direction of bright guide stars.

With state-of-the-art astronomical instruments of the European Extremely Large Telescope (E-ELT), DICE scientists plan to continue the hunt for extrasolar planets. The discovery of Earth-like planets also intensifies interest in the search for extraterrestrial life, particularly regarding those that orbit in the host star's habitable zone.

"To increase the sensitivity of direct imaging of extrasolar planets, DICE scientists developed two new coronagraphs."

capabilities of ground-based telescopes in Europe and the United States.

DICE scientists completed surveys on gas giant planets around nearby stars. Specifically, they investigated the formation and evolution of planetary systems in our galaxy. Massive stars that are relatively young in comparison to our own Sun were the starting point. Next, they looked at stars similar to HR 8799 with four planets orbiting around it.

DICE

- ★ Coordinated by Leiden University in the Netherlands.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/91794>

INTERVIEW

GRAND DISCOVERIES SHED LIGHT ON THE DYNAMICS AND EVOLUTION OF MULTIPLE PLANETARY SYSTEMS

The path to the complete understanding of exoplanets is undoubtedly a long one. To help the scientific community solve remaining puzzles, an EU-funded project is studying the role of binary planetesimals in planet formation, exploring planetary satellites and investigating the underlying physical processes involved in the assemblage of exoplanet systems.

The GRAND (GRAVitational N-body Dynamics: Dynamics and evolution of multiple planetary systems) project has two core objectives: understanding the formation and evolution of planetary satellites, multiple moon systems and binary planetesimals and their role in planet formation; and characterising the properties and evolution of multiple-planet systems.

Although it runs until February 2017, the project has already come a long way. Some of its most interesting results so far include the finding that impactors on Earth-like planets could have a very similar composition to the planets they impact, a detailed analysis of the order of the planets in multiple planetary systems, and stability criteria for moon survival in multi-planet systems.

Prof. Hagai Perets, coordinator of GRAND and Assistant Professor at the Physics Department of Technion in Israel, outlines the project results so far.

★ **Why did you decide to focus your research on multiple planetary systems?**

Among the thousands of new exoplanets discovered over the past few years, a large number are multiple-planet systems, and it's very likely that many of the 'single' planet systems have additional, but as yet undetected companions. Essentially, any attempt to understand planet formation and the structure of exoplanet systems has to deal with multiple-planet systems. In light of my expertise in stellar and planetary dynamics, this field is a natural choice given its important and rich physics.

★ **What is the specific benefit of studying the evolution of such systems?**

The interaction between planets and moons in planetary systems plays several important roles in the formation and their respective growth through collisions, as well as in shaping

their structure. These interactions occur over both the short and very long term and change the orbits of the planetary objects. Understanding these interactions is therefore crucial in explaining the origins and characteristics of exoplanets and of our own Solar system.

★ **What kind of data did you use for your research?**

My research is mostly theoretical and I use both analytic and simulation tools to model the evolution of planetary systems. In terms of data, I use both data from simulations as well as data from observations, most notably data obtained from the Kepler mission for transit detection of planets, missions exploring the Solar system and its moons, as well as data from ground telescopes.

★ **You notably solved an old problem regarding the Earth-Moon composition similarity. Can you elaborate on that?**

The origin of moons had been debated over the previous century. The main paradigm over the past 40 years has set out that the Moon was formed following a giant impact of a Mars-like object with the proto-Earth. These models had proved successful in explaining most of the properties of the Moon and the Earth-Moon system.

However one main challenge could not be overcome — the composition problem. It was found that the isotopic compositions of the Earth and the Moon are very similar. However, simulations of giant impacts showed that most of the material eventually forming the Moon had to come from the impactor and not the Earth itself, as is the case for other planetary objects in the Solar system such as Mars and the asteroid Vesta. This problem had become even more acute as improved composition measurements showed



PROF. HAGAI PERETS



how similar the Earth and the Moon are.

In my research I have reconsidered some of the basic assumptions in this logic, and in particular I asked the question of whether the composition of impactors is as different as that of other non-impacting planets in a Solar system. We used data from dozens of extensive simulations of Solar system-like formations and studied the compositions of the planets and those of Earth-like impactors. We found that although different planets had different compositions, the composition of impactors (just before the impact) was much more similar to the planet they hit. Moreover, in a non-negligible fraction of the cases, we found that there were as many composition similarities between the Moon-like object expected to form and the planet they impacted as between the Earth and the Moon. In other words, we showed that the 40-year old composition problem might not be a problem at all, and that the giant-impact hypothesis can overcome it.

★ **How do you hope your study of the order of the planets in exoplanet systems will contribute to future theoretical predictions?**

One of the projects I'm working on is exploring the order of planets in exoplanet systems — if we have three planets of different sizes we could have six permutations of how to order them, for example. The order of the planets is a result of a complicated evolution, much like other properties of the planets like the ellipticity (eccentricity) of their orbits or the distribution of their size. The latter two serve as important properties where distribution can be used to constrain the formation processes of the planets. As such they are studied extensively.



In my research I try to advance the notion that the order of the planets is another property which has hitherto been mostly ignored, but can convey as much if not more information than the other, heavily studied, properties. Our preliminary results show that the properties of the order of the planets are not trivial and are not consistent with many of the current predictions — hence they provide new observational constraints on theories for the formation of exoplanets.

★ **Other than that, what would you say are the most important things you have learned from the research so far?**

Among other things I devised a completely novel method for analysing data from the Kepler mission so as to determine the distribution of the inclination between exoplanets' orbits and their host star — an important property for understanding their evolution. This new method provided for the first time large-scale statistical properties of the inclination distribution and its relation to

planets' sizes, distances and multiplicity, something that could not be obtained with any other existing method.

★ **The project ends in February 2017. What do you hope will be its overall impact when you've achieved all of your objectives?**

I hope the project will shed new light and open up the study on the order of multi-planet systems, and hence relate and correlate the properties of different planets in the same system — an issue which has rarely been explored so far. I also hope to change our views of satellite systems and their formation and dynamics, with respect to both the Earth-Moon system (which I further explore) and other Solar system moons.

GRAND

- ★ Coordinated by Technion in Israel.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/project/rcn/107309>

EU RESEARCHERS SET TO CREATE WORLD'S FIRST SEMI-COMMERCIAL SPACE MISSION

An EU-funded project is aiming to raise private sector funds for a new space telescope to study exoplanets, potentially becoming the world's first semi-commercial space mission.

The EXODATA (A commercially supported space telescope) project is aiming to raise as much as half of the cost of a new space mission by selling satellite time and data internationally. If successful, this mission could revolutionise the funding model for space missions which, up until now, have been largely funded by the public sector.

The space mission, called Twinkle, is set to launch in three years. The Twinkle telescope will scan exoplanets — the planets orbiting the stars we see in the night sky — and will aim to find out what they are made of.

Information gathered by the satellite is likely to include a planet's chemical composition and its weather systems.

Ultimately the mission will allow scientists to determine whether or not it could support life or indeed is already inhabited. EXODATA has already determined where there might be a market for data gathered by the Twinkle satellite.

'Research institutes and universities in regions of the world that do not have

access to space technology, including South America and South East Asia, are strongly interested in our project,' outlines Jonathan Tennyson, EXODATA project coordinator.

According to Tennyson, market surveys carried out by the project have uncovered a particular interest in buying satellite time. This could mean selling a slice of time such as a few satellite orbits of the Earth which lasts around 90 minutes. Those buying the time would then be able to determine which data collected by the satellite they are interested in. 'We are now at the stage of getting potential buyers to commit to writing letters of intent to buy Twinkle's time and data. To achieve this, we have hired two business development managers who will tour the world to secure our potential customers,' he adds.

The funds raised by the private sector will support the technical development stage of the Twinkle telescope over the next three years. Meanwhile, the remaining project costs will be paid for by the public sector and philanthropists.

As well as being the world's first commercially-backed space telescope, the Twinkle mission is also aiming to reduce the costs of a space mission. 'The overall cost of Twinkle is a fraction of the cost of a publically-funded space mission,' says Tennyson.

To bring down the costs, the mission will use satellite technology that has already been tried and tested. Surrey

Satellite Technology Ltd will construct the spacecraft using a platform it has already developed for high-resolution Earth imaging.

Twinkle will also reuse existing software and have a high level of autonomy to minimise operational costs. The semi-commercial funding model is another way of helping to bring down costs since it is faster and cheaper, he adds.

'The project seems to be going well. I am cautiously optimistic that our novel funding model will succeed. If it works, we already have other scientists interested in using us and our model to fund the launch of their satellites,' Tennyson concludes.

"We are now at the stage of getting potential buyers to commit to writing letters of intent to buy Twinkle's time and data."

EXODATA

- ★ Coordinated by University College London in the United Kingdom.
- ★ Funded under Horizon 2020.
- ★ <http://cordis.europa.eu/news/rcn/125320>



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INTERVIEW

A WATER DETECTION TECHNIQUE TO SHORTLIST POTENTIALLY-HABITABLE EXOPLANETS

So far, NASA's Kepler has led to the discovery of 2 325 exoplanets. But clearly not all of them are habitable. To help detect suitable candidates, identify the range of atmospheric conditions on planets with water and shed light on how planetary magnetic fields originate and evolve, the HOTMOL project is devising new tools relying on spectro-polarimetry.

To qualify as an exoplanet, a planetary object needs to meet four criteria: the first two are a mass or minimum mass equal to or lighter than 30 Jupiter masses and the presence of a host star. Then, to prove that the found object satisfies these criteria, sufficient follow-up observations and validation to rule out the possibility of facing a false positive, as well as the availability of such information along with other orbital and physical properties in peer-reviewed publications, are needed.

Identifying an Earth-like planet that can sustain life is, however, a whole other story. Life as we know it notably requires liquid water, a molecule that current technologies are capable of detecting only on hot Jupiters.

To overcome this problem, the EU-funded HOTMOL (Hot Molecules in Exoplanets and Inner Disks) project uses spectro-polarimetry in the hope of detecting hot molecules — water vapour and other volatiles — on exoplanets and in the inner part of protoplanetary disks. This is a key objective of the project, along with taking the first steps towards understanding how planetary magnetic fields originate and evolve, and how efficiently they shield the atmospheres from dehydration by the stellar wind.

The HOTMOL project is led by Prof. Dr Svetlana Berdyugina from Albert Ludwigs University of Freiburg in Germany. She outlines how the project will lead to sensitive methods for detecting hot molecules on exoplanets, and how such

SPECIAL FEATURE

results are fundamental for advancing current understanding of the star+planet system.

★ **How can the presence of hot molecules inform us about the presence of water on specific exoplanets?**

Prof. Dr Svetlana Berdyugina: We find hot water molecules in stars and hot Jupiters, at temperatures of thousands of degrees, and cold water molecules and ice in interstellar clouds and the outskirts of the Solar system, at only a few degrees Kelvin.

To sustain life as we know it, liquid water on the planetary surface is a prerequisite. But detecting liquid water on exoplanet surfaces, and especially on a potentially-habitable Earth-size planet, is not yet possible. However, what we do know is that, if water exists on the surface, it must also be present in the planetary atmosphere in the form of water vapour, evaporating under stellar irradiation together with other related molecules. These hot molecules are key to defining the habitability of planets, and devising sensitive methods to detect them on exoplanets is the first step towards detecting extraterrestrial life.

★ **What kind of methods did you come up with to detect these hot molecules?**

The major problem in studying exoplanetary systems is to separate the planetary light from the outshining stellar light. To achieve this, the HOTMOL team employs a smart double-differential technique called spectro-polarimetry.

Firstly, the planet signal is distinguished in spectral lines, because particular molecules may not be present in stellar spectra or can be shifted in velocity with respect to stellar lines. Secondly, planetary spectral lines become conspicuous in polarised light near certain orbital phases. Thus, the lines would appear and disappear in polarised light periodically as the planet orbits the star. This approach increases detection sensitivity by at least an order of magnitude, and it is also a sanity check for the detection of molecules using only spectroscopy.

The spectral and polarisation signals combined provide unique information on physical conditions in both exoplanets and near-stellar planetesimals. An unexpected spin-off of this project was employing the same technique for detecting photo-synthetic organisms on distant planets. We have measured polarised spectra of terrestrial plants and bacteria and computed spectra of Earth-like planets with photosynthetic biosignatures. We showed that our technique is much more sensitive than others to such biosignatures. It is possible that such signals can be searched for with current large telescopes in a few nearby planetary systems, especially around Alpha Centauri A and B stars, if planets were to be found there one day.

★ **How do these techniques compare to current ones?**

Current observations employ only unpolarised flux and spectra to detect exoplanets. The HOTMOL team leads the effort to power these studies with polarised light. As explained earlier, the sensitivity is already an order of magnitude better in polarised light, but it is still being improved by implementing new optics and electronics technologies.

Moreover, polarised flux variations are observable independently of whether the planet transits the star or not, which provides this technique with a potential for application to a much larger sample of exoplanets. A spectral cross-correlation technique employed by others has proven its potential to detect exoplanets. Enhancing it with polarisation measurements will deliver a wealth of information on the physics of their atmospheres.



© Svetlana Berdyugina

PROF. DR SVETLANA BERDYUGINA

★ **What would be the technical prerequisites to using these tools in exoplanet research?**

While developing novel techniques is our first challenge, implementing them for a broad usage is our final goal. In particular, having a dedicated observing facility such as a network of telescopes equipped with high-sensitivity polarimeters is an important prerequisite.

Together with our collaborators at the University of Turku (Finland) and the University of Hawaii (USA) we have constructed several copies of our high-sensitivity polarimeters which are employed in telescopes around the world: in La Palma and Tenerife (Canarias), Mauna Kea and Haleakala (Hawaii), and at the end of this year also in Tasmania. We are also members of the PLANETS telescope consortium (Polarized Light from Atmospheres of Nearby Extra-Terrestrial Systems) together with the Hawaii (USA) and Tohoku (Japan) Universities. This telescope to be constructed at Haleakala will be one of the dedicated facilities in our network.

Unambiguous detection of life on exoplanets requires a much larger facility. The first steps will be perhaps taken with the 30m-class telescopes, such as the ESO E-ELT to be built in Chile, but systematic studies of life distribution in the solar neighbourhood will require a 100m-class facility such as the Colossus and Exo-Life Finder (ELF) telescopes to which we contribute science cases.

★ **What do you still need to achieve by the end of the project?**

During the four years of the project we have developed many theoretical tools and obtained and analysed a lot of observational data. The last year of the project is dedicated to finalising many publications which are now being prepared by team members. Towards the end of the fifth year we will organise an international conference and school on hot molecules and biosignatures in exoplanets, where we will present our results and provide the community with tutorials on how to use our tools and data.

★ **When and how will these tools be made available to the community?**

Making our theoretical tools available for use by a broader community is one of HOTMOL's major goals. We have developed a dedicated website where our tools can be run online, even using a mobile phone. They now include computations



of molecular magnetic properties, molecular polarised spectra, exoplanetary transits and eclipses, polarised reflected light from exoplanets, and stellar scattered polarisation. We continue adding more tools for exoplanetary studies and will maintain this website beyond the project end. Our resources also include data obtained with our instruments. The use of the tools is free for everybody via online registration.

HOTMOL

- ★ Coordinated by the Kiepenheuer Institute for Solar Physics in Germany.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://cordis.europa.eu/project/rcn/102784>
- ★ Project website: <http://www.hotmol.eu>

SCIENTISTS SEARCH THE STARS FOR POSSIBLE LIFE

EU researchers have pioneered new calibration strategies for detecting 'habitable' planets outside our solar system — with impressive results already.

The existence of extra-terrestrial life presupposes the existence of habitable planets — like Earth — outside our solar system. What makes our own planet so special is the fact that it has a solid outer crust and is located at a distance from the sun where liquid water can exist. Only a few other planets satisfying these 'habitability' criteria have ever been discovered.

Through pioneering new calibration strategies for detecting the tiniest variations in light waves from stars, the EU-funded WAVELENGTH STANDARDS (Development of new wavelength standards for the search for habitable planets) project aims to help astronomers find new 'habitable' planets, and perhaps one day help us answer the question of whether we are truly alone in the universe.

Star performance

The five-year project, due for completion at the end of 2016, has already recorded several achievements. 'We have

participated in several international, long-term projects with the instruments we have helped to develop and build,' explains project coordinator Professor Ansgar Reiners from the Georg-August-Universität Göttingen, Germany.

'These projects have involved the search for extrasolar planets and life elsewhere in the universe. Some discoveries have proved important for our understanding of planet formation, such as the planet we found orbiting Kapteyn's star.'

WAVELENGTH STANDARDS has also made a significant contribution to the CARMENES project, which built two spectrographs (instruments to measure wavelengths) with sensitivity extending into the infrared in order to search for Earth-like planets around low-mass stars. Reiners' team was responsible for calibration, data reduction and analysis.

'Another success has been our responsibility for calibration in the CRIRES+ project at the European Southern Observatory's (ESO) Very Large Telescope. Our group is

also going to be in charge of the calibration unit for the design of the planned high-resolution spectrograph for ESO's flagship project, the 39 m European Extremely Large Telescope (E-ELT).'

Funding from the EU's European Research Council (ERC) also enabled Reiners to carry out high precision experiments with local telescopes and couple them with state-of-the-art frequency calibration methods (called laser frequency combs). 'We were able to install all necessary equipment required for highest precision measurements in-house,' adds Reiners.

"We have participated in several international, long-term projects with the instruments we have helped to develop and build."

On the right wavelength

In order to detect 'habitable' planets outside our solar system, extremely sensitive equipment is required. Minute, periodic changes in starlight, which indicate that the star is being orbited by a planet, must be identified.

Such investigations require ultra-precise light sources that can be used as reference points to allow the measurement of light wavelengths. For 'cold' stars however — the type of stars that are closest to us — the calibrations required have until now simply not been available.

'A small, Earth-like planet is detectable as a change in wavelength observed from a star; in other words, the star very slightly changes colour,' explains Reiners. 'This is why we need new wavelength standards that tell us at what particular wavelengths we are receiving from the starlight at any given time, and this is where our



project promises to make a difference. Our group is now one of the few worldwide that can provide calibration strategies and facilities for the next generation of radial velocity spectrometers.'

WAVELENGTH STANDARDS

- ★ Coordinated by the University of Göttingen in Germany.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://cordis.europa.eu/news/rcn/125340>

NEW DATABASE OF MOLECULAR LINE LISTS LIFTS THE VEIL ON THE COMPOSITION OF EXOPLANET ATMOSPHERES

Now that scientists have identified a very high number of exoplanets, the next step — and probably the most exciting one — will consist in shortlisting actual Earth-like planets. Doing this requires an enormous quantity of spectroscopic data which the EU-backed EXOMOL project just so happens to have compiled in a single database.

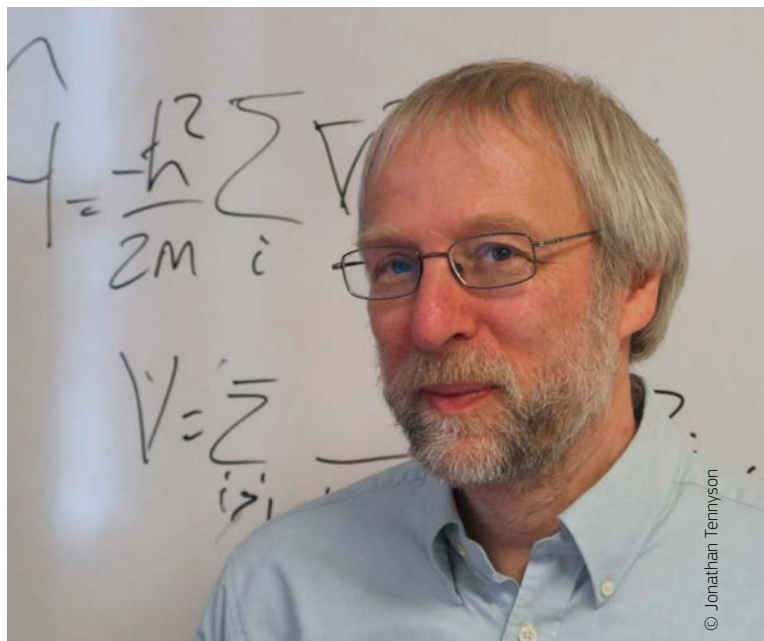
Completed in April 2016, EXOMOL (ExoMol: molecular line lists for exoplanet atmospheres) used a mixture of first principles and empirically-tuned quantum mechanical methods to provide comprehensive transition line lists for molecules found in hot atmospheres.

The huge database, which can be used to compute up to 100 billion transitions, will contribute to spectral characterisation and simulation, but will also serve as input to atmospheric models of exoplanets, brown dwarfs, cool stars and other models, including those of combustion and sunspots.

Prof. Jonathan Tennyson, who coordinated the project for University College London, highlights how this tool will prove invaluable in deriving the chemical composition, temperature and other fundamental characteristics of the objects the scientific community hopes to characterise thanks to a new generation of telescopes.

★ **Why is it valuable for the scientific community to be provided with comprehensive line lists for molecules found in hot atmospheres?**

Prof. Jonathan Tennyson: The way molecules absorb and emit light gets increasingly complicated with temperature. So modelling the way light passes through a hot atmosphere, such



PROF. JONATHAN TENNYSON

as that of a 'cool' star, brown dwarf or exoplanet, requires a huge quantity of data: perhaps several billion lines for a single molecule. EXOMOL has provided extensive line lists for the key molecules required in these studies.

★ **How will your work contribute to the effectiveness of new European-funded telescopes?**

These line lists are essential for interpreting astronomical observations from hot bodies. They provide the underpinning which allows one to extrapolate information from these observations. They are also important for providing models of the bodies in question.

★ **How did you manage to create these lists?**

Our approach is basically theoretical. We try to make a complete quantum mechanical model for how each molecule absorbs light. However, some parts (in particular the precise

wavelengths) are very hard to get right by solving the equations of quantum mechanics: they are too complicated to do it accurately enough. So we use all laboratory data there is

to help us improve the model. Many of the calculations are huge, so they require very large computers and lots of computing time.

★ **How can interested scientists benefit from your work?**

We provide the data on our website and we are also working with a number of groups to try and provide line lists in more manageable forms. You can imagine that running complex models with billions of lines is tough, so we try to convert our results into forms that are better tuned with models.

★ **More specifically, can you provide an example of a situation where EXOMOL will facilitate the work of the scientific community?**

Probably the best example is our methane result. We created the first comprehensive line list for methane with 10 billion lines — although it is still not complete at the highest temperatures of interest. Using this line list in models gave a fully quantitative model of T-dwarfs, cool failed stars that are sometimes called methane stars, an exercise in which other, previous models had completely failed.

Recently we have also been involved in the first study of the atmosphere of a 'super-earth' exoplanet. The use of our line lists showed that the only molecule with a clear signature was hydrogen cyanide! This is not a planet I would want to visit.

★ **The project ended last month. Are you planning to keep developing your database anyway?**

Absolutely. We have received some follow-up funding from STFC (the UK research council that funds astronomy research) and we still have a number of ongoing projects.

I should add that although the motivation and selection of molecules was aimed very much at astronomy, our line lists are widely used in other fields. Rather remarkably I am UCL's most cited engineer! We also have a couple of projects funded by people interested in monitoring hot gas emissions from smoke stacks. This environment is surprisingly similar to that of the exoplanets we are studying.

EXOMOL

★ Coordinated by University College London in the United Kingdom.

★ Funded under FP7-IDEAS-ERC.

★ <http://cordis.europa.eu/project/rcn/98590>

★ Project website:
<http://www.exomol.com>

"We created the first comprehensive line list for methane with 10 billion lines."



BIOLOGY AND MEDICINE

POSITIVE DIAGNOSIS FOR NEURAL THERAPEUTIC IMPLANTS

Ensuring implanted therapeutic devices are compatible with diagnostic systems will improve neurological healthcare and create new market potential.

The EU-funded DENECON (Devices for Neurocontrol and Neurorehabilitation) project was launched in 2013 in order to address a key challenge facing cutting-edge nano-electronic neuromodulation devices. These are minute therapeutic implants that are designed to stimulate nerve activity and help patients suffering neurological conditions to recover certain functions.

The problem is that while these devices have been shown to offer significant patient care benefits, many are incompatible with current diagnostic systems, such as 'Magnetic resonance imaging' (MRI) scanners. No neuromodulation system currently available on the market is certified as 'MRI' safe, and electronic neuromodulation therapy is typically perceived as

being a last resort because of this incompatibility. This has inhibited their widespread implementation.

The key objective of the DENECON project has therefore been to tackle incompatibility issues between 'Active implanted medical devices' (AIMD) and certain diagnostic systems. This will lead to improved healthcare and increased market acceptance of new therapeutic devices.

In order to achieve this, the project has carried out various tests, including a demonstration of an MRI-compatible 'Transcranial magnetic stimulator' (TMS) therapeutic device. New sensor and packaging technology for invasive and non-invasive neural sensing, again compatible with MRI, has also been developed, along with newly

developed methods to independently test the compatibility of therapeutic and diagnostic devices.

The project's work will now feed into recommendations for both AIMD and MRI manufacturers, as well as for companies involved in other high-tech medical fields such as ultrasound imaging and non-invasive neuromodulation devices. This could also be helpful in the development of future standards and technical specifications that address diagnostic and therapeutic systems.

The project comes at a critical time for Europe. An ageing population means that incidences of neurological diseases like Parkinson's disease and epilepsy are far more likely, leading to increased social and healthcare costs.

In addition, healthcare professionals forecast a strong increase in co-morbidity — the presence of one or more diseases in addition to a primary disease — as Europe gets older. If several diseases affect the same patient at the same time, diagnostic techniques and therapies for one condition may be incompatible with techniques needed to address another.

Demonstrating the coexistence by design of implanted neuromodulation therapy devices and key diagnostic systems will therefore make a significant contribution towards better and more efficient healthcare provision. At present for example, late-stage patients with

Parkinson's neurodegenerative diseases can only undergo MRI scans of a very restricted nature after implantation of neuromodulation devices.

The coexistence of therapeutic and diagnostic devices and systems is also important because the effectiveness and efficiency of therapeutic treatments can be multiplied by the simultaneous registration of neuronal functions.

Finally, the project will provide a significant boost to Europe's vitally important healthcare sector. Providing strong evidence of efficacy and safety will lead to further take-up of neuro-stimulation therapies and strengthen European intellectual property in the

field. This will enable European firms to increase their market share in therapeutic devices and strengthen their global position in diagnostic systems at the same time.

DENECOR

- ★ Coordinated by Philips Medical Systems in the Netherlands.
- ★ Funded under FP7-JTI.
- ★ <http://cordis.europa.eu/news/rcn/125099>
- ★ Project website: <http://www.denecor.info/en/home/>
- ★  <http://bit.ly/24NGc3n>

DRUGS RELEASED BY MAGNETS

Scientists have developed smart biomaterials that could deliver drugs to diseased tissues at specific times and are controlled by a remote magnetic trigger.

'Magnetic nanoparticle-vesicle aggregates' (MNPVs) are microscopic drug delivery systems that release their contents in response to a magnetic signal. Particles approximately a billionth of a metre in size are attached to drug-containing lipid vesicles, which are in turn embedded in a tissue-like hydrogel.

For applications such as tissue engineering or regenerative medicine, MNPVs need to deliver drugs or other bioactive materials to the affected site at the correct time. To do this, scientists turned MNPVs into magnetically responsive smart biomaterials in the EU-funded project MAGNANOVS (Magnetically responsive nanoparticle-vesicle hydrogels as

'smart' biomaterials for the spatiotemporal control of cellular responses).

The idea behind MAGNANOVS was to make MNPVs release drugs when exposed to a magnetic field, and then self-destruct once the payload is

delivered. This method could be used to convert an inactive prodrug into an active form after it is magnetically released from an MNPV.

Although researchers still need to overcome some hurdles, MAGNANOVS' nanoparticle-vesicle system shows great promise for delivering treatments to cells without affecting the surrounding tissues. Having demonstrated that it works using a model enzyme/substrate system, this method could also be used to develop biosensors and industrial catalysts.

"The idea behind MAGNANOVS was to make MNPVs release drugs when exposed to a magnetic field, and then self-destruct once the payload is delivered."

delivered. After working out how to chemically attach magnetic nanoparticles to lipid vesicles, scientists developed methods for magnetically releasing drugs from the resulting MNPVs in suspension.

One of their objectives entailed releasing two molecules that work together to trigger a cellular response — for example, an enzyme and its substrate. By magnetically releasing the digestive enzyme trypsin into a protein solution, researchers demonstrated that large biomolecules could be released from MNPVs in suspension rather than gels. The fact that trypsin remained active and digested the protein demonstrated the system's potential for delivering enzymes to cells to initiate a cellular response.

In a further innovation, researchers reversibly attached proteins and enzymes onto the surface of magnetic

MAGNANOVS

- ★ Coordinated by the University of Manchester in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/181093>



BIOARTIFICIAL LIVER THERAPY

Acute liver failure is a devastating clinical syndrome with a mortality rate of 60 to 80%. A 'bioartificial liver' (BAL) that supports natural liver recovery or bridges the period until a donor liver is available would be a lifesaver.

A BAL is a bioreactor loaded with potentially 10 billion embedded liver cells. The BAL used consists of a combination of a bioreactor and the human liver cell line HepaRG which closely mimics the human liver. This extracorporeal supportive device temporarily replaces liver function. The ideal BAL is based on human cells that mimic how a normal liver functions. It has to carry out three key tasks: detoxification, protein synthesis and regulation of homeostasis. HepaRG is the only human cell line in the world that is able to carry out these key tasks, particularly in combination with the AMC-bioreactor which provides an environment promoting cell maturation. Preclinical experiments have shown the effectiveness, safety and feasibility of BAL systems in a small preclinical model.

The EU-funded BALANCE (Development of a bioartificial liver therapy in acute liver failure) consortium has developed and upscaled the AMC-BAL and tested the BAL in a large preclinical model. The cell line was found to be functionally stable and not tumourigenic during growth on soft agar and in an *in vivo*

immunodeficient mouse model. The bioreactor was upscaled and met the regulatory criteria for biological and chemical safety, physical integrity and functionality. The culture conditions of the HepaRG-BAL were optimised, and it was found that BAL culturing decreased sensitivity to plasma toxicity. This suggests that repetitive single BAL treatments will increase therapeutic efficiency while decreasing costs.

An appropriate non-human clinical model based on paracetamol overdose was successfully developed. The main study showed that pronounced kidney, muscle and liver damage was slowed down or even reversed in the filled BAL-treated subjects. Further studies on the biobank samples are currently underway.

Regulatory documentation for initiating clinical trials in Europe has been established, including the clinical protocol and case report forms that can be accessed via the project website. This will be used in a full clinical trial in the future.

A comprehensive market analysis and a business plan have been finalised in

preparation for continuation of the research and clinical phases planned. The potential impact of an effective BAL system on healthcare is immense. In the future, it could offer thousands of patients a better outlook in terms of surviving severe liver failure.

BALANCE

- ★ Coordinated by AMC in the Netherlands.
- ★ Funded under FP7-HEALTH.
- ★ <http://cordis.europa.eu/result/rcn/151722>



MULTIDRUG RESISTANCE DEPENDS ON THE 'SOCIALITY' OF ANTIBIOTIC RESISTANCE

EU-funded research through the COEVOCON project has described how antibiotic resistance is strengthened by trace antibiotics found at much lower concentrations than previously thought.

The research, published in the journal 'Antimicrobial Agents and Chemotherapy', has shown how trace concentrations of antibiotics, such as those found in sewage outfalls, are enough to enable bacteria to keep antibiotic resistance. Alarming, the concentrations are much lower than previously anticipated, and this helps to explain why antibiotic resistance is so persistent in the natural environment.

methods to combat such resistance has become an increasingly prominent feature in the EU's healthcare policy priorities.

ARGs as a source of clinical resistance

The new research undertaken at the UK's University of York through the COEVOCON (Coevolution of bacteria and conjugative plasmids) project has highlighted how 'Antibiotic resistance genes' (ARGs) are a major source of clinical resistance. In particular, the research has described the different mechanisms of resistance as either 'selfish' or 'cooperative'. A selfish drug resistance only benefits the individual cell with the resistance, whilst a cooperative antibiotic resistance benefits both the resistant cell and the surrounding cells whether they are resistant or not.

The COEVOCON researchers came up with these findings by analysing a plasmid cell called RK2 in *Echerichia coli*, a bacterium which can cause infectious diarrhoea. RK2 encodes both cooperative resistance to the antibiotic

"The research has described the different mechanisms of resistance as either 'selfish' or 'cooperative'."

and misuse have led to the evolution of strains resistant to the most commonly used antibiotics. Antibiotic resistance has become a major threat to global health, with 'multidrug-resistant' (MDR) bacteria now being observed on a global scale. As a result, finding new and innovative

ampicillin and selfish resistance to another antibiotic, tetracycline. They discovered that selfish drug resistance is selected at antibiotic concentrations of around 100-fold lower than would be expected. This is equivalent to the residues of antibiotics found in contaminated sewage outfalls.

‘The most common way bacteria become resistant to antibiotics is through horizontal gene transfer,’ commented Dr Jamie Wood, one of the project researchers based at York. ‘Small bits of DNA, called plasmids, contain the resistance and can hop from one bacterium to another. Worse still, plasmids often contain more than one resistance.’

Michael Bottery, a PhD student actively involved in the research added: ‘There is a reservoir of antibiotic resistance out there which bacteria can pick and choose from. What we have found is some of that resistance can exist at much lower concentrations of antibiotic than previously understood.’

Limitations to the study and need for further research

However, the researchers have also suggested that there are some limitations to their study. They first point to the fact that there may be other factors, in addition to sociality, regarding differences in the fitness reaction norms of the antibiotics, such as the fact that ampicillin is bactericidal and tetracycline is bacteriostatic.

Secondly, the research used exemplars of cooperative and selfish resistance, and more research will be required to



test the importance of sociality in terms of the selective conditions for other resistance mechanisms.

The COEVOCON project began in January 2013 and will conclude in January 2018. It received approximately EUR 1 230 000 in EU funding.

COEVOCON

- ★ Coordinated by the University of York in the United Kingdom.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://cordis.europa.eu/news/rcn/125062>

THERAPEUTIC CONTACT LENSES

Delivering effective drug doses to the eye can be a challenge. To address this, a European study has developed novel drug-carrying contact lenses.

The bioavailability of most topical ophthalmic medications is surprisingly limited. The major obstacle to targeting the eye with therapeutics is the presence of various barriers such as the epithelium and the dynamics of eye tissue, which control the concentration and entry of solutes into the eye. These

barriers impede the effective passage of many drugs and lead to minimal dose absorption.

To address the reduced penetration and efficacy of topically applied molecules, most medications contain an increased dose of the active ingredient. However,

“Scientists tested a number of active molecules with different hydrophilicities for their capacity to interact with the lens and to achieve controlled release.”



this often leads to toxicity, therefore necessitating the development of more effective methods for delivering drugs. An ideal solution for chronic ocular conditions is the use of contact lenses that allow for controlled-release of the impregnated drugs.

The EU-funded THERALENS (Biomimetic therapeutic hydrogel layers for interaction with corneal tissues) project set out to advance existing technologies for attaching drugs to contact lenses by avoiding the use of toxic chemicals. To achieve this, they used novel biomimetic nanoparticles based on the phospholipid DMPC, which could be embedded with the lens. The novelty of these nanoparticles

lies in their chemical reactivity: on the inside, they can interact with hydrophobic drugs while retaining their water solubility; on the outside, in addition, the phospholipid is already present in the natural environment of the eye.

During the THERALENS project, scientists tested a number of active molecules with different hydrophilicities for their capacity to interact with the lens and to achieve

controlled release. They extensively optimised the strategy for coating these nanoparticles on the contact lens. This led to an overall surface improvement and enabled hydrophilic and hydrophobic ophthalmic drugs and phospholipid supplements to penetrate the tear film.

The THERALENS system of ocular drug delivery received a great deal of interest from the pharmaceutical industry, resulting

in a patent application. Commercial exploitation of this technology could increase the efficacy of ophthalmic medications, with fewer cytotoxic side effects.

THERALENS

- ★ Coordinated by Aston University in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/181094>

MOLECULAR MARKERS OF RADIATION-INDUCED CANCER IMPROVE RISK ESTIMATES

A European study has combined epidemiology and radiobiology to assess cancer risks in the breast, lung, thyroid and digestive tract after exposure to ionising radiation with low doses.

Due to a lack of statistical power and competing risk factors not under control, conventional epidemiology has limitations in studying cancer risks after exposure to ionising radiation with low dose. The EU-funded project EPIRADIO (Combining epidemiology and radiobiology to assess cancer risks in the breast, lung, thyroid and digestive tract after exposures to ionizing radiation with total doses in the order of 100 mSv or below) integrated molecular biology in the modelling of radiation-induced disease processes and improved cancer risk estimates based on epidemiological data.

A biobank of blood samples from over 370 donors belonging to the French Haemangioma Cohort was established as an import tool for future research on low-dose radiation effects in humans. DNA measurements of freshly frozen breast cancer samples from 46 female Mayak workers and

non-exposed controls revealed the 'Tumour necrosis factor' (TNF) and miRNA 3184 as candidates for markers of radiation-induced breast cancer. Studies on the DNA, RNA and protein level of thyroid cancer samples from two independent cohorts confirmed CLIP2 as a biomarker for radiation-induced thyroid cancer diagnosed in a person under 20 years of age.

Numerous biological endpoints have been measured for both low and high-dose exposures of primary human breast stem cells from cosmetic or elective surgery. Co-culturing human lung epithelial cells with fibroblasts enhances 'Epithelial to mesenchymal transition' (EMT), suggesting the importance of the microenvironment for pre-carcinogenic changes in normal epithelium. Extension of *in vitro* data on intercellular induction of apoptosis in oncogenic transformed cells to *in vivo* conditions indicates that irradiation may enhance or reduce induced apoptosis depending on system parameters.

Radiation treatment for haemangioma during infancy was found to cause, among Swedish females with familial predisposition, a breast cancer risk more than two times higher than among other females. A new model of carcinogenesis in the thyroid incorporating two different pathways of thyroid cancer depending on CLIP2 expression and based on post-Chernobyl data, decreased the uncertainty of radiation risk estimations considerably compared to assessments currently used in radiation protection. Colon cancer with chromosomal instability was found to be much more influenced by lifestyle than colon cancer with microsatellite instability.

Finally, EPIRADIO delivered quantitative cancer risk estimates for different exposure scenarios relevant to radiation protection.

EPIRADIO

- ★ Coordinated by Helmholtz Zentrum München in Germany.
- ★ Funded under FP7-EURATOM-FISSION.
- ★ <http://cordis.europa.eu/result/rcn/181109>
- ★ Project website: <http://www.epiradio.eu/>



SOCIAL SCIENCES AND HUMANITIES

FRESH THINKING NEEDED TO TACKLE 'CRIMMIGRATION'

EU researchers have suggested that Europe should re-examine current punitive migration control measures and ensure the judicial rights of migrants.

In addition to dealing with the current migration crisis, many European countries now have large numbers of foreign citizens among their prison populations — in some countries reaching over 50% — and operate extensive detention facilities for immigrants. All this has contributed to a progressive intertwining and merging of crime control and migration control practices in Europe.

The EU-funded CRIMMIGRATION ('Crimmigration': Crime Control in the Borderlands of Europe) project was launched in 2011 in order to analyse the impact that this growing emphasis on migration control is having on criminal justice agencies such as the police, prisons and detention facilities. For example, is the focus on punishment and reintegration of offenders gradually being replaced by a focus on diversion, immobilisation and deportation?

'Novel forms of punishment and new rationalities of social control have emerged, a phenomenon that could be termed "crimmigration" control,' explains project coordinator Katja Franko from the University of Oslo in Norway. 'In the course of this project we discovered how important deportation has become, particularly in certain countries such as Norway, and how criminal law is increasingly being used for the purpose of border control.'

Franko believes that new legal, organisational and normative responses are required to address this recent phenomenon. 'More awareness is needed of the punitive aspects of migration control measures — such as for example immigration detention and deportation — and the related need to provide procedural rights and legal aid to the affected populations,' she says. 'We also need new ways of thinking about who is the subject of rights and protection in European countries.'

Franko adds that policing agencies also need to see immigrants as equally important subjects for protection as EU citizens. 'This is why we suggest, among other things, a need for systematic counting of migrant mortality at the EU's external borders.'

In order to achieve its objectives, the project began by carrying out a series of ethnographic studies, interviews and analyses of legal and policy documents concerning the policing of EU borders, immigration detention facilities, prisons and deportation practices. Key research findings confirmed the project team's original hypothesis that mass migration is having a major impact on crime control practices and overall penal cultures in Europe.

Much of this valuable research has since been published in peer-reviewed scientific

journals; the project's article on the EU border control agency Frontex, for example, received the British Journal of Criminology Radzinowicz Prize for 2015. In addition however, a key priority throughout the five-year project has been to encourage the active engagement of citizens on this issue.

'We thought it important to actively engage with, and communicate our research to, the general public and policymakers in light of the migration crisis in Europe,' says Franko. 'We therefore produced a series of opinion pieces in newspapers, made presentations to relevant government departments and organised not only scientific seminars and conferences but also events open to the general public.'

The CRIMMIGRATION project, which was officially completed in March 2016, has therefore made an important contribution to better understanding how police and criminal justice institutions currently deal with the highly topical issue of migrants and migration.

CRIMMIGRATION

- ★ Coordinated by the University of Oslo in Norway.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://cordis.europa.eu/news/rcn/125200>

MULTIFACETED APPROACH TO MEASURING SOCIETAL WELLBEING

Measuring societal wellbeing in today's complex world through common standard indicators and macroeconomic measures has its limitations. An EU initiative has provided a more realistic depiction of a society's progress.

The analysis of wellbeing determinants has been conducted at various levels — individual, regional and national — but with no correlation between them. A key indicator of socioeconomic performance and general progress is 'Gross domestic product' (GDP). However, alone, it fails to provide a comprehensive view of societal performance.

To address the issue, the EU-funded EWEBE (Micro and macro determinants of well-being) project sought to determine the extent to which wellbeing drivers influence personal wellbeing at individual, regional and national levels. It also looked into whether such drivers vary within and between EU countries.

EWEBE is based on 'equitable and sustainable' wellbeing, an indicator identified by Italy's National Council for Economics and Labour and National Institute of Statistics, together with entrepreneurs, trade unions and civil society. It combines GDP with indicators such as inequality and sustainability.

Findings from an online survey show that the proportion of temporary jobs greatly influences how much effort and time respondents put into work-life balance. The extent to which they volunteer also positively affects how much they invest in social relationships. In addition, trust in justice in the regions greatly impacts their involvement in politics and institutions.

Project partners also analysed the determinants of financial inclusion — a key enabler for reducing poverty and boosting prosperity — at individual, regional and national levels across Europe. They exploited regional financial and economic data from The Life in Transition Survey II. The 2010 survey examined households, mainly in Eastern Europe



communist regimes, to assess public attitudes, wellbeing and impacts of economic and political change. Results show that the probability of financial inclusion is determined by household income, employment type, marital status, education, age, religion and ethnicity.

EWEBE took a multidimensional approach to measuring societal wellbeing by considering economic, social and demographic determinants at local through to national levels. This will provide better information to policymakers tasked with developing and evaluating policies designed to promote societal progress.

EWEBE

- ★ Coordinated by the University of Rome Tor Vergata in Italy.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/181136>

ITALIANS AND SWEDES TESTED ON TAX COMPLIANCE

With recently renewed political and public interest in the fight against tax evasion, one EU-funded project has timely published research exploring the levels of tax compliance in two EU Member States.

The WILLINGTOPAY? (Willing to Pay? Testing Institutional Theory with Experiments) project, coordinated by the European University Institute in Florence, Italy, is broadly focused on the interactive relationships between policy choices, institutions and ideas. This is at the core of the project's research, and in simple terms it is interested in exploring and explaining the multiple paths and different choices made in various democratic welfare states. One of the primary policy areas that the project is focusing on to explore these issues is taxation.

Social scientists have evidence showing that differences in social norms and culture help to explain why some

people are more willing to cheat with regards to their taxes. The project decided to test their central theory on whether such cultural differences are indeed a strong indicator for tax evasion, and chose two EU Member States that arguably lie at opposite ends of the taxation spectrum — Sweden and Italy.

In a survey testing Europeans' perceptions of honesty, 28% chose Sweden as the most honest country in the EU. In contrast, Italians are viewed by other Europeans (and often by Italians themselves) as being notorious tax evaders. In a 2010 book ('L'Evasione Fiscale') by Italian intellectual Alessandro Santoro, it is estimated that Italy's underground economy amounts to some EUR 250 billion.

Conducting the experiments

The WILLINGTOPAY? researchers then tested 638 participants (311 in Italy; 327 in Sweden) to see whether popular perceptions of each country with regards to tax evasion were broadly accurate. First, the researchers allowed participants to earn 'real' money for performing a simple clerical task. They were then asked to declare their income for tax purposes; they were free to declare whatever amount they wanted. However, they were told in advance that there was a 5% chance they would be audited. If they were caught cheating, they would have to pay a fine equal to double the taxes due. Importantly, the results

from all audits were only revealed at the end of the experiment, to avoid the possibility that being audited in one round would affect participant behaviour in subsequent rounds.

In total, nine rounds were conducted. In seven of them, participants received a part of their tax contribution back as a form of redistribution. In each round, the researchers made a few changes to their methodology. For example, in the first three rounds they set a 30% tax rate, but they varied the amount of money that was redistributed to the participant.

Unexpected results

The overall results of the experiment were surprising — the researchers found no significant difference between the propensity of Swedes and Italians to engage in tax evasion. However, when they further examined their data, they did find important differences in what kind of dishonesty is seen across the two countries. In short, people might be completely honest (paying all of their taxes), completely dishonest (paying none of them) or partially dishonest, paying more

than nothing but less than what they actually owe (called ‘fudging’).

Swedish participants are more likely to be either completely dishonest or completely honest, whilst Italians are more likely to ‘fudge’ and engage in moderately dishonest behaviour. Participants who fudged were also more likely to be dishonest with themselves about their behaviour. 18% of fudgers indicated that they reported their full income, whilst none of those who were completely dishonest said that they reported their full income.

Whilst the WILLINGTOPAY? results indicate that prevailing national stereotypes are less than accurate (with Italians and Swedes having around the same average level of tax compliance), the researchers indicate that those participants who chose fudging strategies do so to maintain a positive moral reputation and self-image. Such moral ambiguity gives individuals ample room to cheat a little, as well as to tolerate moderate wrongdoing.

Overall, the research indicates the dangers of many individuals choosing

“Swedish participants are more likely to be either completely dishonest or completely honest, whilst Italians are more likely to ‘fudge’ and engage in moderately dishonest behaviour.”

to adopt fudging strategies when declaring their taxes. The project team poignantly warns that relatively small acts of dishonesty, when undertaken by large numbers of both businesses and individuals, can cause serious harm to societies through lower tax revenues and poorer public services.

The WILLINGTOPAY? project is due to finish in August 2017 and has received nearly EUR 2 500 000 in EU funding.

WILLINGTOPAY?

- ★ Coordinated by the European University Institute in Italy.
- ★ Funded under FP7-IDEAS-ERC.
- ★ <http://cordis.europa.eu/news/rcn/125120>
- ★ Project website: <http://willingtopay.eu/>

YOUNG EU MIGRANTS POSITIVELY CONTRIBUTING TO BRITISH ECONOMY

An EU-funded project has discussed its recent findings with regards to young EU migrants to the United Kingdom, a timely move given the country's upcoming referendum on continued EU membership.



Researchers from the EU-funded STYLE (Strategic Transitions for Youth Labour in Europe) project have presented results from their research paper ‘Dimensions of labour market integration among young EU migrant citizens in the UK’. In advance of the UK's 23 June referendum on EU membership, these findings provide timely and accurate information on the real impact of young EU migrants to the British economy.

The researchers studied the levels of young people migrating to Britain from across the EU and elsewhere, their qualifications and what types of jobs they did following their arrival. Overall they found that young Europeans (defined as between the ages of 20 and 34) are well integrated into the British labour market. 60% of all migrants who arrived

in the UK in the last five years are in this age group. They have higher employment rates, work longer, and are less likely to receive unemployment benefit when compared to their British counterparts.

However, the researchers also clearly identified differences in the pay and conditions young EU migrants will accept. Young EU migrants from Central and Eastern Europe (CEE) Member States are often paid less and are more likely to work under precarious contracts. The researchers also found that CEE migrants were very often overqualified for the jobs that they did.

Study methodology

The methodology used by the STYLE researchers focused on six different groups of young people in the UK. Specifically they focused on those who had been born outside of the UK, who were not British nationals, and who were resident in the UK for one year or more, having arrived in the previous five years. The analysis was based on pooled data from the UK Labour Force Survey (2010–2014), a large survey of Britain's resident population.

The researchers then split them into the following groups: the eight CEE Member States (CEE8) that joined the EU in 2004; Bulgaria and Romania; southern European countries (Cyprus, Greece, Italy, Malta, Portugal, Spain); all remaining EU countries; and migrants from the rest of the world.

The researchers found that, overall, young EU migrants have relatively high employment rates, with young CEE8 migrants having an employment rate of 82 % compared with an employment rate of 73 % for young people born in the UK. They also discovered that young EU migrants in Britain work slightly longer hours than their British counterparts — workers on average in the UK work a 40-hour week, with most EU migrant citizens working at least one extra hour per week. Concerning unemployment rates, the researchers found that whilst 8.5 % of those born in Britain were unemployed between 2010 and 2014, just 5 % of those from the CEE8 Member States had been without a job. Moreover, the probability of unemployed EU migrant citizens receiving unemployment benefits was around 20 %, compared to 38 % amongst young British nationals.

Assessing young EU migrants' economic contribution

The project researchers also discovered that young EU migrant workers overall made a positive contribution to the UK's economy, due to a number of factors. Firstly, they alleviate skills shortages, with CEE8 and Romanian and Bulgarian citizens in Britain much more likely to work in manufacturing or construction. The researchers pointed out that they thus positively contribute to the British government's long-term strategy to rebalance the UK economy away from a reliance on the services industry. Much more surprising, and contrary to general belief, young migrants from Romania and Bulgaria are just as likely as young British nationals to work in the financial services industry.

The study also shows that many of the EU migrant citizens in the UK are highly qualified, and often overqualified for the jobs they are working in. Young migrants from the rest of the EU and outside Europe did better than expected in the jobs they secured when matched with the median for qualifications held by others in the same occupation.

In terms of pay, the researchers found differences — CEE8 and Bulgarian/Romanian nationals are paid around one fifth less than their UK peers in terms of hourly wages, whilst Southern Europeans have a comparable rate, and those from the rest of Europe (mostly French and German nationals) have on average more than 20 % higher hourly wages.

Overall, young EU migrants are well integrated into the UK labour market and provide much needed skills in various sectors of the British economy. However, there are significant differences when it comes to comparison of their pay and skills, with migrants from CEE8 and Bulgaria/Romania being at a distinct disadvantage.

The STYLE project, coordinated by the University of Brighton, is due to finish in August 2017.

STYLE

- ★ Coordinated by the University of Brighton in the United Kingdom.
- ★ Funded under FP7-SSH.
- ★ <http://cordis.europa.eu/news/rcn/125019>
- ★ Project website: <http://www.style-research.eu/>
- ★  <http://bit.ly/24NRW5X>

SMARTER SOCIAL ACTIVISM FOR A BETTER WORLD

Social activism is increasing in today's world, often leading to civil strife and hostility on a national level. A study of the phenomenon has yielded tools, conclusions and recommendations to address activism more appropriately.



In recent years, social activism such as the Occupy movement or the Arab Spring has been bringing profound social change with it and reshaping the geopolitical landscape. To increase our understanding on the topic, the EU-funded TMFOA (The moral foundations of activism) project investigated the role of moral conviction in collective action, and in particular cooperative effort towards social change.

While current research suggests that strong collective action emerges from a politicisation process where people

identify with a social movement and its values, TMFOA advanced and tested its own theories on the topic. It examined the reasons behind higher levels of collective action readiness among the politicised, and the potential for friction. The research also suggested that holding a moral conviction in support of a collective cause could lead people to justify the use of violence in pursuit of this cause.

The project found that some of its suggestions or predictions were more valid than others. It noted a strong relationship between the level of politicised collective identification and the extent to which individuals held a moral conviction in support of the collective cause. Researchers also found that politicised collective identification and moral conviction both affected willingness to engage in collective action.

They concluded that politicised individuals respond negatively to those less committed to the collective cause, taking into account the role of moral convictions. This showed that moral convictions in support of a collective cause encourage hostile collective action, underlining the importance of considering the moral aspects of

activism. Moreover, providing protesters with effective peaceful means to further their goals diminishes their support for hostile collective action.

In addition, the research team developed a tool to measure the extent to which individuals see a reliance on rational means in the formation and evaluation of belief as a moral issue. It also investigated differences between religious and non-religious individuals in moralising rationality, as well as the consequences of such differences.

Importantly, the research results showed stronger moralisation of rational processes of belief formation and evaluation among the non-religious than the religious. This explained why the non-religious responded more negatively to violations of rationality than the religious. These results can be crucial in advancing more peaceful social change.

TMFOA

- ★ Coordinated by the University of Exeter in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/181078>

ENERGY AND TRANSPORT

EUROPEAN RAILWAYS BENEFIT FROM INNOVATIVE PLATFORM FOR SIMULATING AND EVALUATING ON-BOARD POSITIONING SYSTEMS

The EU-funded EATS project has developed a novel positioning system that will assist European railways in better implementing the 'European train control system' (ETCS).

The ETCS aims to introduce a single harmonised system of signalling, control and train protection that would replace the many incompatible safety systems that currently exist on European railways, particularly on high-speed rail lines. It is an EU legal requirement that all new, upgraded or renewed tracks and rolling stock within the European rail network should adopt the ETCS.

Implementing the ETCS

However, the rollout of the ETCS, which is divided into four distinct levels (ETCS 1-4), has been a major concern for train manufacturers and railway infrastructure managers. This has been due to a variety of reasons, including various interpretations in the

specification of the system's behaviour, available laboratory certification procedures not being able to fully address all of the system's needs, long and expensive field-testing, and other technical difficulties.

The EATS (ETCS Advanced Testing and Smart Train Positioning System) project aimed to develop new on-board location systems by combining 'Global navigation satellite system' (GNSS), 'Universal mobile telecommunications system' (UMTS) and 'Global system for mobile communications — railway' (GSM-R) technologies, as well as including multi-antenna configurations on the train. This would allow for the migration from ETCS level 2 to level 3 which would improve the overall efficiency of European railways.

Utilising ATLAS

To design, implement and evaluate the new location systems, EATS has utilised the innovative 'Advanced Train LocAtion Simulator' (ATLAS), which is modular, extensible and highly configurable. It allows for the configuration of the train to be analysed together with the on-board location systems and even for the train's route to be studied. Moreover, it provides a powerful performance evaluation tool that allows for visualising the results of hundreds of simulations at a glance.

ATLAS comprises of four key modules: the ATLAS Route Simulator, which calculates the global positioning and/or velocity of each receiver and sensor contained in the train, using a specific train model and track layout; the

“EATS has utilised the innovative ‘Advanced Train LocAtion Simulator’ (ATLAS), which is modular, extensible and highly configurable.”

ATLAS Input Generator, which uses the data from the Route Simulator and generates the input sources with configured errors for the algorithms to be tested in the Position Estimator; the ATLAS Position Estimator, the module responsible for testing different location algorithms; and finally the ATLAS

Performance Analyser, which allows the user to compare and contrast the behaviour of each positioning configuration carried out, and thus to select the most favourable or convenient.

EATS used ATLAS and its four specific modules to automate the testing of different antenna distributions applied to a train model under several performance zones. In addition to this, positioning algorithms and different technologies used for positioning have been tested to allow the comparison of their performance and suitability for the railway sector.

By developing innovative on-board positioning systems, the project will

contribute to improving both the safety and the efficiency of the European railway network by facilitating a quicker rollout of the ETCS at a time when passenger and freight numbers are rapidly increasing across Europe.

EATS

- ★ Coordinated by CEIT-IK4 Technology Centre in Spain.
- ★ Funded under FP7-TRANSPORT.
- ★ <http://cordis.europa.eu/news/rcn/125100>
- ★ Project website: <http://www.eats-eu.org/index.html>

SAVING UP SUN FOR A RAINY DAY

A major issue with solar power is the fact that photovoltaic systems cannot operate without sunshine. To address the availability problem of solar energy, EU-funded researchers considered direct storage in the form of a clean fuel, hydrogen.

Hydrogen is a clean gas that, when fed into fuel cells, produces water. Fuel cells operate like batteries to generate electricity through a chemical reaction. There is no combustion involved, and because of this there are no emissions. Not surprisingly, hydrogen stood out as the energy source that can replace fossil fuels.

To date, the production of hydrogen has relied on non-renewable routes, such as steam reforming of natural gas. The researchers working on the project COCHALPEC (Development of electrodes based on copper chalcogenide

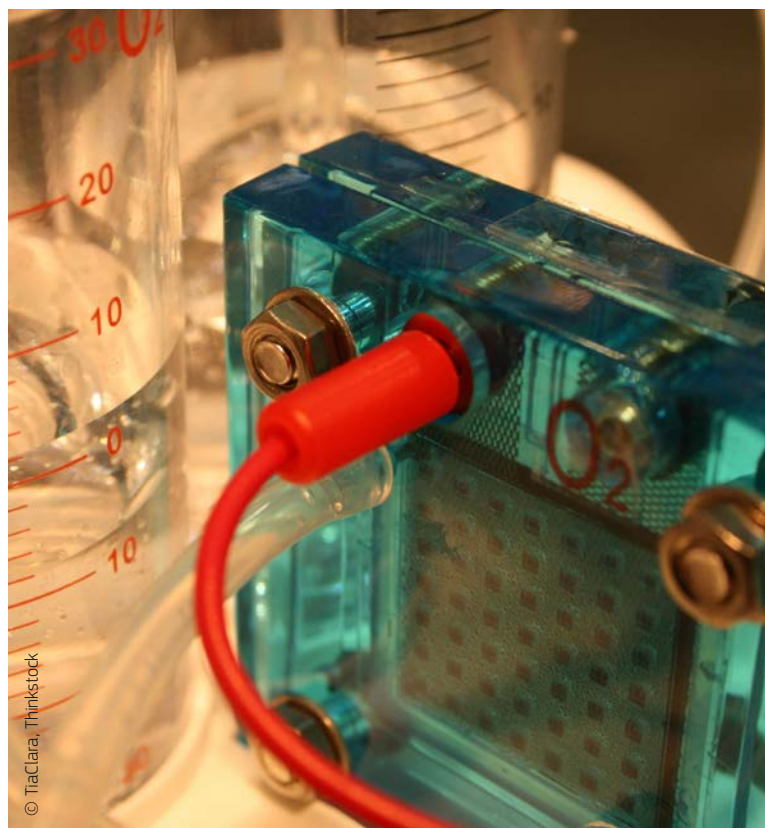
nanocrystals for photoelectrochemical energy conversion) demonstrated an alternative and sustainable route to produce hydrogen.

The starting point was the development of solar panels

capable of generating an electrical current to split water molecules into oxygen and hydrogen. While the concept is simple, the cost of water-splitting technologies is too high. The COCHALPEC researchers responded to the challenge by devising a new way to build low-cost photo-electrochemical cells.

The key to the solution was the adoption of what are known as 2D materials, which essentially consist of a single layer of atoms. The COCHALPEC team focused on the synthesis of these materials in the form of nanocrystalline films. Through uniform dispersion in a liquid solvent, tungsten diselenide is transformed into thin flakes. This solution, resembling an ink of tungsten diselenide, is then injected at the interface between two immiscible liquids, which is used as a ‘rolling pin’ to shape the flakes into a high-quality thin film.

Photoelectrodes fabricated this way were tested and found to be superior, in terms of efficiency, to thin films made from the same material using other methods. By the end



of the COCHALPEC project in May 2015, the conversion efficiency achieved was about 1%. Although fairly low, this could be further improved to provide higher yields in the future.

COCHALPEC

- ★ Coordinated by EPFL in Switzerland.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/181110>

INNOVATIVE WIND POWER DRIVETRAINS WITH IMPROVED COMPONENTS

Brushless double-feed generators are beginning to make their way into new drivetrain designs, eliminating the need for maintenance works and increasing reliability. An EU-funded consortium has successfully developed a first of its kind 3 MW, medium-speed, brushless, double-feed drivetrain with ramifications for offshore wind power in particular.

Maintaining low operation and maintenance costs and increasing the reliability of wind turbines are high priorities if Europe is to reach 20% renewable energy in the overall energy supply by 2020. Brushless generator technology can help increase wind turbine installations, while also retaining Europe's competitiveness.

The WINDRIVE (Industrialization of a 3 MW medium-speed brushless DFIG drivetrain for wind turbine applications) consortium developed brushless 'Doubly-fed induction generator' (DFIG) technology for wind power generation, taking it from the laboratory to an industrial-scale machine for multi-megawatt wind turbine applications.

Medium-speed 'Wind turbine drivetrains' (WTDTs) are more reliable than current WTDTs, which are based on a three-stage gearbox and DFIG. Provided that the range of speeds is moderate, the converter rating needs only to be a fraction of the total generator output, thereby keeping the system cost low, yet maintaining reliability. The converter rating is generally about one third of the generator rating, allowing speed variations of about 33%.

Varying the converter voltage can be used to manage the reactive power flow from the generator. Control schemes were developed to enhance the response of the system to changing wind speeds and to accommodate varying grid conditions.

The majority of wind turbine failures happen within the gearbox, leading to costly repairs and downtime. This novel drivetrain integrates more efficient and reliable components. Project partners developed a two-stage gearbox, excluding the third high-speed stage, which is the part of the gearbox with the highest failure rate.

WINDRIVE supports the exploitation of a more reliable and cost-effective generator system for the wind power industry. This



novel and disruptive drivetrain technology, together with the improved gearbox, should lead to wider adoption of wind power generation, especially offshore, thereby boosting the low-carbon economy and increasing energy security for the EU.

WINDRIVE

- ★ Coordinated by Wind Technologies in the United Kingdom.
- ★ Funded under FP7-SME.
- ★ <http://cordis.europa.eu/result/rcn/147695>
- ★ Project website: <http://www.bdfg.com/>
- ★  <http://www.bdfg.com/>

INNOVATIVE SOLUTIONS FOR TRAFFIC MANAGEMENT AND URBAN MOBILITY

A consortium of regional research clusters joined efforts to help advance developments and improvements in the fields of 'Traffic, health and environment' (THE). The aim was to create a base supporting the delivery of 'Intelligent solutions for sustaining urban economies' (ISSUE).

The EU-funded project THE ISSUE (Traffic – health – environment. Intelligent solutions sustaining urban economies) examined transport policy and technology as key elements in achieving sustainable urban economies throughout Europe. Comprising of 13 core and 22 associate partners from more than 10 research clusters across Europe, the consortium included industry, research institutions and government bodies from each project region.

Teams studied the impact of traffic on health and the environment and identified the potential of various technological solutions to promote sustainable transport in cities. Proposed solutions are based on 'Information and communication technologies' (ICT) and downstream space data and services used to reduce traffic congestion as well as improve air quality and journey duration.

THE ISSUE's main deliverable was a state-of-the-art 'Programme of Innovation in Sustainable Transport and Intelligent Mobility (2014-2020)', which highlights 46 innovation actions addressing strategic objectives in six challenge areas. Each area reflects priorities where existing ICT and space technologies could advance operational implementation and market growth of innovations in intelligent traffic management and urban mobility. A new 'European special interest group' (ESIG) in traffic, health and environment was established by the project's 12 regional clusters to

take the Programme forward. The ESIG will also secure the cluster network's long-term future, help deliver the joint action plan and assist with the future inclusion of other regions.

Other project achievements include a 'Roadmap for Innovation in Transport & Urban Mobility', a new approach to university-industry-government relationships in promoting innovation, and new perspectives regarding future urban mobility patterns. Another output is the publication 'Space and ICT Applications Supporting Smart, Green, Integrated Transport and Urban Mobility'.

Project work has paved the way for a forward-looking, Europe-wide research and implementation plan that promises more sustainable transport economies across Europe's cities, towns and regions. THE ISSUE has provided support to regional policy and planning bodies and regional authorities, enabling them to deliver smart, green, integrated transport solutions with environmental and health benefits.

THE ISSUE

- ★ Coordinated by Leicester City Council in the United Kingdom.
- ★ Funded under FP7-REGIONS.
- ★ <http://cordis.europa.eu/result/rcn/150904>
- ★ Project website: <http://www.theissue.eu/>

ENVIRONMENT AND SOCIETY

CITIES GIVEN PLATFORM TO ACHIEVE ENERGY EFFICIENCY

European researchers have launched an online platform to help city planners achieve energy efficiency and carry out effective sustainable planning.

Developed through the EU-funded PLEEC (Planning for Energy Efficient Cities) project, the platform provides information and resources to guide city planners interested in developing their own 'Energy efficiency action plans' (EEAPs) in order to help meet EU climate goals. The platform shares the experiences of six project partners who have developed their own EEAPs, and provides step-by-step guidance for others on what needs to be done.

Developing city-specific EEAPs

For example, the platform begins with information on how cities can first achieve an agreement on developing an EEAP. Key points include getting political support, cooperating across departments and providing strong arguments for putting in place an EEAP. Getting a positive decision to develop an EEAP means explaining why resources should be directed to this instead of something else.

The platform then provides advice on how to prepare for the EEAP and how to engage stakeholders. At the end, there is a checklist of what to think of when writing the EEAP.

The publication of the six EEAPs from cities involved in the project — Stoke-on-Trent in the UK, Eskilstuna in Sweden, Santiago de Compostela in Spain, Turku and

Jyväskylä in Finland and Tartu in Estonia — is another key result. These EEAPs are the result of three years of collaborative work, and are based on the findings of a smart city analysis that was carried out through the project.

These smart city analyses sought to support forward-looking and evidence-based strategic planning approaches. They began by identifying the most relevant 'assets' and 'deficits' in each city's energy efficiency performance, and carried out benchmarking across key fields.

The analyses also helped to identify cities with similar profiles, where good practices could be shared. The PLEEC platform provides the perfect facility for achieving this, long after this project has been completed.

The importance of thinking local

Another key finding of the project has been that understanding local conditions in different cities is vital to developing successful EEAPs. While actions cannot simply be copied from one city to another, the consortium did find that sharing experiences can help cities identify their own path towards a more energy-efficient future.

All this means that cities now have a resource at their fingertips to help them

become smarter and more energy efficient. The energy efficiency potential in cities has not been fully realised. A key goal of the EU's 20-20-20 strategy is to improve energy efficiency by 20% by 2020, and while individual strategies and approaches can address separate aspects — such as thermal insulation and greener transport — coordinated strategic planning is needed to have a long-term sustainable impact.

The PLEEC project, which was officially completed at the end of March 2016, has addressed this challenge by bringing together 18 partners, including municipalities, universities and industries. Through connecting scientific excellence and innovative enterprises in the energy sector with ambitious urban areas, the project has delivered an important tool that will help other cities contribute towards achieving EU energy efficiency goals and bring benefits to citizens.

PLEEC

- ★ Coordinated by Eskilstuna Energi & Miljö AB in Sweden.
- ★ Funded under FP7-ENERGY.
- ★ <http://cordis.europa.eu/news/rcn/125141>
- ★ Project website: <http://www.pleecproject.eu/>
- ★  <http://bit.ly/1OpdH2y>

POLLEN STUDIES HELP PROTECT WEST AFRICAN BIODIVERSITY

Tropical forests and savannahs are biodiversity hotspots and have a profound influence on temperature, precipitation and carbon storage. Understanding how the two biomes control plant diversity will support efforts to prevent plant extinction and therefore loss of biodiversity during the current biodiversity and climate crises.

The EU-backed MIOVAT (Miocene vegetation of the African tropics (project MioVAT)) initiative used fossilised pollen and spores to investigate the evolutionary history of tropical forest and savannah biomes in West Africa during the Miocene Period, 23 to 5.3 million years ago. The Miocene was a critical time in the evolution of West African vegetation, when grasses utilising the C4 photosynthetic pathway rapidly extended their range, giving rise to the savannahs.

Researchers used acid digestion and density separation to release fossil pollen and spores from sediment samples from West Africa. These were then studied using a range of microscopy techniques. In addition, the team compiled an image library of fossil pollen and spores derived from the Palaeogene-Neogene rainforests of southern Nigeria.

Pollen samples from oak (*Quercus*) and spruce (*Picea*) were imaged for the purpose of comparative microscopy work. Grass (*Poaceae*) from herbarium sheets and fossil grass pollen from sediment samples were imaged and used to gather data on pollen morphology across the grass family.

Experiments were also conducted to compare the human and computer classification of grass pollen. Researchers used computational methods to quantify the complexity of grass pollen surface ornamentation. The aim here was to study self-organised vegetation patterns in dryland ecosystems.

The result was new methods for classifying pollen grains based on high-resolution imaging and computational image analyses. The comparative work carried out on oak, pine and grass pollen revealed that the combination of brightfield illumination, confocal microscopy and scanning electron microscopy increased the taxonomic resolution of



the pollen and spore fossil record. This increased the range and depth of hypotheses that can be tested using the fossil pollen and spore record.

MIOVAT provided a new computational approach to describing 2D shapes. It also highlighted the growing concern regarding classification of biological objects using computational methods and more traditional approaches based on human analyses.

Furthermore, project findings will help to explain the role of extinction in shaping the tropical vegetation of West Africa and the evolutionary success of grasses. This vital information will make a significant contribution to conserving the biodiversity of tropical forests and savannahs in the face of a changing climate.

MIOVAT

- ★ Coordinated by the University of Exeter in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/181118>

EU RESEARCHERS CONTRIBUTE TO BETTER AIR QUALITY POLICY

An EU-funded project has undertaken detailed research to support the review and implementation of the EU's comprehensive air quality legislation.

Air quality has become one of the primary environmental concerns for EU citizens in the last decade. Although air quality has substantially improved in the last 20 years, there has been a growing realisation that technical measures will not be sufficient alone to achieve the high standards for air quality contained within EU environmental legislation. Policymakers are now also focussing on the socio-economic dimension of air quality policies in order to improve their effective and overall acceptance amongst EU citizens.

The FP7-funded SEFIRA (Socio-economic implications for individual responses to

Air Pollution Policies in EU +27) project has thus spent the past three years coordinating some of the best scientific and socio-economic resources to achieve a deeper understanding of these complex issues. Due to finish at the end of May 2016, the project team hosted a final workshop in Brussels on 20 April 2016 to highlight their results and formally present them to European stakeholders.

Understanding perceptions and awareness of air quality issues

The project team utilised a transdisciplinary approach that encompassed fields

as diverse as economics, political science, geology and atmospheric sciences. They undertook a detailed analysis of documents to ascertain how relevant EU Directives have been translated into national and local measures to combat air pollution.

They then interviewed 38 experts from four European countries to find out which the main obstacles to full policy implementation are. Finally, they undertook detailed focus groups in four European cities (Antwerp, Milan, Warsaw and Malmo) to understand citizens' real concerns and vision for the future with regards to air quality. They

discovered a stark difference in attitudes and awareness — for example, residents of Antwerp were seen as highly active and organised over the issue, with their efforts even being featured in local Flemish media. Such high levels of activism were not recorded in the other three cities.

Using the 'Computer assisted web interviewing' (CAWI) method, the project also conducted over 16 000 individual interviews across seven EU Member States (Austria, Belgium, Germany, Italy, Poland, Sweden and the UK). Participants were screened with regards to demography as well as their mobility and eating habits. Specifically, participants had to be over 18 years old, used pollution-causing vehicles and ate meat and dairy products for more than four days per week. They were then asked detailed questions on their opinions and attitudes towards various environmental issues.

The researchers discovered that attitudes and perceptions differed markedly across countries, age groups, levels of education and genders. For example, when asked whether they agreed with the statement that it is not up to the individual to adopt environmentally friendly behaviour, only 19% of Austrian participants and 18% of British participants agreed with this, in contrast to 30% of Belgians. One quarter of Polish participants agreed with the statement that environmental protection is not an important issue, substantially higher than in Western European countries. In

Austria, men were less willing to change their mobility habits than women, and were willing to pay 40% more than they currently do (in taxes, charges, etc.) in order not to change their habits. With regards to eating habits, men in Austria and Belgium were willing to pay 65% more than women in order not to change their diets. One surprising result from the project was that better educated participants were willing to pay 70% more than less educated participants to not change their mobility habits.

Policy implications and next steps

SEFIRA's work is the first time that such research methods have been applied to the issue of air quality. With their results showing such a plethora of views from European citizens, they argue that policymakers need to find a way to balance and integrate such individual perceptions with the technical requirements and priorities for ongoing policy action. In particular, individual acceptability of environmental policy should be considered during the policy implementation process.

The project's results were well-received by the policymakers present. MEP Eleanora Evi, a speaker during the workshop and an active member of the European Parliament's Environment Committee, stated that the project results were highly topical, particularly in the wake of recent events such as the Volkswagen emissions scandal.

'This project comes at the right moment in order to speed up the debate on these issues, especially as some files such as the Air Quality Directive, seem to be at stake,' she commented.

Although the project will soon finish, the project team have stated that they will continue to conduct further analysis of their results and undertake more research on the topic. Overall, the project aimed to show how taking such a multidisciplinary approach and how the methodology utilised for the SEFIRA research can be applied to better policymaking and policy implementation at EU, national and local levels.

SEFIRA

- ★ Coordinated by the University of Urbino in Italy.
- ★ Funded under FP7-ENVIRONMENT.
- ★ <http://cordis.europa.eu/news/rcn/125162>
- ★ Project website: <http://www.sefira-project.eu/>



EUROPE'S DROUGHT HAZARD, IMPACTS, VULNERABILITY AND FUTURE

An EU team has examined Europe's drought history to predict future hazards. Results include a major impact database, pan-European vulnerability and risk maps, as well as options for drought management for different geo-climatic settings.

Europe has previously experienced widespread droughts, in addition to a general drying trend in southern regions. These have strongly affected agriculture, wildfires and water availability in populated areas (water supply, energy production, water-born transport, ecosystems).

The EU-funded DROUGHT-R&SPI (Fostering European drought research and science-policy interfacing) project aimed to

reduce Europe's vulnerability to drought. This goal was soon accomplished via six multi-scale case-studies of water-stressed areas, combined with pan-European-scale analyses. Retrospective analysis of drought patterns, impacts and measures taken was expected to shed light on what to expect in future. The project also aimed to develop new methodologies for early warning. Additionally, the consortium supported the integration of research and policy, including risk reduction and preparedness, by initiating various drought dialogues on case studies and at national and European level. Results were linked in with the European Drought Centre.

There were also three project-organised drought dialogues, which led to stakeholder discussions on case studies and Europe-wide. Topics included drought risk factors, interpreting options in EU policy documents, evolution of current methods, early warning, communication about past and future drought hazards, and feedback on drought management and policy.



Developments included setting up a historical (1958 to 2009) European Drought Reference (EDR) database. A historical study into direct measurements revealed a wetting trend in northern Europe and the reverse in southern Europe, although the summer streamflow decreased almost everywhere. Findings inferred from proxy data archived between 1500 and 1950 revealed that the

“The group outlined policy recommendations for drought reduction in six case study areas in Switzerland, Greece, Spain, Italy, the Netherlands and Portugal.”

frequency of dry periods had not increased in most regions. Researchers used the EDR to test hydrological models, resulting in an assessment of the drought consequences of climate change. The team also contributed

improved understanding of drought-causing atmospheric processes, and the importance of groundwater storage.

The group outlined policy recommendations for drought reduction in six case study areas in Switzerland, Greece, Spain, Italy, the Netherlands and Portugal. Collectively, the

studies concluded that the complex situation needs tailored management responses in each region.

A general output was a set of pan-European maps indicating vulnerability to drought impact and likelihood of occurrence. The risk for agriculture is highest in the Mediterranean, while other populated areas face risks affecting the public water supply. Further maps break down vulnerability according to 19 separate factors. At present, a one-size-fits-all drought index does not exist, and management will depend on tailored indicator and decision-support systems.

DROUGHT-R&SPI assessed how drought will threaten various European regions, and such work supports policy options for reducing vulnerability and improving adaptability.

DROUGHT-R&SPI

- ★ Coordinated by Wageningen University in the Netherlands.
- ★ Funded under FP7-ENVIRONMENT.
- ★ <http://cordis.europa.eu/result/rcn/181144>
- ★ Project website: <http://www.eu-drought.org/>

GEOTHERMAL FLUIDS IN SUPERCRITICAL CONDITIONS

Most geological processes in the Earth's crust and upper mantle occur in pressure and temperature conditions near the critical point of water. EU-funded scientists have developed a model of dissolved components in pure water to understand fluid-rock interactions in such supercritical conditions.



Accurate calculation of the thermodynamic properties of aqueous solutes is a prerequisite for predicting the consequences of fluid-rock interactions. The equations of state proposed by Helgeson, Kirkham and Flowers — widely known as the HKF model — can be applied to temperatures up to 600 °C and pressures as high as 4 kilobars.

However, comparisons of predicted values for aqueous electrolytes with experimental data have revealed

discrepancies. The predictions of observable thermodynamic properties are too wide as temperature and pressure approach the critical point of water. The aim of the EU-funded project FLUIDEQ (A new equation of state for solutes in high-temperature fluids) was to revise the HKF model.

To this end, scientists adopted a statistical mechanics approach to develop the theoretical framework that links molecular-scale processes to macroscopic thermodynamic properties. The

insights gained can also form the basis for development of a new equation of state that covers the currently inaccessible conditions.

Specifically, extensive simulations were carried out on electrolyte and non-electrolyte aqueous solutions under conditions near the critical point of water. The scientists combined the results with experimental data on thermodynamic properties of various solutes as well as structural parameters (for example, partial molar volumes of the solutions).

Understanding geothermal fluid chemistry and transport requires filling in knowledge gaps. Equations of state describe the hydrothermal system. Geochemical models can be derived from the values of thermodynamic parameters for various minerals and fluid species. The FLUIDEQ project has therefore removed some of the biggest barriers to such comprehensive modelling of geothermal systems.

FLUIDEQ

- ★ Coordinated by ETH Zurich in Switzerland.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/181112>

IT AND TELECOMMUNICATIONS

NOVEL 5G INTERVEHICULAR SYSTEM PROMISES IMPROVED ROAD SAFETY

The Horizon 2020-funded METIS-II project has devised and configured a new 5G 'Radio access system' (RAN) for intervehicular communication that allows cars to 'talk' to each other in real-time conditions.

The system is intended to improve road safety in a future scenario where 5G technologies have become a normal aspect of everyday life. Every year more than 26 000 people die on Europe's roads and many more suffer horrific road traffic accidents.

The EU has been engaged in several coordinated efforts to review the rules for the training and qualification of professional drivers, as well as reform the safety management principles for motorways and road infrastructure. However, the METIS-II (Mobile and wireless communications Enablers for Twenty-twenty (2020) Information Society-II) project team strongly believe that technology could also provide a lasting and viable solution to reducing such high numbers of road-related deaths.

Overall, METIS-II aims to provide an important platform for a European-led early global consensus on fundamental questions connected to the development of the future mobile and wireless communications system, and pave the way for future standardisation. The project objective is to lay the foundation for a future mobile and wireless communications system for 2020 and beyond. Specifically amongst the project's end goals is to optimise the performance and interconnection of in-vehicle mobile communications systems and, by doing so, contribute to improved road safety and lower traffic accident rates, one of

the many possible applications of 5G technology.

Presenting the intervehicular system

In particular, researchers from the Polytechnic University of Valencia, one of the METIS-II consortium partners, presented their 5G intervehicular communication system for improved road safety demo at the 2016 edition of the Mobile World Congress that took place in Barcelona from 22 to 25 February. The 3D computer-generated demo highlights how cars on the streets of Madrid are able to communicate with each other in real-time conditions and allowed viewers to experience this from both a bird's-eye-view and street-view perspective.

The main novelty of the new 5G radio access system is that it allows the continual adjustment of waveforms in such a way that vehicles can communicate with each other, thereby overcoming the hurdle of not having a set station for communication.

In terms of hardware, the system includes three programmable cards, each of which has a high-performance 'Field-programmable gate array' (FPGA) to integrate different waveforms, which are what carries data through the air, and four antennas. These cards will allow direct communication between vehicles, as well as the integration of intervehicular communications into

conventional mobile communication systems.

Laying the groundwork for the future 5G network

METIS-II envisions an overall 5G RAN system to operate in a wide range of spectrum bands to address the diverse services that would be offered using the technology. Studies have shown that large contiguous spectrum bands are preferable for various reasons, in particular related to device complexity. In general, the 5G system will build upon a set of spectrum usage forms such as the use of dedicated licensed spectrum, horizontal sharing of bands with differentiation according to limited spectrum pools, mutual renting and unlicensed use, as well as vertical sharing of bands.

METIS-II, although financed through the EU's Horizon 2020 programme, boasts a truly global consortium, with partners located across the world, from Europe to Taiwan and the United States. The project is due to finish in July 2017 and received nearly EUR 8 000 000 in EU funding.

METIS-II

- ★ Coordinated by Ericsson in Sweden.
- ★ Funded under H2020-ICT.
- ★ <http://cordis.europa.eu/news/rcn/125020>
- ★ Project website: <https://metis-ii.5g-ppp.eu/>
- ★  <http://bit.ly/1UVDqq2>

HOW WE LOCATE LIMBS IMPROVES COMPUTER INTERFACES

The ability to sense the location, orientation and movement of the body and its parts is known as proprioception, enabling us to know the precise position of our limbs. An EU-funded initiative has investigated the phenomenon in order to improve interaction between people and computers.

Through proprioception, it is easy for us to describe the location of our left hand or point to it with the right, even with our eyes closed. What's more, we never feel that our hand is in two places at once, even though we simultaneously process visual and proprioceptive information on its current location.

The EU-funded LOCANDMOTION (Sensory integration for limb localization and action) project investigated how vision and proprioception are combined to generate estimates of hand and target locations. The initiative tested the hypothesis that proprioception resists visual realignment and that intersensory alignment is not needed for effective action.

A study of the relevant literature and experiments showed that proprioception may not be very useful for identifying the position of the hand relative to a target. In fact, multiple movements made in the dark can result in the hand drifting from the target without its owner realising it.

Researchers showed that this drift is due to an individual's prior belief that their ability to find a target is very high, possibly a result of their daily experience with accurate full-vision movements. The movement errors accumulate until an error from proprioception counteracts trust in the motor command (which tells the hand where to go).

A separate study, where participants were asked to report the perceived position of their unseen hand, revealed that expectations regarding the ability of motor commands may override sensory input. This and the previous study involved identifying the position of the stationary hand after movement.

Another two studies focused on localisation during movement. Results from the first study showed that if the target was visual, then visual information was more important for online control. However, if the target was proprioceptive, participants relied more on proprioception for online control. The second study described a model for explaining why people tend to overestimate the position of their unseen hand during movement and why they underestimate when reaching for a target.

LOCANDMOTION has increased understanding of how people use proprioception, something that had not been as well understood as vision. This knowledge of sensory integration will help to improve how people adapt to virtual reality, mixed reality and teleoperation systems, resulting in improved designs for human-computer interfaces.

LOCANDMOTION

- ★ Coordinated by the University of Barcelona in Spain.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/181130>



NEW SCROLLING METHOD PROMISES ACCELERATED SKIM READING AND DATA RECALL

EU-funded researchers have developed innovative new scrolling software that allows for documents to be skimmed 60% faster and with a higher recall rate.

The explosion of digital content and data that we take in from screens each day through documents, email chains, web pages and social media flows is enormous. Consequently, the rapid comprehension of complex information has become an essential aspect of modern life. The continuous scrolling technique typically used to browse this data is, however, far from perfect. In conventional scrolling, a number of objects are moving in the viewer window, which is problematic for visual attention. First, motion blur makes it impossible to focus on an object. Second, the user is not able to direct their attention for long enough to comprehend the content before it scrolls out of the window.

The EU-funded COMPUTED (Computational User Interface Design) project has created the Spotlights software to address many

of the shortcomings of conventional scrolling. The naming of the new software is based on the spotlight metaphor of human visual attention. According to existing research, visual attention needs about half a second to focus, which is longer than the average amount of time that a sentence or picture remains on the screen when using the normal scrolling technique.

Spotlights works by locating the visually important elements on each webpage (whether it is a document, PDF, video or web document), and presents them using a transparent layer that appears on top of the text. These elements can take a number of forms, including pictures, tables, graphs, headlines and sub-headings. In essence, the software chooses what the user should focus on and allows them enough time to be able to do so.

Testing Spotlights

The project team conducted three separate studies to test the new software. The first study tested user recall and was informed by empirical research on skim reading, emphasising the influence of time pressure, complex documents and a focus on comprehension. Users were asked to recall keywords and figures, also numerically rating their comprehension. To directly test whether Spotlights improved users' ability to attend to objects

"Spotlights works by locating the visually important elements on each webpage, and presents them using a transparent layer that appears on top of the text."

during scrolling, the researchers also collected data on gaze and scrolling behaviour. User recall was greatly improved with scrolling rates being 60% faster. Users were also more confident with their comprehension of long documents when using Spotlights as a result.

The second study focused on overall comprehension and compared Spotlights to normal scrolling in a questionnaire-based test accompanied by standard workload metrics. The project team learnt from the recall study that participants employed more backward tracking. To help this behaviour, the project turned on Spotlights' 'Click-and-Go' feature. When an object is highlighted, the user can specifically select it by clicking on it with the cursor, warping the user to that object in the document and removing any other highlighted objects from view. The user was also able to return to potentially important and/or interesting objects within the document. Overall, the team concluded that Spotlights helped users to orient themselves better to

unfamiliar content, particularly by helping them to quickly understand the high-level structure of a book.

Finally, the third study considered skim reading done for lookup and filtering purposes. A target was given and the user had to locate it in the document. For this, the researchers expected that scroll speed would be higher than in the second study, as the participants were searching for a specific object in the document and not attempting overall understanding. The results were highly promising, showing that participants were twice as successful in localising targets as they were in normal scrolling when using Spotlights.

Next steps

The project team sees many opportunities to develop Spotlights further, with their research being the first attempt to maximise the amount of the information on the screen for human visual attention. They acknowledge that it is presently a prototype and will need further development,

but have already considered numerous avenues of further research and testing.

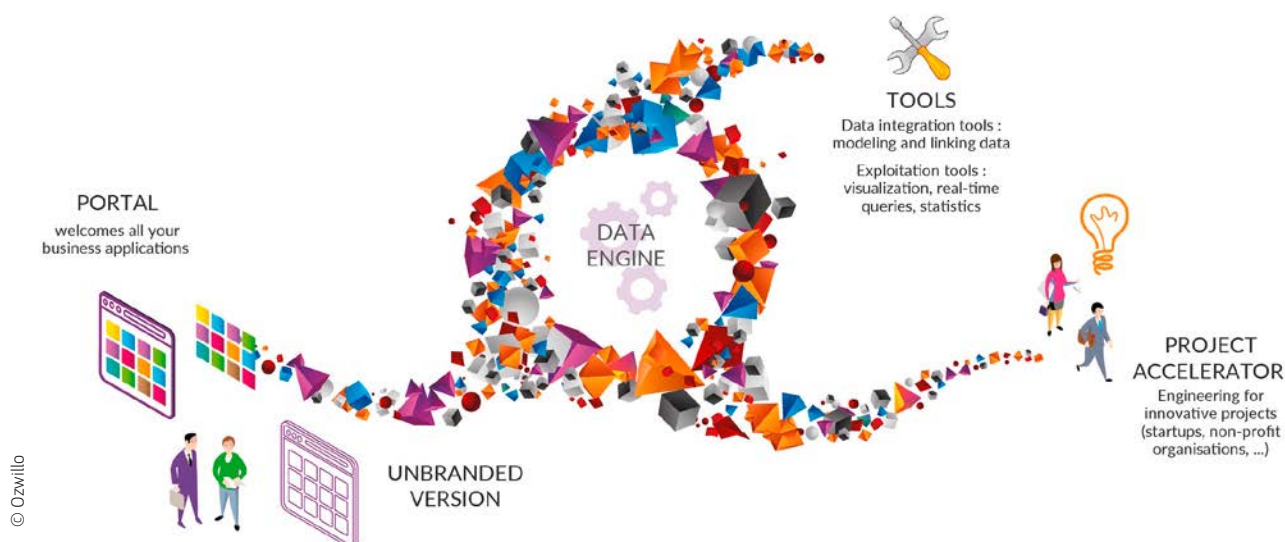
These include adjusting exposure parameters for individual personalisation that would in theory lead to better performance rates. Some users developed strategies to counteract Spotlights by focussing on the middle of the screen instead of trying to find the best upcoming spotlight, so new techniques to automatically guide attention to the next object should be considered. Finally, there needs to be more consideration of how the complexity or unpredictability of an object affects visual processing requirements, with one possibility being to pre-process objects for complexity and modulate exposure time accordingly.

COMPUTED

- ★ Coordinated by Aalto University in Finland.
- ★ Funded under ERC-STG.
- ★ <http://cordis.europa.eu/news/rcn/124982>

OZWILLO BRINGS PUBLIC SERVICES TOGETHER IN A SINGLE, ONLINE PLATFORM

How can the services provided by local authorities be brought to the Internet, in a way that prevents the segmentation often observed by citizens and businesses? This question was at the heart of the OASIS project, which created a platform called Ozwillo to answer it. The platform facilitates access to, and sharing of, information by federating public services in a unique environment.



In 2016, many regions of Europe still see their citizens and businesses faced with the difficulty or even impossibility of finding information and services provided by local public authorities on the internet — and where they can, this information is often segmented in a counter-intuitive manner.

'Public players are still in the culture of power associated with information retention. They have not yet assimilated the ongoing change of context where information sharing creates value, makes it more efficient by enabling collaborative

work, and allows for saving money that would otherwise be spent in management or legal issues,' says Bruno Thuillier, coordinator of the EU-funded OASIS (Openly Accessible Services and Interacting Society) project which gave birth to Ozwillo.

With his peers, Thuillier argues that federating services in a unique environment will enable public administrations to make better use of customer and business information and to adapt public services (e-services) so that they better meet their needs. He expects this will result in more

accessible, more user-friendly, more efficiently run and less expensive services.

These ideas came to fruition with Ozwilllo, which took advantage of open platforms and cloud architecture to provide an initial set of 12 applications to citizens, public authorities and businesses. 'We first chose applications to work out a complete chain of dematerialisation. But we could not adapt all of them because providers of financial management, human resources, billing, etc. work with software that can not be moved to the cloud without being completely re-developed,' Thuillier recalls. 'So our selection has evolved to include a large panel of use cases, from tourism to economic development, public procurement, short circuit, participatory mapping, etc. At the end of the pilot we had 26 applications, which was much more than expected.'

Post, share and get inspired

The scalable data infrastructure at the heart of Ozwilllo allows applications to post, retrieve and share data. 'Business applications used by public bodies can be adapted to the Ozwilllo platform by service providers only once, with no need to develop connections with each of the other applications. It means data sharing can take place directly and automatically between applications, except for personal data that are shareable only on the initiative of the individual concerned,' Thuillier explains. The data is semantically linked together and with particular data repositories such as ISO, Eurostat, the National Statistical Institute, etc.

One example of Ozwilllo application is 'Agrilocal', a French public procurement platform for local school catering. Local producers agree to open their data (organisation details, production, ...) to local public authorities (Chamber of Agriculture, County Council), forming the most updated common database of the territory. This is reused in other applications such as InvProm, a Turkish application for the management of activity areas.

Another example is the Spanish application 'Environmental Incidents Management' which aims to collect and process

citizen reports on road incidents. It is compatible with the use of a French mobile application named Javise which allows citizens to report incidents to different public authorities. This compatibility can also inspire public authorities to create brand new applications from the data shared by other users.

Continued development

Ozwilllo may already be used by over 250 organizations and more than 1 500 individuals, but Thuillier and his team do not intend to stop there. The platform continues to benefit from funding from the French government, new applications are expected and an association was created that brings together half of the members of the OASIS consortium along with new public members and private individuals. A first private investor also joined Ozwilllo to foster its development and, last but not least, the first contracts with application providers have been signed.

'We conducted two market studies and established a roadmap for the gradual development of services around the management of data,' Thuillier says. 'Since then, we have adapted our communication and associated new partners such as FNCCR, a French national union of public bodies managing networks (electricity, gas, oil, Internet), to facilitate data management from connected objects and the IoT. Smart cities is a strategic market for Ozwilllo.'

A co-built project with an intermunicipal union representing 260 public bodies in the south of France was also initiated to create an unbranded version of the Ozwilllo portal for the regional territory of Alpes Provence-Alpes Côte d'Azur (PACA Region). Thuillier is confident that all these improvements will directly benefit all partners and regions in Europe.

OASIS

- ★ Coordinated by Pôle Numérique in France.
- ★ Funded under CIP.
- ★ <http://cordis.europa.eu/project/rcn/191906>
- ★ Project website: <https://www.ozwilllo.com>

ACCURATE CHILDREN'S CLOTHING SIZE APP TO BOOST EU COMPETITIVENESS

EU-funded researchers have developed an innovative app that gives accurate sizing guides for children, benefiting both consumers and EU-based clothing companies.

Buying clothes for children can be a quagmire. Sizing is often inaccurate, especially since it is frequently categorised according to the age of the child, even though children of the same age are very often different heights. The problem is particularly acute for online sales of children's clothing, and for family members and friends who may wish to buy clothes but find picking the right size difficult. But one EU-funded project is on track to finding a solution.

KIDSIZE (Development of a new extended product-service to overcome size assignment and fitting barriers for children fashion on-line market



addressing customer needs) has developed an app for smartphones and tablets that can take highly precise 3D measurements of a child. By taking a couple of photos of the child, the app can provide 30 measurements with just a 0.5 – 1 cm error factor. This compares to an error factor of 2 – 5 cm made when using a conventional tape measure.

'KIDSIZE will help children's clothing companies to sell more by clearing up sizing concerns both online and in the shop itself — to the mutual advantage of the buyer and the clothing companies,' explained Alfredo Ballester, the technical manager of the KIDSIZE project. 'Moreover, it will help to cut down the expenses involved in product returns for the companies, and the hassle for the buyers and children.'

Increasing competitiveness

KIDSIZE holds promising potential for boosting competitiveness in the EU's children's clothing sector. The project estimates that implementing its technology could save European clothing companies around EUR 130.5 million within five years.

'KIDSIZE works with companies that provide high quality children's clothes, which is most European small and medium-sized children's clothing enterprises. Meanwhile, it will be distributed by wide-reaching European associations like Children's Fashion Europe, Nova CHILD and ASEPRI. We hope that an accurate sizing tool used by European brands will give the sector a significant competitive advantage,' Ballester continued.

The KIDSIZE app works alongside the project's Size Allocation Engine. Based on the dimensions calculated by the app, the engine gives the user two sizing recommendations — the right size for wearing the garment straight away, and the best fit to allow room for the child to grow.

The app works for children aged 3 to 12 years and also provides special paediatric measurements for babies less than 3 years old.

'Our project results show that KIDSIZE provides the right sizing recommendations 80 – 90% of the time. This outperforms age or height-based

recommendations which are right only 45 – 55% of the time,' Ballester says.

Next steps

The project, which finished in March 2016, took the technology through its development, testing and demonstration phases. This included the creation of a demonstration shop which included the popular clothing brands Bóboli and Sucre d'Orge. The app has been made available via Google Play in Europe for beta testers.

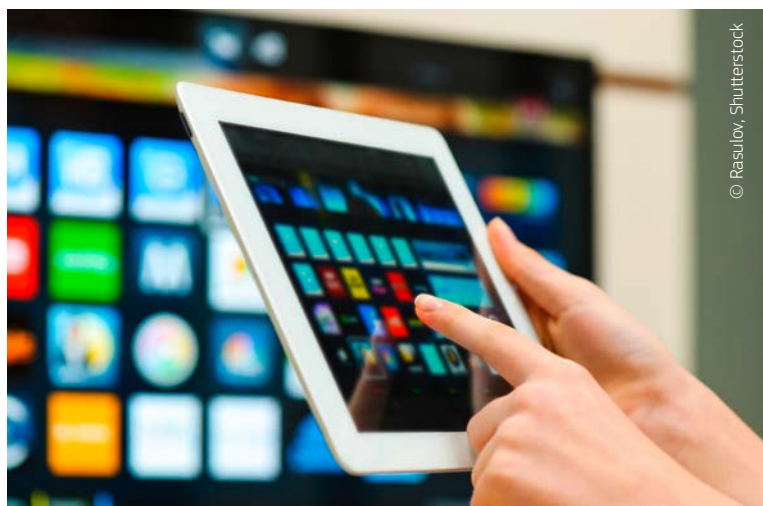
'The next steps are making the app compatible with other mobile operating systems like iOS and Windows, refining the app to make it failure-proof and eventually rolling out its use to a large number of manufacturers and brands,' Ballester concluded.

KIDSIZE

- ★ Coordinated by the European Children's Fashion Association in Spain.
- ★ Funded under FP7-SME.
- ★ <http://cordis.europa.eu/news/rcn/125180>
- ★ Project website: <http://www.kidsizesolution.com/>

ONE APP FOR A SMOOTH MULTI-DEVICE USER EXPERIENCE

The EU-funded MEDIASCAPE project is helping broadcasters provide socially engaging content to viewers using multiple devices.



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How do you watch television? Perhaps you're moving from a traditional cable or satellite broadcast to a streaming service on your PC, tablet or phone? Or maybe you like to 'multi-task' during TV time, checking the news on your smartphone or interacting with other viewers on Twitter and Facebook?

Clearly, the way we watch TV has drastically changed. However, the way television is broadcast has essentially remained the same.

The MEDIASCAPE (Dynamic Media Service Creation Adaptation and Publishing on Every Device) project is disrupting this dynamic by helping broadcasters provide a socially engaging and comprehensive entertainment experience. Instead of providing content through either a TV or a streaming service, broadcasters can use MEDIASCAPE to seamlessly interact with viewers across multiple devices.

Turning to the app

The challenge is that many of today's applications are designed for a specific device, meaning broadcasters have to design, implement, distribute and maintain a set of complex apps tailored to each individual device. Enter MEDIASCAPE, which instead of focusing on the device, is looking to build consistency into the app itself — allowing it to run independently across multiple devices. Specifically, the project is providing the standardised technology developers need to create the connected service apps required for advanced multi-user services.

MEDIASCAPE provides access to an array of information on the various 'Application program interfaces' (APIs) and user-oriented media application prototypes that it's developing. Developers are then free to incorporate these prototypes into their own applications. Examples of prototypes already available include controlling an internet radio with a Chrome extension, along with several connected device applications for the Eurovision Song Contest.

Developers also have access to the Discovery API library, which provides an inventory of device-specific features. Here,

when building an app, a developer can first reference the database to ensure their design is able to function across devices. Another useful feature pertaining to multi-device capability is the adaptation engine, one of the core technological components developed by MEDIASCAPE.

“A key technology coming from the project is the ‘User interface engine’ (UI-engine) library, which allows developers to create responsive and adaptive user interface layouts for multi-device media applications.”

This engine uses current context and device capabilities to dynamically assign certain parts of an application’s content to a specific device.

A key technology coming from the project is the ‘User interface engine’ (UI-engine) library, which allows developers to create responsive and adaptive user interface layouts for multi-device media applications. This is important as, in the past, when facing a single-device user interface, a developer had to first define CSS templates, then organise items in the layout,

before finally creating a different template for each targeted device. With all the devices now being used, these templates can quickly add up. The UI-engine library offers a more versatile solution for creating responsive and adaptive user interfaces depending on the multi-device context of the user.

A win-win-win for broadcasters

MEDIASCAPE’s research and supported technology is benefiting users, broadcasters and developers alike. For example, thanks to MEDIASCAPE’s technological breakthroughs, users can move from device to device — or use multiple devices simultaneously — without a break in content.

Broadcasters, on the other hand, can now create and provide a single application that reaches its target audience regardless of the device being used. From a developer’s standpoint, creating apps for TV is now as easy as creating a basic HTML webpage — thereby enabling broader participation in their creation and increasing the range and diversity of potential applications.

MEDIASCAPE

- ★ Coordinated by VICOMTECH in Spain.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/news/rcn/125101>
- ★ Project website: <http://mediascapeproject.eu/>

WHAT DO I SPY WITH MY LITTLE EYE?

Understanding what the eyes are looking at and what activity they are doing can help man-machine interface technology and advance many high-tech applications. Partners in the European project MARIE have delved into this very subject and contributed to taking this technology into the future.

There are many new high-tech systems and services that rely on recognising human actions and behaviour.

As more automation and machine intelligence rely on human-machine interaction, it is important to advance this discipline and further its potential. One particular area of interest is understanding eye movements (i.e. where you’re looking, what you’re looking at or how you’re looking) and getting intelligent machines to react accordingly.

The EU-funded project MARIE (Multimodal activity recognition for interactive environments) worked on advancing the technology involved in recognising human eye activity. It successfully used eye movement patterns to capture user activity and intention, and designed a new methodology for evaluating activity recognition performance. This included classifying eye movements that match each activity and mapping movement sequences.

The MARIE project partners developed and evaluated algorithms for assessing different eye movements and signals, including eye fixation and blinking, in different contexts and situations. Discerning different eye movements was successfully carried out while participants were copying a text, reading a paper, taking notes, watching a video and browsing the Internet. The team was also able to understand when participants read something while in motion, such as when walking or driving a vehicle.

The project published the results of its work, including a database of eye movements that can be used by other researchers. Several other sets of results were also published, with several researchers having worked on the topic. The results were disseminated through different media and were well received by the research community, underlining the success of eye-based activity recognition.

Furthermore, the MARIE project devised a comprehensive system of evaluation, including data comparison and error scoring, paving the way for more accurate and useful results in the future. This helped remedy significant drawbacks in how researchers measured and evaluated their progress in this area. By collaborating with over 30 leading researchers in the field, the project also mapped out how the research can move



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forward into the future. This technology has enormous potential in many high-tech fields, and may end up in applications in areas such as security, medicine, transport and many others.

MARIE

- ★ Coordinated by Lancaster University in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/87119>

INDUSTRIAL TECHNOLOGIES

NEW PLATFORM PROVIDES SME ACCESS TO SIMULATION TECHNOLOGIES

The EU-funded CLOUDSME project has made it easier for SMEs looking to apply simulation technologies in order to achieve operational efficiencies.

While simulation software is now widely used in manufacturing and engineering to analyse chemical processes, manufacturing systems, logistics and supply chains, take-up of simulation software by SMEs has until now been low. This is mostly due to high barriers of entry such as hardware prices, licensing costs and technical expertise. In this respect, European SMEs can find themselves at a competitive disadvantage.

Completed in March 2016, the CLOUDSME (Cloud based Simulation platform for Manufacturing and Engineering) project addressed this challenge by developing a cloud-based platform. Here, SMEs have easy access to recently developed process simulation apps applicable across a broad range of sectors and targeted specifically at smaller businesses. The platform also creates a significant market opportunity for app developers, who have often found it difficult to reach SMEs.

The project platform provides examples of how companies are already using CLOUDSME technology to achieve operational efficiencies in their respective sectors, and enables SMEs to explore and test the first available tools. New applications are constantly being developed and uploaded onto the site. The CLOUDSME platform also enables companies to build customised cloud applications.

One interesting application uploaded onto the platform involved a small UK brewer, an eager early adopter of innovative sustainable technologies. This company helped to develop a cloud-based process optimisation simulation tool, which has attracted great interest among Europe's craft brewing community.

The tool, developed by an independent supplier of simulation software and services, is designed to help brewers achieve a better understanding of their brewing processes and as a consequence enable them to brew better beer. By leveraging the power of a cloud platform like CLOUDSME, anybody who has internet access can acquire the tool.

Another experimental scenario involved linking up a patented insole design simulation programme — used to tailor sports footwear and shoes for people with foot problems — with a cloud-based version. A portal was established through which scans could be uploaded to the cloud-based software service, which then validated the scanned image to produce the tailored insole design.

Simulation software is typically based on numerical simulation or event simulation, and usually consists of a visual modelling tool, a simulation tool, an experimentation manager to support statistically correct experimentation and a results generator to bring together key

experimentation findings. Companies use simulation software because it can significantly reduce costs through identifying more efficient development, production, procurement, logistics or financial processes.

The CLOUDSME project consortium involved experienced partners — including 12 SMEs — ranging from cloud hardware and platform providers to simulation software providers, end users and technology integrators. The project built upon existing and proven technologies, thus enabling the project to deliver implementable results quickly.

The platform, which will continue to run, will help ensure that manufacturing and engineering SMEs — the backbone of the EU's economy — have access to simulation tools that could lead to operational efficiencies and increased competitiveness. The platform will also provide new business opportunities not only to end-user SMEs but also to simulation software and cloud service providers.

CLOUDSME

- ★ Coordinated by the University of Westminster in the United Kingdom.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/news/rcn/125079>
- ★ Project website: <http://cloudsme.eu/>
- ★  <http://bit.ly/1T7IhTU>

AUTOMATIC PARACHUTE LANDING

An EU team has developed separate parachute soft-landing systems for two types of small aircraft. The different versions, and associated subsystems, were successfully shown to be deployable by either the pilot or remote activation.

Certain recent aviation accidents suggest that there is a need for parachute systems for 'Light sport aircraft' (LSA) and 'Near space capsules' (NSCs). The systems would slow the descent and prevent crash-landings in vehicles up to 600 kg.

The EU-funded PARAPLANE (Development of a new steerable parachute system for rescue of small and medium

size airplanes) project aimed to design, develop and test such a system. The concept included a steerable parachute, plus a control and guidance module. The descent and

landing system for LSAs would be carried on-board and activated by the pilot in an emergency. For NSCs, the system would be operated remotely from a ground station.

Work began with stating the requirements, for both hardware design and experimental testing. The next step saw the team compare the usage similarities and differences between LSAs and NSCs. The comparison yielded an emergency scenario for LSAs capable of reliable operation anywhere. The NSC scenario was more dependent on pre-selected landing sites within a known area. Hence the team designed and manufactured two different parachute systems; one was modified from an existing design, while the S2 was new.

The team designed and manufactured additional sub-systems, including a rocket extraction system and an electrical activation circuit. A separate control unit involved developing software for ground navigation and control, autonomous



guidance, and flight data acquisition. Other developments included two types of simulation software.

The testing of all systems and components proved successful. The parachutes were qualified for recovery of LSAs and NSCs up to 600 kg. Experiments during remote autonomous flights showed that the systems were able to automatically select suitable landing sites. The parachutes also effectively steered and controlled the descent of the respective aircraft types.

Researchers demonstrated the results and applications at numerous public workshops and academic conferences.

PARAPLANE represents new developments in aviation safety systems, designed to reduce casualties through controlled parachute descents and by avoiding crash-landings. It also represents a significant commercial and technological opportunity for European SMEs.

PARAPLANE

- ★ Coordinated by CIMSA in Spain.
- ★ Funded under FP7-SME.
- ★ <http://cordis.europa.eu/result/rcn/181143>
- ★ Project website: <http://www.cimne.com/paraplane>

SMART 'ELECTRONIC' PAPER PRODUCTS ENHANCE COMPETITIVENESS OF PRINT INDUSTRY



Using cost-efficient printing techniques, an innovative EU-funded project has incorporated wireless sensor technology into paper products. The technology offers innovative applications in a variety of different fields, varying from logistics to smart packaging.

Recent technological advances have enabled the incorporation of electronic-enabled sensors directly into paper products. In one example, electronic packaging can verify medicine authenticity, while emails can be sent confirming when

the package is opened by the correct person at the correct address.

Until recently, it wasn't economically feasible to produce packages and labels with sensors. However, the EU-backed project ROPAS (Roll-to-roll Paper Sensors) has overcome this challenge.

To achieve its aims, the project incorporated the technology using low-cost and high-throughput 'Roll-to-roll' (R2R) and 'Sheet-to-sheet' (S2S) printing. It developed a technological platform that integrates printed building blocks consisting of a paper substrate, conductive tracks, an antenna, a battery and sensor switches.

Three applications have demonstrated ROPAS technologies. A security tag makes it possible to determine whether or not a package has been opened. A smart label enables customers to verify radio frequency identification-coded information easily for use in, for example, brand protection and privacy applications. In addition, the smart label is equipped with a temperature and humidity sensor, which monitors the history of a package. Finally, a smart envelope provides tracking and personal delivery services at a high security level, mimicking registered mail, but at a lower cost.

During the project, the team optimised the technical building blocks and completed functional prototypes for all three demonstrators. One promising application that project researchers worked on was fabrication of the 'Organic radical

battery' (ORB). Given the fact that the technology related to this application is quite novel, the team filed a patent application for the ORB electrolyte synthesis methodology.

In parallel, R2R and S2S trials enabled mass production of the demonstrators to begin. Scientists improved the printing processes using flash sintering to cure the conductive ink at high speed on paper, and also made progress on the placement of components. A patent was filed for the smart envelope technology, which holds the promise of huge market potential.

The European paper industry requires innovative and cost-effective ways to add value to its products in order to remain competitive. ROPAS delivered a solution with building blocks for the next generation of multi-functional fibre-based

"One promising application that project researchers worked on was fabrication of the 'Organic radical battery' (ORB)."

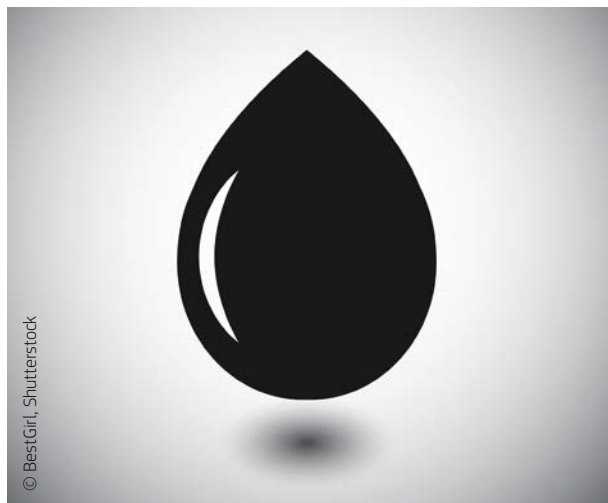
products for multi-billion euro market sectors, including food, packaging, medicine and logistics.

ROPAS

- ★ Coordinated by TNO in the Netherlands.
- ★ Funded under FP7-NMP.
- ★ <http://cordis.europa.eu/result/rcn/92130>
- ★ Project website: <http://www.ropas-project.eu/>

THE SCIENCE OF DROPLETS

The dynamics of impinging liquid droplets onto solid surfaces plays a crucial role in a variety of processes, including inkjet printing and spray coating. Recent efforts in understanding and, thereby, controlling droplet impingement have focused on dry, non-flat surfaces.



The EU-funded project NONFLATIMPINGEMENT (Droplet impingement on non-flat surfaces) carried out numerical modelling of the interaction of liquid droplets impinging on non-flat surfaces. This research represents a major step forward in respect of earlier theoretical and

numerical studies, which were limited to flat surfaces.

Initially, the project team used the commercial package ANSYS Fluent, a comprehensive suite of computational fluid

dynamics software for modelling fluid flow. They selected what is known as the volume of fluid method as the most

appropriate for numerical simulations of the droplets' flow between two immiscible fluids.

This method involves solving Navier-Stokes equations for both mass and momentum transport in addition to the advection of a scalar quantity called volume fraction. Numerical simulations captured the liquid-air interface behaviour using a grid refinement technique. This meant that accurate predictions in the area of interest could be made.

During the course of the project, standard models applicable under the conditions of fluid catalytic cracking, a common conversion process in petroleum refineries, were further enhanced. Dynamic contact angle models and the newly developed wetting force model were incorporated to improve numerical modelling of the solid-liquid interaction.

Project researchers validated the robustness of the new approach against previously reported modelling results and experimental data. Fundamental mechanisms governing the droplet spreading dynamics over both hydrophilic and hydrophobic non-flat surfaces were established, as were the synergistic effects of processing parameters.

The numerical model developed within NONFLATIMPINGEMENT proved capable of simulating real-world phenomena and contributed to the extraction of valuable information for petroleum refinery operations. One particularly important aspect is that the conversion of high-molecular-weight fractions of crude oils to gasoline and other products stands to benefit from the insights gained through the project.

NONFLATIMPINGEMENT

- ★ Coordinated by City University in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/181128>

"Project researchers validated the robustness of the new approach against previously reported modelling results as well as experimental data."

SECURITY AND SAFETY

HIGH-TECH KITS PROMISE RAPID, EFFECTIVE EMERGENCY RELIEF

New emergency kits have been developed to help relief organisations respond quicker to large-scale disasters and potentially save many more lives.

Developed through the EU-funded SPEEDKITS (Rapid deployable kits as seeds for self-recovery) project, these cost-effective, modular and easy-to-use kits, providing first aid support in terms of shelter, medical care, drinking water, sanitation and basic energy needs, will enable humanitarian workers to provide swift and effective aid when disaster strikes.

The kits have been tailored to deal with specific emergencies, and will improve the lives of millions of people during the first hours, days and weeks of a major disaster. They can be deployed in affected cities, improvised camps or scattered rural regions at short notice.

Senegal and South Africa demonstrations

The project's innovative shelter and tent solutions were recently demonstrated in northern Senegal. Emergency housing includes a 'clever roof' (an ultra-lightweight safe shelter for one family) and a 'Progressive House' (a shelter for families of up to five people).

A modular warehouse tent was also set up at the local headquarters of the Senegalese Red Cross. The deployment of these prototypes enabled the consortium to gather valuable information and to fine-tune solutions before bringing the kits to market.

Larger kits for immediate use beyond critical first aid, such as sanitation units, sustainable energy generation and mobile recycling units for debris, have also been developed. Sanitation kits include a foldable raised latrine for emergency cases and a semi-manual water drilling kit.

Another interesting innovation includes a pasteurisation and biogas unit for off-site sludge treatment and a sanitation kit to pasteurise sludge early on before depositing. This kit was recently tested in an agricultural community in the Cape region of South Africa.

The kit was successfully erected within two hours. In parallel, progress has been made towards designing an autonomous rapid deployment plug-and-play hospital that can handle between 80 and 120 people, complete with hygienic rooms and critical installations.

Improving emergency infrastructure

The project builds on existing disaster relief procedures. Humanitarian organisations like the Red Cross have sleeping 'Emergency response units' (ERU), which are put in place immediately after disaster strikes. Each ERU has a specific function, e.g. medical care, sanitation, energy provision or water supply.

The SPEEDKITS project sought to improve the delivery of such emergency infrastructure by first assessing current

equipment solutions and identifying key challenges such as supply bottlenecks and weight. Novel materials and concepts were then developed to drastically reduce volume and weight, making transportation easier.

Successful examples include lightweight but durable and thermally insulated tent materials, novel concepts for energy supply (biogas from sanitation), textiles to line pit latrines and smarter packaging (smaller units have been designed to fit into medium ones, which then go into larger ones, like a Russian doll). As emergency response units need to be onsite as soon as possible, ensuring that the kits are easy to transport and install is essential.

The SPEEDKITS project was guided by the Red Cross and involved experts in material and structural engineering, industrial design and architecture. The new units will not only save lives in the first days and weeks after a disaster, but also put in place the seeds for rebuilding for future generations.

SPEEDKITS

- ★ Coordinated by Centexbel in Belgium.
- ★ Funded under FP7-SECURITY.
- ★ <http://cordis.europa.eu/news/rcn/124893>
- ★ Project website: <http://www.speedkits.eu/>
- ★  <http://bit.ly/1TcBbze>

HARMONISED SECURITY ACROSS DEVICES

In the face of disparate security options across mobile devices, an EU-funded project is proposing to move security applications from device to network nodes.

The rapid rise of mobile devices has left many security gaps in its wake — with sources of concern including operating systems with flaws, configuration issues, vulnerable apps and public networks. All in all, it is estimated that 75% or more of mobile apps would fail basic security tests. OS vulnerabilities, on the other hand, are more than doubling each year.

In the face of these alarming statistics, consumers are left to resort to protection tools that may not exist on all systems, have capabilities that vary greatly across devices, and often consume too many resources. These problems could all be solved in a single technological shift: offloading execution of security applications into a programmable device at the edge of the network — such as a home gateway or an enterprise router.

The SECURED (SECURITY at the network EDGE) project has been designing such a solution since October 2013. A few months before the end of the project, its coordinator Prof. Antonio Lioy, from the Polytechnic University of Turin, details its results so far, how they fit into today's technological landscape and their potential fields of applications.

★ What are the main problems with current mobile device security systems?

Current mobile device security is mostly device-based: users need to locally install the appropriate solution on each of their own devices, for example an anti-virus to protect them against malware or a firewall to block unwanted connections. This is both complex — as the average user tends to have several devices — and difficult — as some security applications are not available for all kind of devices or do not have the same performance or features.

Large companies tend to address this problem by restricting the type of mobile devices used by their employees and by adopting 'Mobile device management' (MDM) system. However, this is not feasible for general users who are therefore increasingly exposed to risks. In a nutshell, security of mobile devices is variable and mostly insufficient, as it depends on the products available and the device used.

★ How does the SECURED architecture help overcome these problems?

SECURED proposes to delegate protection — totally or in part — to a trusted and secure network node, specifically crafted to run security applications selected by the user and configured according a protection policy specified by himself.

We name this device a 'Network edge device' (NED), as to ensure best performance it is preferable to place it in the network as close as possible to the mobile device — although the use of a remote or cloud-based NED is also possible.

When the user connects his mobile device to the NED, a proof of the identity and integrity status of the NED is provided so that the user can trust the NED to work on his behalf, and a dedicated virtual execution domain is created for the user. The NED will then download the selected security controls from user-specified repositories and will configure them according to his protection profile retrieved from a policy repository.

★ Can it be used on existing networks? How?

Yes it can be done, by inserting NEDs into the network and asking the users to connect via a VPN to their selected NED. Of course if the network access point of the user — the home gateway, the Wi-Fi access point or the 3G/4G access node — is already a NED, then a VPN would not be needed and performance would be improved.

In any case, the option to have the NED directly available as first hop in the network or as a remote entity provides a lot of flexibility in the deployment scheme. This in turn permits a gradual adoption of the solution and makes it available also in those environments that do not directly adopt the SECURED technology. In other words, the user is in control of his own security and the only variable parameter is network performance which is maximised with a local NED and decreases with a remote one. Trust and security are guaranteed in both cases.

★ How about future Internet, more specifically the Internet of Things?

The paradigm developed by SECURED is suitable also for the Internet of Things. Typically the nodes of these environments have limited power and capabilities and hence have low or no protection because they cannot execute complex security controls. We can achieve a good degree of protection for IoT nodes by connecting them to the external network via a NED, which takes care of their protection.

★ Cross-network security policies can also be enforced thanks to your system. How did you achieve that?

The NED is actually a component that has many stakeholders, depending on who the owner is. For example, NEDs offered by an 'Internet service provider' (ISP) or a 'Mobile network operator' (MNO) will apply not only the user's security



PROF. ANTONIO LIOY

policy but also the operator's. SECURED has developed algorithms to combine these different policies and apply the resultant one. Of course in cases where the operator's policy is more restrictive than the user's, the NED informs the user of the additional restrictions and provides the option to disconnect.

Security controls and policies are downloaded onto the NED on demand when a user connects to a network, and this automatically works across different networks. Additionally, the solution also provides seamless support for mobility: if a user moves from one access point to a different one then his virtual execution domain is automatically connected to the new access point.

★ **Can you tell us more about the marketplace you created?**

Our targets are normal users who are not necessarily technical security experts. We have therefore tried to simplify the usage of SECURED as much as possible. First we created a high level interface to specify the security policy in a nearly-natural language — actually a restricted language, for example only the verbs related to protection are available, such as 'permit', 'deny' or 'record'.

Then the user can access a marketplace where various security applications are available, quite similar to the typical marketplace you would find on your smartphone. Technically-savvy users can directly select the desired applications while neophytes will benefit from automatic selection based on their specified policy.

For example, if the user asked to block access to websites with inappropriate content for children and to be



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protected from malware, then the system will suggest acquiring a parental control app and an anti-virus one. If more than one app of a certain kind is available, the user is presented with the features that distinguish them such as price, performance and recommendations from other users.

★ **The project will be completed soon. How well do you think it will be received on the market?**

When we started the project back in 2013, our main targets were network/service providers and Wi-Fi hotspots. We still think that these are reasonable adopters but, at the same time, we have discovered that new interesting fields of applications have emerged.

Besides the IoT paradigm which we already discussed, modern software-based networks are a big target: the 'Software-defined networking' (SDN) and 'Network function virtualization' (NFV) paradigms are rapidly changing the

networking scenario from a hardware- to a software-based one. This means that the network itself is a possible adopter of the SECURED technology as it offers on-demand security functions configured according to specific policies and executed in a trusted environment. We had a presentation and a demo in February 2016 at a meeting of the ETSI NFV working group and the SECURED technology raised a lot of interest. So there are various markets where I think SECURED will play a role in the near future.

SECURED

- ★ Coordinated by the Polytechnic University of Turin in Italy.
- ★ Funded under FP7-ICT.
- ★ <http://cordis.europa.eu/project/rcn/110458>
- ★ Project website: <https://www.secured-fp7.eu>
- ★  <http://bit.ly/22kQzdw>

NOVEL TECHNOLOGY IMPROVES PROTECTION FOR VULNERABLE ROAD USERS

EU-funded researchers have studied and piloted a variety of 'Intelligent transport systems' (ITS) to ascertain which will best improve the safety, comfort and mobility for 'Vulnerable road users' (VRUs).

The EU has a target of halving road fatalities by 2020 and figures released by the European Commission show that there were 26 000 fatalities and 135 000 serious injuries on EU roads in 2015, with a combined cost of around EUR 100 billion (rehabilitation, healthcare, material damages, etc.).

Between 2000 and 2012, fatalities among car occupants were reduced by 50% but similar reductions were not experienced by VRUs, with fatalities amongst pedestrians reduced by 34%, cyclists 31%, and motorcyclists 17%. Taken together, VRUs account for 68% of the road fatalities in urban areas. Indeed, incidents involving VRUs are one of the reasons cited for the slowdown in EU road safety between 2015 and 2014.

The three-year VRUITS (Improving Safety and Mobility of Vulnerable Road Users through its Applications) project acknowledges that the ITS approach to traffic management has undoubtedly contributed to the reduction in car fatalities by equipping vehicles and infrastructure with additional technology. However, the researchers argue it has put less emphasis on the safety, comfort and mobility needs of VRUs.

The project sought to redress this balance by analysing different ITS, proposing VRU-centric practices, which were then field tested and piloted. This enabled the researchers to make evidence-based recommendations for future policy and industrial development. Contributing factors such as market readiness, cost-benefit analysis, currently available

infrastructure and societal impact were taken into account when making these recommendations.

Field testing

For infrastructure-based ITS, the project looked at 'Intelligent pedestrian traffic signal' (IPT), 'Crossing adaptive lighting' (CAL) and 'Information on vacancy of bicycle racks' (IVB). With vehicle-based systems, it focused on 'Blind spot detection' (BSD), 'Pedestrian and cyclist detection system + emergency braking' (PCDS+EBR) and 'VRU beacon system' (VBS). Finally, for user-centric systems, it concentrated on 'Powered two wheeled on-coming vehicle information system' (PTW2V), 'Bicycle to vehicle communications' (B2V), 'Green wave for cyclists' (GWC) and 'intersection safety' (INS).

Field trials of recommended practices were held in the Netherlands and Spain. In Valladolid, Spain, system tests were conducted for improvements to pedestrian mobility by sensor controlled traffic lights and to safety through increased visibility at zebra crossing. The trial found that as a result of the modifications 5% fewer pedestrians crossed the road on a red light and pedestrians experienced 20% less waiting time.

The pilot study in Alcalá de Henares looked at intersection safety by using pedestrian detectors and driver notification, finding that the system held a lot of versatility but also the potential to be quite expensive to set up, depending on the existing infrastructure. In Helmond in the Netherlands, researchers also looked at intersection safety but this time for cyclists by piloting a system which warned both car drivers and cyclists of potential collision danger, as well as instituting automatic car braking.

Running these pilots enabled a more advanced technical understanding of the relative costs and benefits of each of the systems. Overall, the study of the 10 systems determined that seven returned benefits that outweighed the cost of implementation, improving the safety, mobility and

comfort of VRUs. The study found that Pedestrian and Cyclist Detection System and Emergency Braking holds promise for the improvement of safety for VRUs but the researchers also acknowledge limitations in research methodology with the difficulty in designing tests which accurately replicate high-risk scenarios. Therefore, the researchers suggest better accident data as one way towards creating optimum systems, as well as a system-wide rather than individual component strategy.

Policy recommendations

The project also made a series of policy and industrial development recommendations. From a design stand-point they recommend the need for improved VRU detection accuracy and interfaces with designs optimised for users. Additionally, they call for devices that can adapt to environmental conditions and are enabled with multiple, cooperative functions. They also underline the need for better prediction of road user behaviour, proper procedures for data usage, standardised systems and legislation enforcement where necessary.

These recommendations come at a timely juncture. Connected and automated driving (C-ITS) has been cited as a key part of the EU's strategy to meet the 2020 50% reduction in road fatalities and the Commission will develop its ITS deployment master plan in the second half of 2016.

VRUITS

- ★ Coordinated by VTT Technical Research Centre in Finland.
 - ★ Funded under FP7-TRANSPORT.
 - ★ <http://cordis.europa.eu/news/rcn/125080>
 - ★ Project website:
<http://www.vruits.eu/>
 - ★  <http://bit.ly/1TcBk5C>
-

ONLINE CRISIS MANAGEMENT TOOLS FOR INFORMING, ADVISING AND PREPARING LOCAL COMMUNITIES

The EU-funded POP-ALERT project has developed new tools for informing and assisting communities during major natural disasters or emergency incidents.

The project, during its final conference in Brussels on 15 March 2016, presented its practical and flexible strategies for preparing populations to cope with crises or disasters.

"The Dashboard includes an interactive and regularly updated map of the crisis area and lists the contact information of all local authorities, including police, fire and civil protection."

The researchers focussed their attention on a variety of stakeholders who, due to their geographical, political or economic situation, are likely to face different types of threats, such as landslips, wildfires, floods, earthquakes and manmade disasters (such as technological failure and terrorism).

More specifically, they targeted both local populations as well as visitors, such as expats and tourists, tackling key factors including cultural differences and language barriers. This allowed them to create a framework that facilitates the assessment of the population's capacity

to absorb and make use of different Crisis Management strategies and technologies developed at the EU level.

Effective communication for crisis management

To develop such a framework, the main principle of the project POP-ALERT (Population Alerting: Linking Emergencies, Resilience and Training) has been that the key to a successful Crisis Management Process is effective communication. When a crisis occurs, the flows of communication between the different actors enable the response to be quick and



effective. In current systems, the authorities and first-responders are made aware of a situation through different monitoring technologies, as well as from certain emergency calls from the population.

However, the project has also focussed on ensuring a 'bottom-up' approach by making the target populations a key lynchpin of the project. The effectiveness of the local and national authorities, as well as emergency services, depends on the preparedness of the population directly impacted by the emergency, but the local population must also be provided with the right training and information from local authorities and first-responders.

To help better inform local populations on what they should do during an incident, the project has written individual factsheets that citizens are able to print out and keep pre-emptively in their home. These factsheets cover a number of hazards, from natural disasters and extreme weather to terrorism. The project also provides advice on how individuals can practically prepare an emergency supply kit, as well as age-specific games to teach children how they should react during an incident.

POP-ALERT Dashboard and Lisbon simulation

Arguably the most innovative tool developed by the project is the POP-ALERT Dashboard for Population Preparedness and Alerting. The online Dashboard would be the central

mechanism in a unified system of warning citizens of danger and providing them with the most up-to-date and relevant information in the case of a major incident. The idea is that during an emergency situation, the Dashboard would be 'owned' by the local authority responsible for coordinating the local response.

The Dashboard was put into practice during a simulated emergency that took place in Lisbon in February 2016. In the scenario, which included 130 participants from across the EU, an earthquake strikes the Portuguese capital, causing many of its ancient buildings and monuments to collapse into ruins.

Lisbon was chosen as its historic centre is densely packed but also because over 10 million tourists visit the city each year, most of whom do not speak Portuguese. This meant that the simulation had to take into account the need to not only communicate clear advice and instructions to the local population, but also effectively address the thousands of tourists caught up in such an emergency situation.

The Dashboard includes an interactive and regularly updated map of the crisis area and lists the contact information of all local authorities, including police, fire and civil protection. The Dashboard also collects and publishes updates and official advice distributed via social media and has a rolling live-feed of realtime updates.

Although the Lisbon simulation was deemed a success, the project's technical coordinator, Hara Caracostas, did admit during the conference that the main drawback of the POP-ALERT strategy is its almost complete reliance on internet tools, as well as addressing the challenge of being able to quickly and simultaneously translate vital information and official advice into several languages or more if required.

Next steps

Ms Caracostas emphasised that emergency response programmes were a national competence but that the POP-ALERT team hopes that its tools and materials will be adopted by EU Member States to provide a framework that would help local authorities synchronise their efforts during an incident.

From a practical perspective, the project team will provide a series of recommendations to the European Commission in the hope that they will develop the POP-ALERT platform further and make full use of it at a European level.

POP-ALERT

- ★ Coordinated by the University of Greenwich in the United Kingdom.
- ★ Funded under FP7-SECURITY.
- ★ <http://cordis.europa.eu/news/rcn/124900>
- ★ Project website: <http://www.pop-alert.eu/>
- ★ <http://bit.ly/1TV5Qy5>

SPACE

SATELLITE REMOTE SENSING FOR MONITORING SPECIES DIVERSITY

Research supported by the FP7-funded EU BON project has shown that 'Satellite remote sensing' (SRS) has proven to be one of the most cost-effective approaches to identifying biodiversity hotspots and predicting changes in species composition.

Published in the journal 'Remote Sensing in Ecology and Conservation', the research examines the real potential of SRS, as well as the pitfalls that need to be avoided to achieve its full potential. The study takes the assessment of diversity in plant communities as a case study. Showing the difficulties in achieving high results by relying only on field data, the paper discusses the advantages of SRS methods.

In contrast to field-based methods, SRS allows for the complete spatial coverage of the Earth's surface under study over a short period of time, the paper found. The paper's lead author was EU BON's (Building the European Biodiversity Observation Network) task leader Dr D. Rocchini from the Fondazione Edmund Bach, one of the project consortium partners.

Going beyond traditional methods

Using traditional methods as laid down by ecologist R. H. Whittaker in 1972, the assessment of biodiversity at local and regional scales relies on both local diversity (called 'alpha-diversity') and species turnover (called 'beta-diversity'). Only with a combination of these two measures can there be an accurate estimate of the biodiversity of a certain area.

While the assessment of alpha-diversity is relatively straightforward, calculation of beta-diversity could prove to be quite

challenging. This is where increased collaboration between the remote sensing and biodiversity communities is needed in order to properly address future challenges and developments. Species monitoring in relatively large areas has always proven to be a more difficult task for ecologists, mainly due to the intrinsic difficulty in evaluating the completeness of the resulting species' lists and in quantifying sampling effort. Inventorying species over a large region is complicated by the fact that it is very difficult for field biologists to inspect every individual organism in the region while accounting for changes in species composition over time.

The new research has shown the high potential of SRS in biodiversity studies while also identifying the challenges underpinning the development of this interdisciplinary field of research. The researchers emphasise that in a period of major environmental change, SRS represents a powerful opportunity for ecologists to gain critical knowledge about the drivers of the spatial and temporal distribution of biodiversity.

Challenges to overcome

However, the research team also emphasises the possible challenges to be overcome when using SRS to map biodiversity hotspots. One of the big issues raised in the study includes the need for increasingly complex data analyses in order to effectively quantify

and monitor global biodiversity via SRS. To achieve this, there would need to be a completely new orientation of Big Data analysis using 'Linked open data' (LOD). Another issue raised was the need to ensure the correct spatial resolution of imaging for various types of environment, from tropical to temperate in order to gain the most accurate biodiversity data.

Overall, the study concluded that further sensitivity studies on environmental parameters derived from remote sensing for biodiversity mapping need to be undertaken to understand the pitfalls and impacts of different data collection processes and models.

The EU BON project will run until May 2017 and is focused on developing a truly harmonised and integrated European biodiversity networking using on-ground and remote sensing biodiversity data from a plethora of various schemes and information facilities.

EU BON

- ★ Coordinated by the Museum für Naturkunde in Germany.
- ★ Funded under FP7-ENVIRONMENT.
- ★ <http://cordis.europa.eu/news/rcn/125039>
- ★ Project website: <http://eubon.eu/>
- ★  <http://bit.ly/1OvoJk>

ANDROMEDA GALAXY'S FIRST SPINNING NEUTRON STAR DISCOVERED

The EU-funded EXTRAS project, after combing through data collected by the European Space Agency's (ESA) XMM-Newton space telescope, has announced the discovery of the first confirmed spinning neutron star in the neighbouring Andromeda galaxy.

The Andromeda (or M31) galaxy is the closest galaxy to our own Milky Way and is a popular focus of study amongst astronomers. On a clear night and away from urban light pollution, it is possible to see Andromeda with the naked eye. With powerful observatories, it is also possible to look deep inside Andromeda. As such, it has been extensively studied for decades by telescopes covering the whole electromagnetic spectrum.

Despite it being a major focus of astronomers' attention, one particular class of object has never been detected, until now that is: spinning neutron stars.

A spinning neutron star is the small and extremely dense remains of a once-enormous star that exploded as a powerful supernova at the end of its natural life. They often spin very rapidly, are the smallest stellar objects known to science, and can sweep regular pulses of radiation towards Earth. They are a common occurrence in the Milky Way, with astronomers estimating that there are over 100 million of them alone, but have remained elusive in Andromeda.

The EXTRAS (Exploring the X-ray Transient and Variable Sky) project was set up to undertake an unprecedented programme of searching and characterising variable sources in the soft X-ray range of data collected by the XMM-Newton telescope. This includes a search for fast transients, which are missed by standard image analysis, as well as a search and characterisation of variability in tens of thousands of sources across a broad range of timescales. Through this process of systematically searching through the XMM-Newton archives, the EXTRAS astronomers have uncovered the signal of an unusual source from Andromeda fitting the profile of a fast-spinning neutron star.

The neutron star in question, newly named 3XMM J004301.4+413017, spins every 1.2 seconds and appears to be feeding on a neighbouring star that orbits it every 1.3 days. Many neutron stars exist in such binary systems, which makes it easier for astronomers to detect. They can cannibalise their companion star, drawing gas from the companion into their magnetic fields.



'We were expecting to detect periodic signals among the brightest X-ray objects in Andromeda, in line with what we already found during the 1960s and 1970s in our own Galaxy,' commented Gian Luca Israel, one of the EXTRAS project astronomers, based at the Italian National Institute for Astrophysics. 'But persistent, bright X-ray pulsars like this are still somewhat peculiar, so it was not completely a sure thing we would find one in Andromeda.'

The project team looked through archival data of Andromeda from 2000-2013, but it wasn't until 2015 that they were finally able to identify this object in Andromeda's outer spiral in just two of the 35 measurements studied. Whilst the precise nature of the system remains unclear, the data does imply that it is both an unusual and exotic find.

European astronomers are now in a better position to uncover more objects like 3XMM J004301.4+413017, both with the XMM-Newton and with future missions such as the ESA's next-generation high-energy observatory, ATHENA.

The EXTRAS project began in September 2013 and will continue until January 2017.

EXTRAS

- ★ Coordinated by the National Institute for Astrophysics in Italy.
- ★ Funded under FP7-SPACE.
- ★ <http://cordis.europa.eu/news/rcn/125059>
- ★ Project website: <http://www.extras-fp7.eu/>

THE EARLY UNIVERSE IN FOCUS

The European Space Agency's (ESA) Planck mission has observed the 'Cosmic microwave background' (CMB) across the entire sky in unprecedented detail. By digging deep into this wealth of data, EU-funded scientists have revealed different facets of the early universe.

CMB is a unique source of information on the universe's past. The spectrum of this legacy of light emitted about 380 000 years ago after the Big Bang points to a rather boring universe, as there are no hints of light degrees of freedom beyond the standard model or of larger-than-expected neutrino masses.

However, the Planck observations have narrowed down the parameter space of 'inflation' — an accelerated expansion that the universe experienced when it was only a tiny fraction of a second old. Also, scientists are now closer than ever to selecting a small class out of the many inflationary models proposed.

Scientists working on the EU-backed project NGSKY (Non-Gaussianity in the sky) focused on the first model of inflation proposed by Alexei Starobinsky in the 1980s. This theoretical model based on a conformal anomaly in quantum gravity is favoured by the first-year Planck observations.

The Starobinsky model is equivalent to a theory of standard gravitation coupled with a propagating real scalar degree of freedom, suitable for driving inflation. The scientists have embedded this higher curvature gravitational model in the fundamental theory of supergravity.

Supergravity, as the low energy limit of superstring theory, provided the right set-up for accommodating cosmic inflation. Scientists used the linearised theory, since it was sufficient for analysing the field spectrum. Their findings suggest that auxiliary fields of the Einstein theory give rise to additional degrees of freedom.

However, there are also the so-called Higgs inflation models that are in agreement with the Planck observations. These give the same predictions as the Starobinsky model. In NGSKY, the scientists demonstrated that there is a simple reason for this coincidence.

Apparently, all these different models are in essence the Starobinsky model

during inflation. This line of research led to establishing the consistency relations for the large-scale structure of the universe as a result of the corresponding consistency relations for inflation.

These relations are nothing more than signatures of underlying symmetries relevant to the cosmological settings. Using symmetries of cosmological magnetohydrodynamics, the scientists provided valuable insights into the interplay among the universe's large structure, the magnetic fields observed and their origin.

Symmetries were adopted to learn more about the connections among magnetic fields, dark matter and baryons. The many important findings of NGSKY have been disseminated to the scientific community through several publications in high-impact peer-reviewed journals.

The NGSKY project's results lay the groundwork for new connections to be established between the physics of



fundamental particles and cosmology and the physics of the very large structures in the universe.

NGSKY

- ★ Coordinated by the University of Geneva in Switzerland.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/181125>

GALACTIC JETS AND THEIR ENGINES

Jets of material spewed out from massive black holes also rise where the remnant of a collapsed star remains bound to its binary companion star. EU-funded scientists have observed jets from such X-ray binaries to shed light on how relativistic jets are produced.

In X-ray binaries, mass is normally accreted from the star rotating around the black hole or neutron star in the form of a disk. The innermost regions of this accretion disk are so hot that the temperatures exceed one million degrees and emit X-rays.

Close to the accreting compact object, a significant fraction of the in-falling matter is ejected in collimated jets that stretch for thousands of light years. Using high-resolution data from interferometric arrays of radio telescopes, EU-funded research shed new light on how black holes produce these powerful jets.

In the GALACTIC JETS (Studies of jets from galactic black holes and neutron stars) project, scientists used the Very Large Array and the

Very Large Baseline Array in the USA as well as the European VLBI Network to look at the radiation emitted by X-ray binaries at all wavelengths.

The aim was to obtain observations when hard X-rays dominated their luminosity, and subsequently monitor the radiation sources over a period ranging from several days to a few weeks. This strategy allowed the scientists to catch the radio and X-ray outburst of several black holes and neutron stars.

The X-ray binary known as XTE J1908+904 detected at the end of 2013 was found to eject two knots of plasma. Measurements of the apparent opening angle and expansion rate placed constraints on the maximum velocity of relativistic particles spewed into space.

The scientists also detected an accreting neutron star near the massive black hole Sagittarius A, AX J1745.6-2901. During periods dominated by soft X-ray emission, powerful winds that disappeared with the development of jets that predominantly emitted hard X-rays were observed.

The observations compiled during the GALACTIC JETS project gave scientists a valuable opportunity to delve into the mystery of galactic jets. They are still not well understood and further high-quality data will be needed to conclusively confirm scientific hypotheses on how they form and what powers them.



GALACTIC JETS

- ★ Coordinated by the University of Oxford in the United Kingdom.
- ★ Funded under FP7-PEOPLE.
- ★ <http://cordis.europa.eu/result/rcn/181077>

EVENTS

SEPTEMBER
07►08

Linköping, SWEDEN

CONFERENCE

ATBEST FINAL INTERNATIONAL CONFERENCE

The EU-funded ATBEST project will be hosting its final international conference in Linköping, Sweden, from 7 to 8 September 2016.

The two-day conference programme will explore how to maximise the efficiency and sustainability of the biogas supply chain and will comprise of presentations from leading academics, networking opportunities and an industry-led workshop focusing on the biogas market of the future.

The ATBEST project is due to finish in June 2017 and has been tackling several key research challenges along the biogas supply chain, from improving its competitiveness with respect to fossil derived fuels to increasing the sustainability of the biogas industry in Europe.

For further information, please visit:
<http://www.atbest.eu/Conference/>

SEPTEMBER
16

Ljubljana, SLOVENIA

WORKSHOP

FINAL STREST WORKSHOP

The EU-funded STREST project will hold its final workshop in Ljubljana, Slovenia, on 16 September 2016.

The final STREST stakeholder workshop aims to communicate the innovative products developed during the project, namely new research results on natural extreme events and harmonised methods for risk assessment leading to the standardisation and implementation in Europe of stress tests for various classes of Critical Infrastructure (CIs).

It will present the results of applications from a large selection of CIs: petrochemical plants, hydropower dams, oil pipelines, gas networks, port infrastructures and industrial districts. The main innovations presented will be related to seismic hazard and risk, coastal and downstream flooding, and the process of domino effects across natural hazards and CI elements.

For further information, please visit:
http://strest.ethz.ch:8080/opencms/export/sites/default/content/STREST_public/STREST_finalworkshop_flyer.pdf

SEPTEMBER
21►22

Billund, DENMARK

CONFERENCE

ANNUAL SDH CONFERENCE

The EU-funded SDHP2M project will be organising the fourth annual SDH (Solar District Heating) conference in Billund, Denmark, from 21 to 22 September 2016.

The conference will focus on sharing international experience in system concepts and technologies for large-scale solar heating plants and their integration into district heating networks.

Market actors and policy makers from countries with new and developed markets will share their know-how and lessons learnt regarding market preparation and support instruments. Moreover, experienced Danish operators will be available as SDH ambassadors and advisors during the whole event and will lead technical visits to one of the most modern Danish SDH plants in Gram.

For further information, please visit:
<http://solar-district-heating.eu/NewsEvents/SDHConference2016.aspx>

SEPT.
22►23



TURKU, Finland

CONFERENCE

SUSMILK FINAL CONFERENCE

The EU-funded SUSMILK project will be holding its final conference in Santiago de Compostela, Spain from 22 to 23 September 2016.

The final conference of the SUSMILK project will provide insights and present its results on how the project has developed novel solutions for increasing sustainability and competitiveness in the dairy sector. The project has championed the integration of innovative and efficient technologies into a 'green dairy' concept that aims to maximise water and energy savings, and has been a crucial component of the project.

Topics to be covered during the two-day conference include heating and cooling technologies, water treatment systems and the pre-concentration of milk.

For further information, please visit:
<http://www.susmilk.com/index.php/en-resourcen/en-events/27-en-news/233-en-news-sfc2016>

EVENTS

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<http://cordis.europa.eu/events>

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