IUPAP International Union of Pure and Applied Physics

Newsletter

JUNE 2020

President: **Michel Spiro** • Editor-in-Chief: **Kok Khoo Phua** • Editors: **Maitri Bobba; Judy Yeo**

IUPAP Office hosted & supported by: **NANYANG TECHNOLOGICAL UNIVERSITY, SINGAPORE**

PRESIDENTS' NOTE

The pandemic is confronting the world with many challenges, not only those related to fighting the disease and the epidemic, but also in terms of how to carry on most of our usual activities while staying at home. This is having a huge impact on several aspects of our lives such as the economy, education and scientific research, and is also affecting human relations in all sorts of ways with unprecedented effects on the psychology of individuals and societal behavior. The physics community is affected by most of these aspects. Scientific collaboration usually requires face-to-face meetings, many of which occur at conferences. In fact, one of the main contributions of the IUPAP in past years has been providing sponsorship for international conferences that are now affected in this unprecedented way. Many organizers are now switching to online conferences, an issue we started to discuss within the IUPAP's Executive Council in view of the need to reduce the CO2 footprint. Online conferences, however, lack the added value that face-to-face conversation and personal knowledge brings to any human activity. On top of this drawback, "attending" online conferences might be difficult for people in developing countries with unstable internet connections. Another issue to consider when organizing an online conference is time zones – not everybody would be willing to participate in a conference that takes place during their night. Organizers should then include the option of recording presentations and making them available online for people to watch afterwards at any time.To avoid traveling to a conference, it would be an interesting option to organise conferences in parallel across the world and link these conferences virtually. Attendees can then physically participate in their local conference and at the same time, have access to the other conferences remotely.

As with other aspects that the disease is highlighting, human groups with poorer a priori conditions are those that are most affected by both the disease and the lockdown. We also note that the extra work, besides scientific activity, usually done by women (taking care of children, of education, of domestic tasks) penalizes those who perform these tasks much more during the Covid-19 period and just after. Now that more men understand how household duties impact their research, we hope that they will support expanding the criteria for appointments and promotions beyond the usual criteria of publications and grants, and developing broader multi-faceted criteria for these purposes.

In the present circumstances, IUPAP had to take an immediate decision regarding the 30th General Assembly, which was to be held in Beijing in October 2020. Although many countries are beginning to ease their restrictions, it is likely that those on international travel will be among the last to be loosened, making it very unlikely that it would be possible to hold the 30th General Assembly in October 2020 in our usual format. As informal discussions during meeting breaks are a key part in the working of the General Assembly, so it was felt that a delayed face-to-face General Assembly was preferable to an on-time video/tele General Assembly. The Chinese Physical Society agreed to host the meeting a year later, and Executive Council resolved to postpone the 30th General Assembly to 20th to 22nd October 2021. However, this will be the first time since the 6th General Assembly in Amsterdam in 1948 that the interval between General Assemblies has not been 3 years. For that reason, the Executive Council requested that the Members of IUPAP confirm the Resolution by email. This process concluded on 28th May 2020 and the Executive Council Resolution has been confirmed. Over 90% of the possible votes were received and all were in support of the decision. We will be postponing the 30th General Assembly for about a year. This decision has many implications for our operations, and IUPAP members, for members of the executive council and of commissions, and for the members of Working Groups. All of those involved will receive detailed information on how we propose to manage these implications and what is now asked of them. In outline

- Membership of many of these bodies goes from General Assembly to General Assembly, and so the present members will stay in position for an additional year.
- In agreement with the bylaws, nominations for the Executive Council and Commissions will be open on or before 20th March 2021, and nominations made by IUPAP members should be received no later than 20th May 2021.
- Reports from Commissions, Working Groups and the Neutrino Panel will naturally go to the General Assembly, but the Council and Commission Chairs will be having a video/tele meeting in October 2020 and request that, in addition to the reports to the General Assembly, these bodies also report to that meeting of the Council and Commission Chairs. It is important to learn how these components of IUPAP are managing the COVID disruption, and how they plan to move forward.

As some IUPAP members require advance notice of the likely fees in the next triennium, the Commission on Policy and Finance is working to provide those estimates to the Executive Council before 30th June. It is planned to ask IUPAP members to confirm the 2021 fees in an email vote, in the same manner that the postponement of the 30th GA was confirmed.

The Executive Council has also been working on preparing a revised form of the statutes to be considered by the 30th General Assembly. Postponing that General Assembly has been a practical exercise in managing the type of electronic decision-making process they will be introducing in the revised statutes, and it has led them to think through the changes again.

Last but not least, IUPAP sends its best wishes to the entire physics community in these difficult times of COVID-19. We are all enduring a painful experience: difficult time now and probably to come. We hope nevertheless that people are learning to appreciate the value of science and scientific expertise, of shared reliable information, of collaborative efforts and of informed decisions. This will be an asset for the future and for the world not only in the fight against epidemics but also in facing global challenges like global warming, loss

of biodiversity, waste management, shortage of clean water, … and reinforce friendship and peace on a worldwide basis.
In all this, physics, and more generally basic sciences, can and must contribute. IUPAP is encouraging physicists to contribute by:

- Developing smart and powerful modelling
- Inventing new tools which are, if possible, widely affordable and clean from the point of view of the environment.
- Developing remote access of all kinds, but allowing for the necessary face-to-face meetings to better acquaint ourselves with each other and contribute to better global understanding and peace.

That way, IUPAP will contribute to its mission, '*to assist in the worldwide development of physics, to foster international cooperation, and to help in the application of physics toward solving problems of concern to humanity*'.

Michel Spiro
President of IUPAP
Chair, Steering Committee for the proclamation of IYBSSD 2022

Bruce McKellar
Past President

Silvina Ponce Dawson
Acting President Designate

Quantum statistics

Andrea Young (2020 YSP winner – C10)

Quantum statistics are strongly constrained by dimensionality. For d≥3, the requirement that the quantum mechanical wave-function be single valued mandates that exchanging identical particles multiplies the wave-function by either +1 or -1, resulting in the familiar bosonic and fermionic statistics. However, in two dimensions the distinguishability between clockwise and counter-clockwise exchange relaxes this requirement, and allows for anyons, particles in which interparticle exchange can introduce an arbitrary phase to the wave function. Rather than an abstraction, lower dimensional physics can be readily accessed in the lab by confining electrons to a subspace of our three dimensional world, for example at interfaces in three dimensional materials, or in two dimensional crystals such as graphene.

2010 saw a major breakthrough in two dimensional physics with the invention of van der Waals heterostructures [1], in which two dimensional crystals can be arbitrarily interleaved, one atomic layer at a time. This advance spawned a thriving field by enabling the creation of two dimensional electronic systems inaccessible by conventional growth techniques. Notable examples include structures assembled from chemically incompatible materials as well as those with arbitrarily controllable interlayer twists.

Dr. Young's work centers on the physics of ultra-clean van der Waals heterostructures, in which disorder is so low that the constituent electrons can interact and form new phases of matter. In the simplest case, electrons in a graphene layer are subjected to a large magnetic field, and undergo cyclotron motion. Because cyclotron motion is independent of position, electrons in different parts of a two-dimensional sample have identical quantum mechanical energy spectra, forming highly degenerate Landau levels. At partial fillings of these levels, the large degeneracy is broken by inter-electron interactions, with electrons self-organizing in strongly correlated states. In some of these states, characterized by Hall conductivity quantized to a rational fraction of the conductance quantum, e^2/h—the electrons become so strongly entangled with each other that they lose their identity. The elementary excitations of the system instead have dramatically different quantum numbers than bare electrons, in particular fractional charge and, remarkably, fractional statistics.

Dr. Young's lab at the University of California Santa Barbara has pioneered techniques to create, detect, and manipulate these states of matter. In one example (see Figure), van der Waals heterostructures are used to create a different kind of band structure, known as the Hofstadter butterfly[2], through the interplay of ultra-high magnetic fields (achieved at the National High Magnetic Field Laboratory in Tallahassee, Florida) and a moiré lattice formed from the interference of the lattices in graphene and hexagonal boron nitride. At partial filling of these intricately textured fractal bands, new states are observed characterized by both a fractional Hall conductivity and a fractional lattice occupation [3]. Known as fractional Chern insulators, these states localize a fractionally charged anyon on each lattice site. Ongoing work seeks to control these anyons through design of defects in the superlattice, to both carefully measure their properties and, remarkably, as a means to encode quantum information[4]

[1] Nature Nanotechnology 5, 722 (2010). [2].Nature 497, 598-602 (2013); Nature 497, 594–597(2013); Science 340, 1427-1430 (2013). [3] Science 360, 62-66 (2018). [4] Reviews of Modern Physics 80, 1083-1159 (2008)

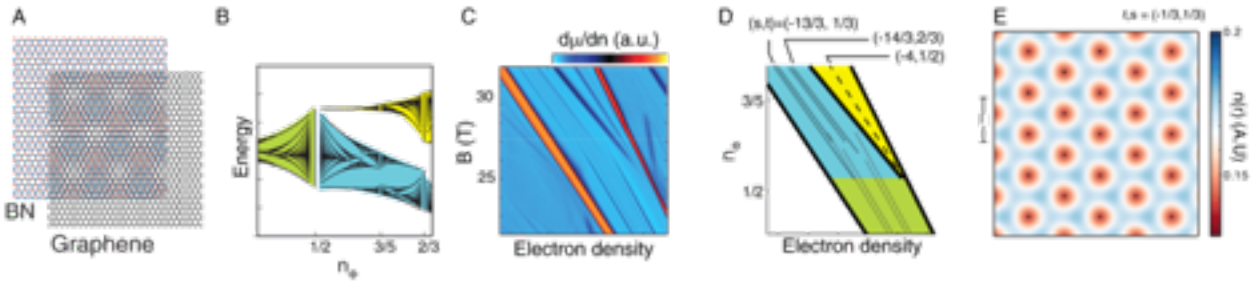


Figure 1: Fractional Chern insulators in a Hofstadter butterfly.(A) Schematic of a moiré pattern between graphene and hexagonal boron nitride. (B) Energy spectrum in a magnetic field. Here n_Φ is the number of magnetic flux quanta threading each moiré lattice unit cell. (C) Experimental data. Dark lines trace energy gaps; their slope (t) and intercept (s), in appropriate units, encode the charge quantum and number of charges fixed to each lattice site. (D) Schematic with s and t quantum number indicated. Notable are states with both fractional s and fractional t, known as fractional Chern insulators. (E) theoretical simulation of the ground state wave function of a fractional Chern insulator. It does not break the lattice symmetry, but each lattice site binds one third of an electron charge. Adapted from [3].

Spinning black-hole binaries: a bridge between astronomy and relativity

Davide Gerosa (2020 YSP winner – AC2), University of Birmingham, UK

Almost all of the information we have collected about the world we live in came to us through photons. Gravitational waves provide a qualitatively new way to observe the Universe that complements traditional electromagnetic observations. The weak coupling between gravity and matter, while making the experimental effort so challenging, also allows gravitational waves to propagate without scattering or absorption. Gravitational waves, therefore, provide an unobscured view of the most energetic phenomena in the Universe, with immense potential for discoveries.

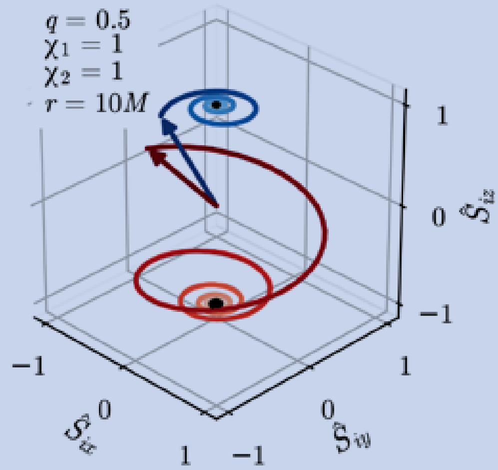
Some of the strongest astrophysical sources of GWs are merging binary systems involving black holes. In 2015, gravitational waves were observed by the twin LIGO interferometers (Abbott et al 2016). This revolutionary achievement was not only the first direct detection of gravitational waves, but also the first irrefutable observation of a binary black-hole system.

Black holes in Einstein's theory of General Relativity are fully characterized by just two numbers: their masses and spins. Despite the simplicity of isolated black holes, the evolutionary dynamics of BH binaries is rich and complex. Relativistic spin-spin and spin-orbit couplings cause the BH spins and the orbital plane to precess about the direction of the total angular momentum (Apostolatos et al 1994). Spin precession is both a blessing and a curse for gravitational-wave observations. Misaligned spins encode precious astrophysical information on the sources, providing a further handle to disentangle their formation pathways. At the same time, the additional complexity of the signal requires more sophisticated models and computationally demanding analysis. Our team made recent theoretical breakthroughs towards the understanding of black-hole binary spin precession, establishing a new fundamental link between the formation channels of astrophysical compact objects and the gravitational-wave signatures observed by LIGO.

The behavior we observed in earlier projects using computationally expensive methods suggested that spin precession may be simpler than previously appreciated. The presence of hidden constants of motions allowed for a vast simplification of the dynamics. We presented analytic solutions to the spin precession equations at second post-Newtonian using novel effective-potential methods (Kesden et al 2015, Gerosa et al 2015a). Just as the orbits found by Kepler have different shapes (ellipse, parabola, hyperbola) depending on the values of the conserved energy and angular momentum, we discovered that binary black-hole spins precess in three qualitatively different morphology depending on the values of the conserved quantities. These solutions provide a deeper understanding of binary black-hole spin precession, much like the orbits of Kepler are more illuminating than a brute force integration of Newton's inverse square law.

Our new multi-timescale analysis has reshaped the study of precessing binary black-hole systems in the post-Newtonian regime. Their dynamics has been studied for the past 50 years in an orbit-averaged fashion. Our new analytic solutions allowed us to develop a precession-averaged formulation. We can now calculate binary black-hole inspirals from arbitrarily large binary separations, bridging the gap between astrophysical binary formation and the signals emitted at frequencies detectable by LIGO.

At its heart, our analysis consists of a new, efficient, post-Newtonian framework. The public python module we developed, PRECESSION (Gerosa and Kesden 2016), is now a major tool in use by the gravitational-wave community to evolve spinning black holes and was featured in 25+ publications to date. We uncovered morphological transitions (Gerosa et al 2015a), discontinuous limits (Gerosa et al 2017), maximal nutations (Gerosa et al 2019), resonant phenomena (Zhao et al 2017), and new instabilities (Gerosa et al 2015b, Mould and Gerosa 2020). Our findings were exploited to distinguish black hole populations (Rodriguez et al 2016, Gerosa et al 2018) and build waveform models (Chatziioannou et al 2017). Our approach is now at the backbone of state-of-the-art templates used in LIGO/Virgo parameter-estimation pipeline (Khan et al 2019, Pratten et al 2020).



Unstable spin precession in binary black holes. A binary with the two spin initially aligned (top, blue) and an anti-aligned (bottom, red) with the total angular momentum might become unstable to spin precession (Gerosa et al 2015b). The binary departs significantly from its equilibrium configuration (black dots) and incurs large precession cycles (figure from Gerosa and Mould 2020).

References

- Abbott, B.P., Abbott, R., Abbott, T.D., Abernathy, M.R., Acernese, F., Ackley, K., Adams, C., Adams, T., Addesso, P., Adhikari, R.X. and Adya, V.B., 2016. Observation of gravitational waves from a binary black hole merger. Physical review letters, 116(6), p.061102.

- Apostolatos, T.A., Cutler, C., Sussman, G.J. and Thorne, K.S., 1994. Spin-induced orbital precession and its modulation of the gravitational waveforms from merging binaries. Physical Review D, 49(12), p.6274.

- Chatziioannou, K., Klein, A., Yunes, N. and Cornish, N., 2017. Constructing gravitational waves from generic spin-precessing compact binary inspirals. Physical Review D, 95(10), p.104004.

- Kesden, M., Gerosa, D., O'Shaughnessy, R., Berti, E. and Sperhake, U., 2015. Effective potentials and morphological transitions for binary black hole spin precession. Physical review letters, 114(8), p.081103.

- Khan, S., Chatziioannou, K., Hannam, M. and Ohme, F., 2019. Phenomenological model for the gravitational-wave signal from precessing binary black holes with two-spin effects. Physical Review D, 100(2), p.024059.

- Gerosa, D., Kesden, M., Sperhake, U., Berti, E. and O'Shaughnessy, R., 2015a. Multi-timescale analysis of phase transitions in precessing black-hole binaries. Physical Review D, 92(6), p.064016.

- Gerosa, D., Kesden, M., O'Shaughnessy, R., Klein, A., Berti, E., Sperhake, U. and Trifirò, D., 2015b.
- Precessional instability in binary black holes with aligned spins. Physical review letters, 115(14), p.141102.
- Gerosa, D. and Kesden, M., 2016. PRECESSION: Dynamics of spinning black-hole binaries with python. Physical Review D, 93(12), p.124066.
- Gerosa, D., Sperhake, U. and Vošmera, J., 2017. On the equal-mass limit of precessing black-hole binaries. Classical and Quantum Gravity, 34(6), p.064004.
- Gerosa, D., Berti, E., O'Shaughnessy, R., Belczynski, K., Kesden, M., Wysocki, D. and Gladysz, W., 2018. Spin orientations of merging black holes formed from the evolution of stellar binaries.
- Physical Review D, 98(8), p.084036.
- Gerosa, D., Lima, A., Berti, E., Sperhake, U., Kesden, M. and O'Shaughnessy, R., 2019. Wide nutation: binary black-hole spins repeatedly oscillating from full alignment to full anti-alignment.
- Classical and Quantum Gravity, 36(10), p.105003.
- Mould, M. and Gerosa, D., 2020. Endpoint of the up-down instability in precessing binary black holes. arXiv preprint arXiv:2003.02281.
- Pratten, G., García-Quirós, C., Colleoni, M., Ramos-Buades, A., Estellés, H., Mateu-Lucena, M., Jaume, R., Haney, M., Keitel, D., Thompson, J.E. and Husa, S., 2020. Let's twist again: computationally efficient models for the dominant and sub-dominant harmonic modes of precessing binary black holes. arXiv preprint arXiv:2004.06503.
- Rodriguez, C.L., Zevin, M., Pankow, C., Kalogera, V. and Rasio, F.A., 2016. Illuminating black hole binary formation channels with spins in advanced LIGO. The Astrophysical Journal Letters, 832(1), p.L2.
- Zhao, X., Kesden, M. and Gerosa, D., 2017. Nutational resonances, transitional precession, and precession-averaged evolution in binary black-hole systems. Physical Review D, 96(2), p.024007.

Excursions in the Superfluid Universe

Samuli Autti (2020 YSP winner – C5)

For several decades, superfluid helium-3 has been a paramount condensed matter system, manifesting a range of macroscopic quantum phenomena. It also shares a range of features common to many seemingly distant fields such as particle physics and cosmology, which is why it is sometimes called a small universe of its own [1]. This article provides a selected overview of my work in this field. Furthermore, apart from the continuing work on ultra-low temperature superfluid experiments, I am also currently working on direct on-chip demagnetisation cooling of quantum devices, and the use of nano-fabricated mechanical instruments immersed in quantum liquids.

One of the most publicised discoveries in superfluid physics, in recent years, has been the final observation of half-quantum vortices (HQVs) [2,3], concluding four decades of investigations carried out by several groups. The longstanding effort to find them was acclaimed by Nobel Laureate Anthony Leggett, who in 2015 called validating their existence, or otherwise, the most important open problem in superfluid physics. In brief, HQVs arise from the complexity of the superfluid helium-3 order parameter, the apparent half-quantum violation of continuity being accommodated by a distortion of the spin part of the order parameter (Fig 1). That distortion can couple to radio-frequency magnetic fields, and this was used to detect the vortices.

Another important contribution to the understanding of Fermionic condensates is our recent work on breaking the superfluid speed limit, the Landau velocity, which strikingly results in next to no dissipation [4], whereas, traditionally, it was believed that exceeding this speed limit would result in a catastrophic failure of the superfluid condensate. It is worth emphasising that carrying out elementary mechanical experiments in superfluid 3He, such as moving a large probe around and measuring the drag force, can still reveal features never seen before. In this particular experiment, bound quasiparticle excitations, covering all surfaces of the superfluid, shield the bulk of the liquid from dissipation, allowing the probe to exceed the speed limit "undetected". It is believed that these bound states include Majorana fermions, although no experiment has yet been able to show this conclusively.

Beyond the superfluid community, I have been lucky to have had the opportunity to participate in a few other notable condensed-matter excursions. These works include using a magnon Bose-Einstein condensate within superfluid 3He to study emergent features of the superfluid. In particular, the discovery of superfluid time (quasi) crystals [5] has been well received. This novel phase of matter, baptised by Nobel Laureate Frank Wilczek, manifests perpetual periodic motion in its ground state. Other examples are studies of light Higgs bosons in 3He [6], parallel to ongoing efforts to find further Higgs bosons in the Universe, and experimental quantum simulations of exotic propagating Q-ball solitons, a concept which originates from cosmological speculations [7].

[1] G. E. Volovik, The Universe in a Helium Droplet, Oxford Uni press (2003)

[2] S. Autti et al, PRL 117, 255301 (2016)

[3] J. A. Sauls, Physics 9, 148 (2016)

[4] S. Autti et al, arXiv:2002.11492 (2020)

[5] S. Autti et al, PRL 120, 215301 (2018) ; S. Autti et al, arXiv:2003.06313 (2020)

[6] V. V. Zavjalov et al, Nature Comms. 7, 10294 (2016)

[7] S. Autti et al, PRB 97, 014518 (2018) ; S. Autti et al, PRL 108, 108, 145303 (2012)

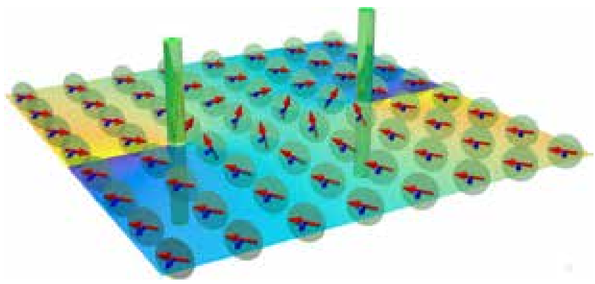


Figure 1. Half-quantum vortices in superfluid 3He (green cylinders) carry a half-quantum of circulating mass flow. The flow is associated with the order parameter phase changing from π to -π (blue background colour) around each vortex. HQVs are connected pairwise by solitons in the spin part of the order parameter (red arrows). In an external magnetic field (blue arrows) the solitons can be detected by magnetic radio-frequency measurements. [S. Autti PhD thesis, Aalto University, Finland (2017)]

Mesoscopic quantum transport in gate-defined van der Waals nanostructures

Ke Wang (2020 YSP winner – C5)

Within condensed matter physics, the study of 2D materials is a diverse and active field of interest with a rich history. High quality 2DEGs in GaAs/AlGaAs heterostructure enabled the discovery of rich quantum Hall physics, including FQHE states from exotic non-Abelian many-body excitations. With the help of electron beam-defined local depletion gates, the system dimension can be further reduced to mesoscopic, where relevant device dimensions become comparable to the electron wavelength. In such gate-defined nanostructures, gate-tunable quantization can be achieved while preserving and manipulating quantum phase coherently, providing versatile experimental platforms to answer many key questions in solid-state physics.

Since the discovery of graphene via mechanical exfoliation, it has been shown that the electronic properties of solids can undergo dramatic change when the material thickness is reduced to the atomic limit. Their exotic band structures are uniquely different from those in conventional 2DEGs. For example, the broken inversion symmetry and strong spin-orbit interaction in atomically-thin semiconducting TMDs polarizes spins in the opposite direction near the band edges of each valley. This combined valley-spin degree of freedom provides a new platform for exotic emergent quantum phenomena and possible quantum device application.

The majority of the research in these new materials have been focused on magneto and optical studies in Hall-bar type device geometry with sample size on the order of 10 um. However, mesoscopic transport and opto-electronic studies in gate-defined nanostructures in 2D material is relatively unexplored due to the challenges in device fabrication. Recently, Prof. Wang has developed robust procedures for making high quality van der Waals (vdW) 2D device with local fine gate patterns without compromising the 2DEG quality. This enabled him to demonstrate relativistic electron-optics, quantum Hall tunneling spectroscopy, and quantum confinement of excitons, paving way to an exciting new direction of studying mesoscopic opto-electronics quantum transport in vdW nanostructures. As demonstrated in these experiments, the capability of spatially and energetically-defining, isolating and manipulating quantum states by designs, allows investigation of small energy scales associated with the exotic quantum behavior, and provides platform for future quantum electronic devices based on manipulating novel quantum degree of freedom, such as valley, layer and sublattice.

Ke Wang acknowledges critical contributions from co-authors in above-mentioned works.

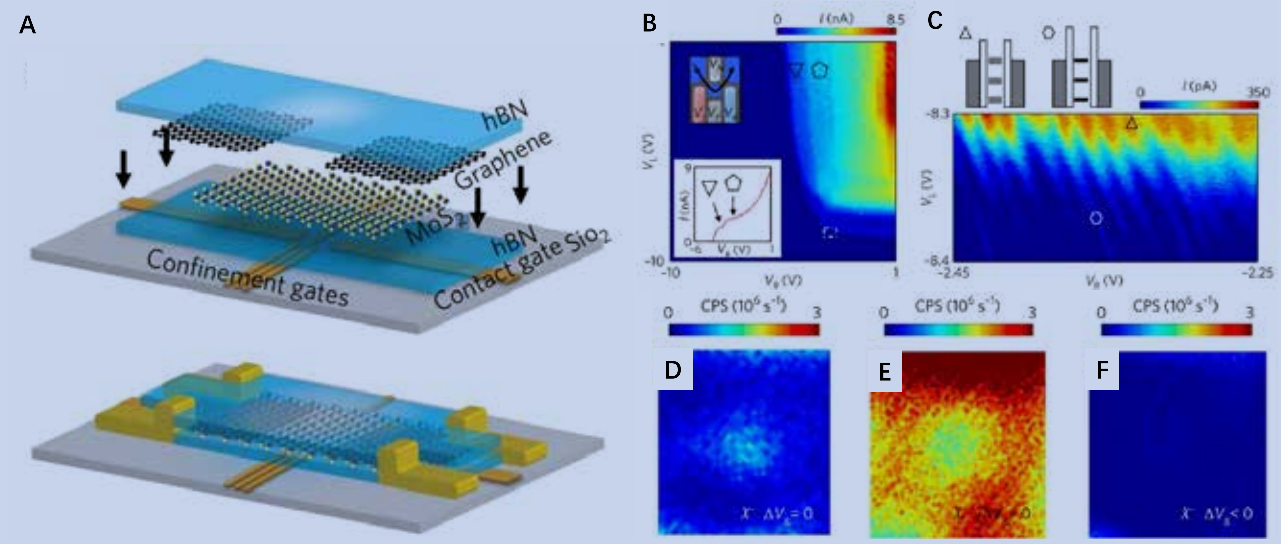


Figure 1. (a) Typical device structure for gate-defined van der Waals nanostructures. (b) Quantized conductance plateau and independent control of tunnel couplings necessary for quantum control have been demonstrated. (c) Coulomb oscillations can be sensitively tuned from thermal-broadened regime (hexagon) to tunnel broadened regime (up-triangle). Charged excitons can be (d) confined (e) anti-confined and (f) depleted with gate control. These demonstration paves a path towards more complicated quantum manipulation and mesoscopic physics in novel 2D materials. Figure adapted from [Nature Nanotechnology 13, 128–132 (2018)]

Professor Paul Woafo, Recipient of the 2020 IUPAP Medal for Outstanding Contributions to the Enhancement of Physics in Developing Countries

Citation: For his many exceptional contributions to the development of physics in Cameroon and the African continent, including founding the Cameroon Physical Society, co-organizing several research collaborations between Cameroon and other countries, founding the Sci-Tech Service to facilitate research on topics of local development, and organizing a series of international conferences on applications of physics to real life problems in developing countries.

Paul Woafo was born on January 12, 1965, and is currently Professor of Physics and Director of the Laboratory of Modelling and Simulation in Engineering, Biomimetics and Prototypes at the University of Yaoundé I in Cameroon. All his school education took place in Cameroon, from the primary to the doctorate level. He defended his Doctorat de spécialité (3e cycle) in 1992 and his Doctorat d'Etat in 1997. The excellence of his work was reflected in a large number of articles in prominent physics journals, including J. Physics: Condensed Matter of IOP-UK, Physical Review B of APS, Solid State Communications, and J.

Physics and Chemistry of Solids. The main topic of his research for his two doctorates was the dynamics of short topological solitons in diverse materials, including ferroelectric materials, hydrogen-bonded materials, surface physics and biological systems. After his recruitment as Lecturer at the University of Yaoundé in 1992, his hard work led to his promotion through the academic ranks, culminating in his appointment to the rank of full Professor in 2005.

Woafo is one of the leading influences behind many Cameroonian physicists. He has successfully supervised 53 Ph.D. theses and a large number of Masters theses. This is indicative of the positive character of a class of scientists who always manage to facilitate work by younger researchers. This supervisory dimension of Woafo's work has spread to Benin, the Central African Republic, and outside of Africa. Most of his former Ph.D. students are respected physicists working in Cameroon and abroad, and many are full professors and directors of research, having benefited tremendously from the scientific opportunities offered by their Ph.D. supervisor. Woafo presently manages a research group conducting both fundamental and applied research with a strong emphasis on modeling, numerical simulations, experimental investigations, and realization of prototypes of devices for industrial, domestic and health uses (www.lamsebp.org).

Woafo is the author of approximately 250 articles in international refereed journals in various fields of fundamental and applied physics. Due to his intensive and extensive scientific contributions, Woafo has played a major role in a number of scientific organizations and has received many special distinctions and prizes.

Prof Paul WOAFO in front of some posters in his laboratory (www.lamsebp.org)

Besides his student mentoring and supervisory activities, Woafo has fostered special teaching topics that have had a strong impact on the development of physics research in Cameroon and the broader region. Especially significant are his engagements in training Masters and Ph.D. students on how to successfully conduct numerical simulations, experimental work, and recently, simulations through embedded technologies.

Most present and former Ph.D. students have benefited from the collaborations established by Woafo with colleagues in other countries in Africa (Benin, Nigeria, and South Africa), Europe (Belgium, France, Germany, Italy, Norway, and Spain), the Americas (Brazil, Canada, and United States) and Asia (India). These benefits have been through Ph.D. supervision, research visits, and postdoctoral appointments. All these research activities have helped Woafo to be admitted to prestigious institutions, such as the Abdus Salam International Centre for Theoretical Physics, where he was awarded the position of Associate Member (junior, regular and senior ranks), and the Alexander von Humboldt Foundation in Germany, where Woafo was accepted as a Humboldtian in 2007. This has also given him the opportunity to collaborate on research with colleagues in a number of countries, and to be elected a member of IUPAP's C3 Commission on Statistical Physics.

Woafo's generosity in sharing scientific knowledge has been extended to the Cameroon community of physicists through his strong involvement in the creation and management of the Cameroon Physical Society. In 2006, with six other physicists, Woafo initiated the creation of the Society, which was finally legalized by the Cameroon government in 2007. During its initial years from 2006 to 2013, Woafo headed the Society, which now counts more than 150 members. While managing the Society, Woafo engaged Cameroonian physicists in organising the first national conference in 2007 to improve the situation of physics in Cameroon. He then instituted a biennial International Conference on Low-Cost High-Level Physics and Solutions to Real Life Problems in Developing Countries. The main focus of this conference is to present results and initiate research activities on high-level topics that can be addressed using theory, experiments, and applications in countries with limited resources, and that can produce results that are publishable in excellent physics journals and/or have an impact on the technological, economic and social development in developing countries. This conference, which has been the only permanent meeting for physicists in Cameroon, has attracted physicists from different parts of the world, including Africa, the Americas and Europe. The sixth edition of this International Conference took place in November 2019. Figure 1 presents a group photograph at the opening of the first edition of the Cameroon Physical Society's International Conference.

Figure 1: Group photograph at the opening ceremony of the first edition of the international conference of the Cameroon Physical Society

Parallel to the Cameroon Physical Society, Woafo initiated the creation of three Cameroonian Student Chapters related, respectively, to the Society for Photonics and Instrumentation Engineers (SPIE), the Optical Society of America (OSA), and the Institute of Electronic and Electrical Engineers-Photonics Society (IEEE). Through these chapters, Woafo has organized special training to empower graduate students and postdocs, not only in the main field of optics and applications, but also in embedded technologies, numerical simulations and career development. Figure 2 presents a photograph of the Cameroon SPIE Student Chapter taken during the celebration of the International Year of Light (IYL) in Cameroon in 2015. As the Cameroon focal point of the IYL, WOAFO, together with Professor Yanne Chembo Kouomou, organized a workshop on research in optoelectronics, optomechanics, optical materials, nonlinear optics, optical telecommunications, and solar cells. The workshop was attended by some 100 participants from Africa, Europe, and Oceania. In other work, Woafo organized a meeting in 2017 entitled, Women in Photonics, to which more than 25 junior women physicists came from different Cameroonian universities gathered to discuss issues related to photonics education and research and the difficulties faced by women engaged in hard science studies.

Figure 2: Cameroon SPIE Student Chapter photograph with some participants during the International Year of Light Celebration in Cameroon during the 2015 edition of the International Conference of the Cameroon Physical Society (Student members wearing black shirts)

Highly sensitive to the lack of experimental training in secondary schools and universities, in 2013, Woafo created a private scientific center called Sci-Tech Services to promote experimental science, reinforce the capacities of scientists in several fields, and conduct technological research activities (www.sci-tech-services.com). This center has provided several practical trainings for students, support to universities (see Figure 3), support to the organization of specialized training for Masters and Ph.D. students, and opened its doors to young scientists eager to conduct experimental parts of their training and research activities (see Figures 4 and 5).

Figure 3: Two university students conducting their experimental physics course at Sci-Tech Services

Figure 4: Some members of the Cameroon IEEE student chapter with their training certificates at the end of a course on microcontrollers programming at Sci-Tech Services.

Figure 5: Some candidates of the APSA experimental physics competition during a training on Arduino programming at Sci-Tech Services.

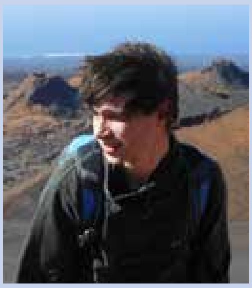
Due to the lack of scientific equipment in most of Cameroon's universities and high schools, Woafo became the local organizer of Challenge for Experimental Physics in Africa. This competition is supported by the French Association pour la Promotion Scientifique de l'Afrique, Cameroon Physical Society, Cameroon Academy of Sciences, French Physical Society, and European Physical Society. The first edition culminated on December 8, 2017, with the awards presentation to four appropriate and inexpensive experimental instruments: a didactic bench for electricity and electronic experiments, physics lab incorporating the use of cell phone screens as oscilloscopes, special signal generator, and solar tracker. The second edition took place in 2019 and led to new instruments fabricated locally by young Africans: a smart farm that uses an embedded technology device to monitor and command the environmental parameters in a poultry farm through cell phones or computers, a didactic bench for experimental training in geometrical optics, didactic bench for experimental training on combinatory and sequential electronics, and an instrument for environmental monitoring of particles, dangerous gases, and gamma radiation. Details for this competition can be found at http://sfp.univ-lille1.fr/concoursphysiqueafrique.

Woafo was elected a Fellow of the Cameroon Academy of Sciences in 2006. In 2016, he was elected Dean of the College of Mathematical and Physical Sciences/Engineering of the Cameroon Academy of Sciences. One of the main roles of the Cameroon Academy of Sciences is to provide independent advice to the Cameroon government on issues related to the organization of education and research in sciences for the development of Cameroon. Inside the Cameroon Academy of Sciences, Woafo was appointed as the one in charge of the creation of the Cameroon Young Scientists Academy (CAYS), which was officially launched in 2018. Woafo is also working on the creation of the Cameroon Academy of Sciences-Centre for Education in Science for Africa, the Mediterranean and Europe (CAS-CESAME), which is a center devoted to the promotion of inquiry-based science education.

At the continental level, Woafo was one the founders of the African Physical Society in Dakar in 2010 and was elected as one of its Vice-Presidents. In science policy, Woafo has acted in several roles at the Ministry of Higher Education, Ministry of Research and Scientific Innovation, and Cameroon Academy of Sciences. Finally, Paul Woafo is often interviewed in newspapers, radio, television, and conferences on ways to optimally organize scientific activities in Cameroon and in the rest of Africa.

YOUNG SCIENTIST PRIZE WINNERS 2020

International Commission on General Relativity and Gravitation (AC2)



Davide Gerosa

"For his outstanding contributions to gravitational-wave astrophysics, including new tests of general relativity."

Davide Gerosa was awarded the 2020 Young Scientist Prize in General Relativity and Gravitation For his outstanding contributions to gravitational-wave astrophysics, including new tests of general relativity.

Davide grew up in northern Italy and received his BSc and MSc in Astrophysics at the University of Milan. He then completed his PhD in Applied Mathematics and Theoretical Physics at the University of Cambridge (UK). In 2016, he was awarded a NASA Einstein Fellowship hosted at the California Institute of Technology (USA) in the research group of Nobel laureate K. Thorne. He is now a faculty member at the University of Birmingham (UK) where he leads his own group within the Institute for Gravitational Wave Astronomy.

Davide's research is in gravitational-wave astronomy and relativistic astrophysics. Compared to standard astrophysical probes, gravitational waves encode qualitatively new information on the most energetic processes in the Universe as well as fine details on the gravitational interaction. Davide develops theoretical and computational models of gravitational-wave sources to maximize the outcome of current and future experiments. His research interests range from black hole binary dynamics to tests of General Relativity, gas accretion onto black holes, black-hole recoils, alternative theories of gravity, as well as statistical gravitational-wave pipelines.

Commission on Low Temperature Physics (C5)

Samuli Autti

"For observations at low temperatures of half-quantum vortices, time crystals and magnon Bose-Einstein condensation in superfluid 3He".

Samuli Autti is currently working as a post-doctoral researcher at Lancaster University in the UK, where he was also a Wihuri Foundation (Finland) post-doctoral fellow in 2017-2019. He received his Ph.D. in physics from Aalto University in Finland in 2017. His research is focused on experiments at ultra-low temperatures, in particular on superfluid 3He. The major discoveries he has authored include the observation of half-quantum vortices in 3He, concluding four decades of investigations, and one of the very first implementations of time (quasi) crystals, emerging from a quasiparticle Bose-Einstein condensate. He is also known for exploiting and publicizing the conceptual connections between superfluid 3He and other, seemingly distant fields, such as particle physics and cosmology.

Ke Wang

"For observations at low temperatures of single-electron silicon qubits, graphene electron-optics, a quantum transistor, and confinement of charged excitons in transition metal dichalcogenides."

Ke Wang obtained his Ph.D. degree in Physics from Princeton University in 2014 after working with Prof. Jason Petta on first generation single-electron silicon quantum devices. During his post-doctoral research at Harvard University with Prof. Philip Kim, he studied novel gate-defined (vdW) nanostructures, in which he demonstrated relativistic electron-optics, quantum Hall tunneling spectroscopy, and quantum confinement of excitons in 2D van der Waals (vdW) materials. He joined the University of Minnesota as an assistant Professor in Physics in 2018. His current research interests include exotic scorrelated behavior and mesoscopic quantum phenomena in novel gate-defined vdW material platforms.

Commission on Magnetism (C9)

Jiadong Zang

"For outstanding theoretical studies of the interplay between magnetism and topology."

Dr. Jiadong Zang has been a tenure-track Assistant Professor of both Physics and Materials Science at the University of New Hampshire since 2015. He received his Ph.D. degree in Theoretical Physics from Fudan University in 2012. From 2012-2015 he was a postdoctoral fellow in the Institute for Quantum Matter at the Johns Hopkins University. His research focuses on theoretical investigations on topological magnetism, spintronics, and quantum materials. Dr. Zang is also an Alexander von Humboldt Research Fellow for Experienced Researchers in 2020-2022.

OPEN FOR NOMINATION

Nominations for IUPAP CERTIFICATE (LONG SERVICE)

__IUPAP__ will be awarding a certificate of gratitude and appreciation to those who have given long and meritorious service to the Union.

Eligibility and details of the nominations can be found at:
https://iupap.org/news2/iupap-certificate-long-service/

All nominations are to be sent to the office at:
iupap.admin@ntu.edu.sg