

ICFOnians

Community News from The Institute of Photonic Sciences



EDITOR'S CORNER

The PhD Pursuit



BROOK HARDWICK
Coordinating Editor



PhD students are a vital part of any research institute. Their original ideas, fresh perspectives, and ambitions are the motor that propels us forward, so much so that Prof. Valerio Pruneri once described PhDs as our institutional clock, measuring our maturity and how much we have accomplished. ICFO puts great stock in our PhDs and realizes that the decision to pursue this degree is not one that is taken lightly. The years of blood, sweat and tears that go into this important achievement represent a challenge that not everyone is capable of taking on, or seeing to completion.

Somewhere between midnight measurements and the ensuing exasperation when results come back... again... with inconclusive evidence, it is not uncommon for PhD students to revisit their motivations for pursuing this top academic recognition. Fame, fortune (?) and of course the immense satisfaction that comes from being the first to achieve/discover/understand something really cool are the most common motivations I have come across for sticking it out. Some Dr.'s I have spoken to around ICFO also admit that they made it through the storm because they are stubborn by nature and prone to finding great satisfaction in proving the naysayers wrong. Others give great credit to their theses advisors who were not only great scientists, but also strong leaders who gave them the confidence to keep going, even when the going got tough.

As we go to print with this edition, ICFO has just launched a new PhD call looking for bright and inspired young minds to join us next year. At the same time, Summer Fellows and students have begun to appear around the facilities, many of whom may be considering the possibility of pursuing their PhD in the future. In the 2016-2017 academic year, the ICFO PhD training program grew and evolved to include a wider range of offerings aiming to accompany students as they launch their PhD careers. Not only has the HR and Education Unit, in collaboration with Academic Programs, been working hard to bring truly inspired young talent to ICFO, they are also working to make sure that these students have the tools they need to get the most they can from this wonderful, exasperating, relentless and fascinating challenge.

This edition of *ICFOians* gives a special focus to the ICFO PhD Training program (pg. 5). As you read on, you will learn that some of our PhD students have received international recognition for their work (pg. 3). You will find still more PhD students in many of our latest research advances that have been published in the top journals in our field, only a small sampling of which we are able to showcase in our Latest Advances section (pg. 4). And of course, we congratulate our newest graduates, Paula, Achim and Alican, who in spite of any moments of frustration encountered along the way, kept their eye on the prize and successfully defended their theses (pg. 6).

Here's to all the ICFOians who enjoy rolling up their sleeves to dive into the challenge of research at the very highest level. It is inspiring to work with people who commit to the challenge not in spite of it being difficult, but because nothing worth achieving is ever easy.

COVER



ICFO Career development programs are based on a variety of components, including participation in cutting-edge science and technology, scientific lectures, specialized seminars and programs, technical workshops, lab tours and other dedicated events.

■ Drawing by Elena Lobera.

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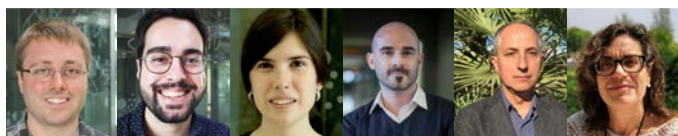
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ICFO NEWS



STUDENT AWARDS

Three ICFOnians have received awards for work related to their PhD theses. Dr. Achim Woessner, whose thesis work was supervised by ICREA Prof. at ICFO Frank Koppens, received the *2017 QEOD Thesis Prize* for applied aspects, for his excellent PhD research and scientific communication regarding his doctoral work on graphene plasmons. ICFO PhD student Jordi Morales Dalmau, a joint student in the Medical Optics research group led by ICREA Prof. at ICFO Turgut Durduran and also the Plasmon Nano-Optics group led by ICREA Prof. at ICFO Romain Quidant, was awarded a *2017 Optics and Photonics Education Scholarship* by SPIE for his potential contributions to the field of optics, photonics or related fields. Clara Gregori, ICFO PhD student in the Medical Optics group led by ICREA Prof. at ICFO Turgut Durduran received the *OSA's Student Presentation Award* at the ECBO Conference for her paper entitled "Cerebral Hemodynamic Responses to a Head-of-be Challenge in Patients with Severe Obstructive Sleep Apnea Before and After Two Years of Continuous Positive Air Pressure Treatment by Diffuse Optics".

BANC SABADELL FOUNDATION PRIZE FOR SCIENCES

The Banc Sabadell Foundation and BIST this year offered the first *Banc Sabadell Foundation Prize for Sciences and Engineering*, aiming to encourage and reward excellent work in scientific areas such as Mathematics, Chemistry, Physics and Engineering by researchers in Spain. ICREA Prof. at ICFO Romain Quidant has been named the recipient of this award for his significant contributions to the field of nanophotonics, which has enormous applications in biomedicine and opens up new avenues for the technology of tomorrow.

2017 PRIZE FOR FUNDAMENTAL ASPECTS OF QUANTUM ELECTRONICS AND OPTICS

The 2017 *European Physical Society's Prize for Fundamental Aspects of Quantum Electronics and Optics* was awarded to ICREA Prof. at ICFO Niek van Hulst for "pioneering contributions to nano-optics and its applications to molecular spectroscopy and to ultra-fast light-matter interactions." The award ceremony took place on June 27, 2017 during CLEO® Europe in Munich.

2017 "MANUEL RICO" – BRUKER NATIONAL PRIZE

ICREA Prof. at ICFO María García-Parajo received the *Brüker-National Prize* for senior scientists from the Spanish Biophysical Society (SBE) in a ceremony that took place in Seville on June 8th, during the SBE Annual congress. The jury cited "...her outstanding scientific work on the development of advanced optical techniques to the study of biological, dynamic processes at the single molecular level on living cells".

BIST NEWS

The BIST IGNITE CALL provides funding to multidisciplinary research involving at least two groups working in different BIST centers. The project proposals, selected by an external scientific committee, show multidisciplinary approaches to solving new or unsolved questions, promoting the cross-fertilization across disciplines, and providing new insights to push the collaboration forward. At the BIST Founding Conference celebrated in early April, five funded projects were announced, in which ICFO will participate in two. 1) *NIGRAPH*: Aitor Mugarza (ICN2), Francisco Javier García de Abajo (ICFO) and Valerio Pruneri (ICFO) will apply a new manufacturing technique to reduce the size of graphene nanostructures up to 1-2 nanometers for their use in optoelectronic devices. 2) *THEIA*: David Merino (ICFO), Jose A. Garrido (ICN2), Mokhtar Chmeissani (IFAE) and Jeroni Nadal (Barraquer Ophthalmological Center) combining the expertise and experience of BIST centers in microscopy, graphene and medical instrumentation to develop a new generation of retinal prostheses based on MEA (multi-electrode array) graphene devices.

Gabriel M. Silberman has been appointed by the BIST Board of Trustees as the new BIST General Director. He brings with him extensive experience in the intersection between public and private research, replacing Miquel A. Pericàs, Director of the Institute of Chemical Research of Catalonia (ICIQ), who was, throughout the past year, also responsible for the management of the BIST. The Board also approved the expansion of the BIST Foundation with the incorporation of the Institute for Bioengineering of Catalonia (IBEC).



ICFO NEWCOMERS



Achim Woessner
Research Engineer



Anamika Nair K.
Student



Anna Kelm
Visiting PhD Student



Ariel Martín
Visiting Scientist



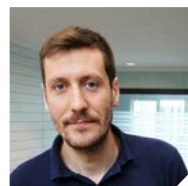
Bruno Naylor
Postdoctoral Researcher



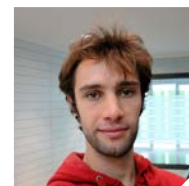
Chetan Deshmukh
PhD Student



Daniel Cano Reol
Postdoctoral Researcher



David Merino
Postdoctoral Researcher



Emanuele Distante
Postdoctoral Researcher



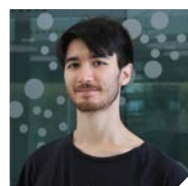
Federica Maruccia
Research Engineer



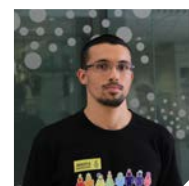
Fernando Sols
Visiting Scientist



Gabriel Senno
Postdoctoral Researcher



Gabriel Mercier
Research Engineer



Gabriel Torregrosa
Student



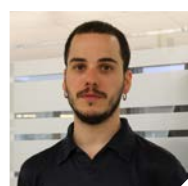
Javier Luna
Student



Jie Luan
Student



Jordi Tura
Postdoctoral Researcher



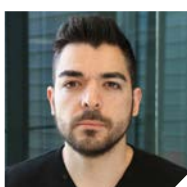
Jorge Delgado
Student



Li-Chun Lin
Research Engineer



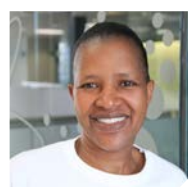
Marco Wiedemann
Student



Mauricio A. Arancibia
Student



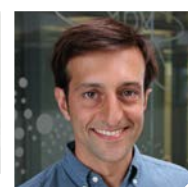
Mélanie Cazaban
Student



Nobanathi Maxakato
Visiting Scientist



Pablo Marin
PhD Student



Pietro Massignan
Visiting Scientist



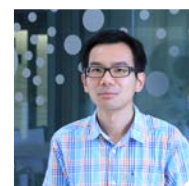
Raúl Blázquez
Student



Rubaiya Hussain
PhD Student



Sara Peña
Student



Soon hoe Lim
Visiting PhD Student



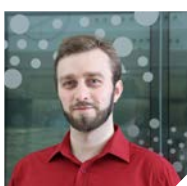
Tihomir Georgiev
Postdoctoral Researcher



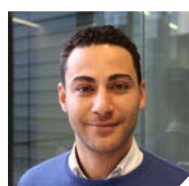
Varun Sharma
Visiting PhD Student



Wei Yang
Postdoctoral Researcher



Wojciech Rogala
Student

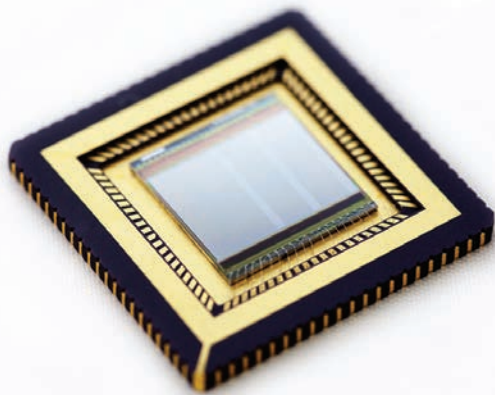


Zakaria M. Abd El-Fattah
Postdoctoral Researcher

Many of us joined ICFO or took a new position at the Institute between April and June.

Welcome to
ICFO!

LATEST ADVANCES



GRAPHENE AND QUANTUM DOTS FOR CMOS-INTEGRATED CAMERA

■ In a study appearing in *Nature Photonics*, and highlighted as the front cover image, ICFO researchers Stijn Goossens, Gabriele Navickaite, Carles Monasterio, Shuchi Gupta, Juan Jose Piqueras, Raul Perez, Gregory Burwell, Ivan Nitkitsky, Tania Lasanta, Teresa Galan and Eric Puma, led by ICREA Professors Frank Koppens and Gerasimos Konstantatos, in collaboration with the company Graphenea, have shown for the first time the monolithic integration of a CMOS integrated circuit with graphene, resulting in a high-resolution image sensor based on graphene and quantum dots (QD). The sensor is highly sensitive to UV, visible and infrared light at the same time, something never achieved before with existing imaging sensors. This discovery will enable a vast amount of applications including safety, security, low cost pocket and smartphone cameras, fire control systems, passive night vision and night surveillance cameras, automotive sensor systems, medical imaging applications, food and pharmaceutical inspection and environmental monitoring, to name a few.

SEEING ELECTRONS SURF THE WAVES OF LIGHT ON GRAPHENE

■ *Science* has published a study in which researchers Dr. Mark Lundberg and Dr. Achim Woessner, led by ICREA Prof. at ICFO Frank Koppens, in collaboration with IIT and Columbia University, studied how light can be used to “see” the quantum nature of an electronic material. Researchers captured light in a net of ultra-high quality graphene and slowed it down so that it moves almost as slow as the electrons in the graphene. To excite and image the ultra-slow plasmons in the graphene, they used a special antenna for light that scans over the surface at a distance of a few nanometers. With this near field nanoscope, they saw that the plasmons on the graphene moved more than 300 times slower than light, dramatically different from what is expected from classical physics laws.

DNA ORIGAMIS SHOW THEIR VERSATILITY FOR SUPER-RESOLUTION MICROSCOPY

■ Up to now, there have been no tools to quantify protein copy number with nanoscale resolution and determine the stoichiometry of complexes observed from super-resolution images. In a study published in *Nature Methods*, ICFO researchers Dr. Francesca Cella Zanacchi and Dr. Carlo Manzo led by Prof. Melike Lakadamyali and ICREA Prof. at ICFO Maria Garcia-Parajo have developed a clever and versatile platform based on DNA origami for calibrating fluorophore and antibody labeling efficiency. The method allows precise quantification of super-resolution images in cellular contexts. The researchers validated the entire structure and calibration capability of the DNA origamis under different experimental conditions, confirming that it can be used as a versatile calibration standard to quantify protein copy number in immunolabeled samples imaged with super-resolution to study a large number of proteins of interest in cellular contexts.

OPTICAL LEVITATING NANO-PARTICLE FOR STOCHASTIC BISTABLE MODELS

■ An optically levitated nanoparticle in vacuum is a clear example of a 3D nano-mechanical resonator. Optimally decoupled from the environment and with an ultra-high Q, this resonator can outperform most clamped micro- and nanofabricated devices in terms of sensitivity. In a study, published in *Nature Communications*, ICFO researchers Francesco Ricci, Dr. Raul Rica, Dr. Marko Spasenovic, Dr. Jan Gieseler, led by ICREA Prof. at ICFO Romain Quidant, in collaboration with researchers from ETH Zurich, have reported on the precise control of the nonlinear dynamics of this resonator, in particular in a regime where the system features bistability. The results of the study provide novel sensor schemes and new capabilities in experimentally simulating complex stochastic nonlinear phenomena.

RESEARCH EXCELLENCE



ICFO Launchpad Advisory Board

Experts in the entrepreneurial process team up with ICFO's KTT Unit

At the core of a frontier research institute are individuals with the drive to do or discover something that no one has ever done before. ICFO is proactive in fostering entrepreneurial activities and spin-off creation, encouraging ICFO'ians to take their new ideas and discoveries “made @ ICFO” out of the lab and into society.

The center offers its researchers the KTT Launchpad, a space and support structure that allows innovative ideas to develop into new technology spin-offs. In addition, ICFO participates in incubator activities and seeks to attract venture capital investment. To date, ICFO has helped create five start-up companies, with additional initiatives in various stages of incubation.

The KTT unit announces the creation of the Launchpad Business Advisory Board, composed of highly-reputed professionals with outstanding expertise in the critical aspects of the entrepreneurial process, who collaborate with the KTT team to advise on ICFO's valorization and licensing strategy, including the creation of start-ups as they move towards market entry.



■ From left to right:

- **Elena Canetti**, Partner, Inveniam Group.
- **Dr. Carles Puente**, Co-founder and Vice President Innovation, Fractus Antennas; Patent Management Professor, Barcelona-Tech.
- **Josep Lluís Sanfeliu**, Managing Partner, Ysios Capital.

TRAINING



ICFO PhD TRAINING

Enhancements to career development for ICFO PhD Students emphasizes initial integration in their doctoral studies

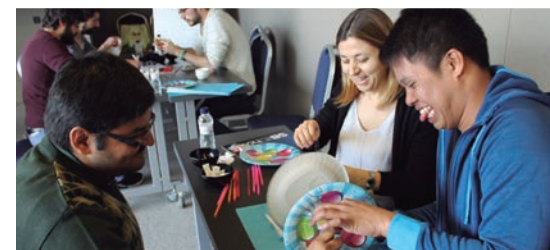
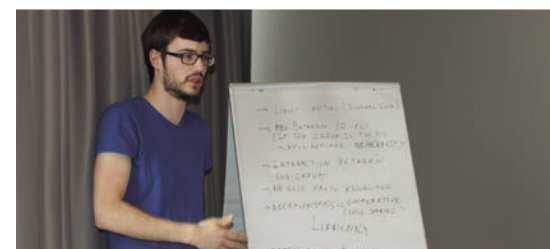
ICFO has received highly competitive funding for two doctoral fellowship programs via the European Commission's Marie Skłodowska-Curie COFUND action. These two new projects, collectively entitled *ICFOstepstone*, will provide up to 45 fellowships between 2016 and 2022, allowing the institute to attract excellent doctoral candidates from around the globe to participate in cutting edge research initiatives.

The *ICFOstepstone* program is allowing training opportunities for PhDs at the institute to grow and evolve. To begin, revised and improved selection procedures have been implemented for the recruitment process, in line with the OTM-R (Open, Transparent and Merit-Based) EC recommendations for recruiting of researchers. One outcome is a cohort-based organization of recruitment and incorporation of new PhD students who, under this new plan, enter ICFO to begin studies in the autumn and spring, and go through the 4-year PhD program together.

Two new cohorts of PhD students joined ICFO this academic year (2016-2017). As has always been ICFO's practice for the training of young scientists, from the day they arrived, they were integrated into an ICFO research group, conducting their studies and research project under the supervision of the corresponding Group Leader.

To help prepare them for the challenges they will face throughout their doctoral studies, especially as they settle in, these new students were welcomed with Initial Training Retreats that include informative sessions, professional skills training, and an opportunity to get to know one another. The Initial Training Retreats are a new initiative, conceived as part of the strategy developed in the 'Action Plan for the implementation of the HRS4R' (Human Resources Strategy for Researchers - <https://www.icfo.es/careers>) at ICFO. This action plan includes specific workpackages for the continuous enhancement of individual career development for ICFO researchers, aiming to offer the best possible opportunities for personal and professional growth while boosting future careers both in the industrial and academic worlds. In addition, it includes a dedicated workpackage devoted to self-audit and improvement of the recruiting & hiring life cycle.

The information and training imparted during the retreat was conceived to help maximize integration and productivity in the first stages of the PhD. Informative sessions cover general information about ICFO, specific information about the PhD Program, its duration and structure and follow-up activities, as well as facilities, services, support and mentoring. Skills crucial for



the successful launch of doctoral studies, including topics such as time and project management, communication skills and research ethics, are also included.

Last but certainly not least, the retreat offers opportunities for socialization and interaction among PhD Students from different research groups. Team-building activities are organized with the aim of reinforcing from the very beginning the interaction between research teams, encouraged not only as an opportunity for the cross-fertilization of ideas, but also as a way of strengthening the ICFO network and creating a motivating and stimulating place to work.

For newly incorporated PhD Students, the Retreats are their first experience within the well-established ICFO+ Training and Development program. Throughout the PhD experience, students can take advantage of ICFO+, which offers a unique package of wide-scope scientific and technical training, courses on entrepreneurship and commercialization techniques, as well as opportunities for professional and personal development.

The feedback received by attendees to these two first Initial PhD Retreats has been extremely positive and we are already looking forward to the next retreat in November for the new cohort of PhD Students joining ICFO during the upcoming academic year.

+ INFO ► phd.icfo.eu

The information and training imparted during the retreat was conceived to help maximize integration and productivity in the first stages of the PhD.



SAMYO MUKHERJEE

■ PhD student in the Nonlinear Optical Phenomena research group led by Prof. Lluís Torner.

"The PhD Retreat was particularly helpful in understanding the structure of the PhD program at ICFO and establishing a peer group. The workshops on time management and research ethics were relevant and helpful at the beginning of my PhD."



SARAH KEARY

■ PhD student in the Single Molecule Biophotonics research group led by ICREA Prof. at ICFO María García-Parajo.

"From a day-to-day perspective, I find that the retreat has influenced my time management habits the most, making me more aware of how important good forward planning is for efficiently conducting experiments. Also, the team building activities helped create a relaxed and friendly environment where fellow PhD students of different stages can help each other with any arising problems."

IN THE FRAME



■ Zillertaler Mountains, Tyrol. Stefan and Cocco.

Stefan Wieser

Live Cell Structured Illumination Super-Resolution Microscopy

■ Stefan grew up in Austria and has an interdisciplinary background in Mathematics, Physics and Biology. He did his PhD in Biophysics and single molecule imaging techniques in the lab of Gerhard J. Schütz, Vienna University of Technology Austria, with subsequent research experience in advanced fluorescence spectroscopy methods and Immunology as an EMBO fellow at the Centre d'Immunologie Marseille-Luminy (CIML), France, in the lab of Didier Marguet. From there he moved to the Institute of Science and Technology (IST), Austria, a joint appointment in the lab of Carl-Philipp Heisenberg and Michael Sixt, and the Medical University Innsbruck (Austria), working on quantitative and image-based approaches for the study of highly dynamic molecular and cellular processes during embryonic stem cell and immune cell migration.

His group at ICFO will work at the interface of Physics and Biology based on ultra-sensitive imaging techniques to gain a mechanistic understanding of cellular processes underlying (patho-) physiological conditions during health and disease. He is interested in pushing current limits of fluorescence superresolution imaging tools to visualize molecular scale information in live cells and tissues and extract quantitative information for modelling of biological processes. For this, his group aims to develop new microscopes for next generation 3D live cell imaging which will provide exciting insights into the dynamics of cell.

OUTSIDE ICFO

■ Stefan likes to be in nature and on the bike, to balance right/left brain hemispheres on a single trail. He also likes feeling "all his cells" at work, which always gives him the right inspiration for global cell biological questions. His favorite trails are at Parc Collserol and in Tyrol, Austria, where he was active in mountain bike and triathlon races in the past.



■ Climbing in Yosemite National Park

Michael Krieg

Neurophotonics and Mechanical Systems Biology

■ Michael is originally from a country that no longer exists- the GDR. He discovered Physics as a Biology undergrad, where he first merged his interests that led him to pursue his PhD in the Cellular Machines group at the TU-Dresden and the Max Planck Institute of Cell Biology and Genetics. He used an Atomic Force Microscope to measure the adhesion force of two isolated zebrafish germ layer progenitor cells and to relate these data to the actual cellular reorganization of the three organ precursor cell types. These results established a new concept in Developmental Biology. From there, he went to Stanford to study the sense of touch in the nematode *C. elegans* and built novel optogenetic tools to visualize mechanical stresses in neurons and during development, for which he was awarded the prestigious K99/R00 career development award given by the National Institute of Health. He then still decided to return to Europe and has been awarded an ERC Starting Grant to help launch his lab at ICFO.

His group at ICFO will work to expand the palette of optogenetic tools to infer forces and deformations during mechanosensation on the level of a single molecule in a living animal. In collaboration with various groups, he will look deeper, faster and narrower to visualize the molecular machines that stabilize neurons of the central and peripheral nervous system against mechanical stresses and allow them to remain functional for an entire lifetime. Exploiting the colors of photons instead of the flavors of neurotransmitters to create an optogenetic synapse, he aims to overcome once and for all synaptic transmission disorders during age and disease.

OUTSIDE ICFO

■ When Michael is not in the lab, you will most likely find him hanging on some cliffs, gobbled up by cracks or tucked behind his camera. With a love for travel and adventure, had he been born in a different age and time, he may have become an explorer and companion of Alexander v Humboldt in his explorations of the South American continent.

COMMUNITY PICTURES



■ Alumni Drinks Gathering at CLEO Europe



■ ICFOians make roses for Sant Jordi 2017



■ Kip Thorne at La Pedrera

BEYOND ICFO



Zhipei Sun

“Looking back, I see that all of my past experiences, including my delightful time at ICFO, were extremely important in preparing me to start my own research group here in Finland”

In the past 10 years, you have gone from Barcelona to Finland. What have you been up to? Clearly, you have not been chasing the sun!

I am honored to be invited to contribute to this newsletter and share my personal experiences in the past ten years with ICFOnians. I moved to ICFO in 2005 just after completing my PhD at the Institute of Physics at the Chinese Academy of Sciences to start my first postdoctoral fellowship in Prof. Majid Ebrahim-Zadeh's group. My work centered on high-power laser pumped optical parametric oscillators. I really enjoyed the work and research environment at ICFO. I also had a wonderful time in Barcelona, and made many good friends. I have been fortunate to keep

“It was wonderful to come back to ICFO last fall. I was quite excited to attend the first Alumni reunion.”



■ The Photonics research group at Aalto University, led by ICFO Alumnus Zhipei Sun (far right)

in touch with many of them. In 2007, my time at ICFO was up and I was offered a research position in the Department of Engineering at Cambridge University (UK). I began researching on various nanomaterials –first with carbon nanotubes and then graphene - for ultrafast pulse generation. In 2013, I took an Associate Professor position at the Aalto University (Finland), which is ideally suited for my nano-phonic research. Looking back, I see that all of my past experiences, including my delightful time at ICFO, were extremely important in preparing me to start my own research group here in Finland. As for the sun, I am with it all the time, as I have it in my name.

What are you working on today?

The current research of my team focuses on non-linear optics of different nanomaterials for a range of photonic and optoelectronic applications. For example, working with collaborators, we recently demonstrated efficient high-order harmonic generation in monolayer two-dimensional layered materials (arXiv, 1608.04101). Later, we found that such multi-photon harmonic processes can be utilized as a useful tool for fast and sensitive characterization of two-dimensional materials (doi:10.1038/ncomms15714).

You came to ICFO last September for the first Alumni reunion. What was your impression?

It was wonderful to come back to ICFO last fall. I was quite excited to attend the first Alumni reunion. It was very well organized and gave me a chance to see all that has happened in ICFO since I left. It was great hearing about the experiences of other friends and alumni in universities and companies. It was also interesting to catch-up on all the new science that is being done at ICFO, including the BIG Bell Test, and the private tours to the labs of Profs. Frank Koppens and Pablo Loza-Alvarez.

I am always happy when I can meet ICFOnians from time to time at conferences, but it was really amazing to get back together with so many friends all at once. It brought back fond memories of playing (and betting on) football, and even queuing for the microwave oven during lunchtime (although we didn't have to queue during the reunion!). I am really grateful that the Alumni Network is making it easier for all of us to be back in touch.

GO & FLY

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women and men have successfully defended their theses at ICFO since its founding in 2002. Together they have helped us measure what we have learned, how far we have come, and how much we have yet to learn. The following ICFOnians have recently succeeded in defending their PhD theses. Honoring ICFO's tradition, ICFOnians gather together to celebrate your accomplishments and encourage you to Go & Fly! Remember that wherever you go, you will always be a part of the ICFO community.



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April 24
2017

PAOLA MANTILLA PÉREZ

“Multi-Junction thin film solar cells for an optimal light harvesting”

TD: Prof. Dr. Jordi Martorell



133
May 11
2017

ACHIM WOESSNER

“Exploring flatland nano-optics with graphene plasmons”

TD: Prof. Dr. Frank Koppens



134
June 23
2017

MEHMET ALICAN NOYAN

“Self-Cleaning Optical Surfaces for the Inkjet and 3d Printing Industry”

TD: Prof. Dr. Valerio Pruneri

HIGH PROFILE



Dario Gil:

“The expectation within a research organization cannot be that all projects will succeed, not by a long shot.”

Vice President, Science & Solutions, IBM Research. Dario Gil received his Ph.D. in Electrical Engineering and Computer Science from M.I.T. He is a leading technologist and senior executive at IBM. In this role, Dr. Gil directs a global organization of ~1,500 researchers across 12 laboratories.



What differences did you encounter between university and industrial research?

By the time I was finishing my PhD at MIT I had my own laboratory and a high degree of autonomy. I remember wondering whether I would continue to enjoy the freedom to pursue my research interests in the context of the overall agenda of my new organization, IBM Research. The biggest difference I encountered once I finally made the transition was the power of pursuing ambitious research goals as part of larger teams. By design, PhD research endeavors are meant to showcase the originality of individual work. In an industrial lab, teaming is king, the basis of our competitive advantage. So, in addition to high IQ's and deep scientific expertise, we need researchers with high emotional intelligence that can foster high performing teams.

Are the remaining challenges for Quantum technologists mostly engineering or scientific?

Within the field of quantum computing, we are undoubtedly entering a golden age. Techniques now exist that prolong coherence in superconducting quantum bits by a factor of over 100 compared to 10 years

ago. We can now measure the most important kinds of quantum errors. As further proof that the technology is becoming a reality, in 2016 we provided the general public access to the first quantum computer in the cloud – the IBM Q experience (<http://research.ibm.com/ibm-qx/>). And we can expect the rapid progress to continue. Despite these advances, to get to the eventual goal of building a large universal quantum computer, coherence times must improve, quantum error rates must decrease, and eventually we must mitigate or correct the errors that do occur. This will require many scientific and engineering breakthroughs.

What is the balance that management should maintain between research controls and the freedom and autonomy researchers require to be innovative?

One strategy is to take a portfolio approach to research investments, with a mix of short, medium and long-term research projects that reflect the appetite for risk of the institution. The expectation within a research organization cannot be that all projects will succeed, not by a long shot. I would argue that a research portfolio without consensus among the leadership is bet-

ter than one with consensus. This is a lesson I learned from Professor Bill Barnett from Stanford University, who holds that the process inside organizations of trying to eliminate non-consensus ideas that sometimes do indeed fail removes the possibility of creating non-consensus good ideas, the most valuable kind due to their originality and superior market capture potential. He insightfully says that “innovation is the management of variance”. I very much agree.

What applications do you see for Artificial Intelligence in the research world?

AI offers the potential to accelerate discovery. For example, it is obviously impossible for any of us to read all the new publications that could be relevant to advance our work, particularly when advances happen in adjacent fields to our core expertise. Thanks to advances in digitization, computing power, machine learning and natural language processing, we see a path to be able to extract the critical information from scientific papers and patents in seconds, enabling the creation of vast knowledge graphs across wide bodies of research. The opportunity is to create AI assistants for each of us to help us be even better scientists.

CHALLENGE

SUDOKU

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MYSTERY ICFONIAN

How much do you know about the people you work with? ICFOnians are a fascinating group, with hobbies, interests and abilities you may never have guessed. To help get to know each other better, have a look around and see if you can guess this edition's **Mystery ICFonian**. Look for the answer in next edition's Challenge section!



1. She likes to travel and has visited 21 different countries.
2. One of her unusual hobbies is unicycling. She has even played unicycle basketball.
3. She speaks two Asian languages and two European languages
4. She is a twin.
5. On the weekends, she likes to go hiking in the mountains.

Ed # 31 (Spring) solution: Prof. Darrick Chang (Theoretical Quantum-Nano Photonics Research Group)

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