MINA-NEWS
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TOP NEWS

Quantum many-body problem solved to order 15

The finding is a major one for theoretical physics: Researchers from Irig, Institut Néel, and the Flatiron Institute (US) designed an algorithm that solves the quantum many-body problem to order 15.

The quantum many-body problem describes phenomena at the atomic scale that standard approaches ("mean field approximation") cannot model. One such example is the fact that cuprates, electrically-conductive materials, become superconducting at temperatures as high as 160 K. The solution, however, is hampered by the number of operations. For order 3 processes, the reciprocal influences between three bodies must be calculated; for order 4 processes it is between four bodies, and so on. At order 15, the computer must complete a staggering 1,000 billion operations!

NEW ALGORITHM SUCCESSFULLY MAKES THE JUMP FROM ORDER 7 TO ORDER 15

Previously, the huge number of operations meant that only processes up to order 7 or so could be solved. Irig's algorithm lightens the computing load drastically, coming in at just 32,768 operations for order 15 processes. The algorithm delivered the first-ever accurate numerical solution to the non-equilibrium Kondo effect, a behavior specific to certain electrical conductors at low temperatures.

The researchers are still investigating the possibilities this algorithm will create. They have already identified several potential uses in quantum computing. In effect, the quantum many-body problem can very accurately describe the physics of an actual set of qubits, beyond the extremely-simplified forms used by mathematicians.

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DIRECTOR'S FOREWORD

"Until further notice..."

The global coronavirus pandemic has arrived in France, and in mid-March the nation went on lockdown until further notice, putting much of the activity on the MINATEC campus on standby.

For the first time in the CEA Grenoble campus' history, which dates back to 1957, all non-essential activities have been curtailed. Major laboratories IMEP-LAHC and LMGP have implemented the same restrictions in line with the French government's orders. Grenoble Institute of Technology-Phelma has closed its doors to all students, faculty, and staff. The BHT1 and BHT2 buildings, home to startups and other innovative companies, have shut down their processes, but are still allowing some tenants access to their office spaces.

Everyone's priority is now to find new ways to keep working. Our scientists are able to log on to their tools and analyze their results from home. They can also pursue their theoretical research, writing, evaluation, and publishing activities. Grenoble Institute of Technology-Phelma has rolled out e-learning for all students. Faculty and staff are working from home.

We are also making sure that critical equipment like our cleanroom HVAC, filtration, and pressurization systems continues to operate correctly. Much of this work is being done remotely and, very occasionally, on-site by technicians.

Sending everyone home is MINATEC's most powerful contribution to fighting the spread of Covid-19 at this stage in the pandemic. Labs and other facilities across the campus have also donated tens of thousands of surgical and FFP 2 masks to Grenoble University Medical Center. Other initiatives are taking shape as this issue of *MINA-News* goes to print. Available 3D printing resources that could potentially make ventilator parts are being identified and investigations on how to best sterilize surgical and other protective masks are underway.

Jean-Charles Guibert, Director, MINATEC

INNOVATION

An original technique for functionalizing microscopes

In research funded by the French National Research Agency (ANR), a team at Irig electrochemically functionalized silicon micropores. The very sensitive biosensors created in this way are suitable for use analyzing living cells.

Their process, inspired by bipolar electrochemistry, involved placing two electrodes on either side of the pore. This technique usually requires voltages that are inversely proportional to the size of the pore. The researchers deposited a nanometric layer of silicon oxide onto the chip, and then selectively removed the oxide only at each micropore. This channels the field lines and reduces the necessary voltage 100-fold. The method, known as contactless electrofunctionalization, can be applied to both planar pores and pores that pass through the material.

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Invisible piezo transducers clean transparent surfaces

Silicon Valley startup Innovasonic turned to Leti to develop an innovation the company patented. The technology leverages ultrasonic waves generated by an array of piezoelectric transducers just 100 µm thick (about the same as a human hair) to clean transparent surfaces. The waves are uncannily effective at removing water droplets and grime. The technology is also very energy efficient.

Innovasonic chose to work with Leti for its expertise in thin-layer piezoelectric materials. The institute has been tasked with developing fabrication processes for the transducers and with optimizing the target characteristics (the wave type, frequency, and amplitude; transducer spacing). Innovasonic addresses LiDAR, automotive cameras, PV solar panels, and other applications that could benefit from the solution's self-cleaning capabilities.

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AFM uplevels from cantilever to ring probe

Until recently, it was widely considered that the atomic force microscope (AFM) had hit a ceiling in terms of resolution. Researchers from Leti, CNRS, and Vmicro changed that with a new type of resonator. The conventional vibrating-cantilever-style probe, which tops out at around 1 MHz, has been replaced by a micrometric optically-excited silicon ring that vibrates at frequencies a hundred times that. The probe is so sensitive, in fact, that it can detect its own Brownian motion of around a tenth of a femtometer.

It could now be possible, for example, to observe sub-microsecond biological phenomena at the scale of a single molecule rather than averaging the signals of multiple molecules. Leti will implement the probe on an AFM at Laas in Toulouse. A patent has been filed to protect this innovation.

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CMOS electronics and quantum devices get ready to move in together

Digital and analog electronics could soon be sharing space with a quantum system on a FD-SOI substrate cooled to 110 mK. Sound strange? Researchers from Leti and Irig recently designed a circuit with these unusual characteristics and presented it at a conference in February. It is only at the proof-of-concept stage. However, it does meet the requirements of tomorrow's qubit circuits. Specifically, the researchers demonstrated that it is possible to boost the transistors to several GHZ, even at 110 mK, while keeping heat dissipation under the circuit's dilution cooler temperature of around 300 µW.

They also confirmed the potential of silicon as the basic material for the qubit, with all of the advantages of decades of industrial CMOS experience. The project was part of the Quantum Silicon Grenoble program.

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Leti 310 nm photonics platform gets a Process Design Kit

Creating photonic circuits that leverage Leti's 310 nm platform just got easier. Mentor Graphics' Tanner design flow now includes an integrated Process Design Kit (PDK). The PDK provides access to a library of proven components and can also be used to design new ones. It is also fully compatible with another Mentor Graphics tool that automates the routing of optical and electrical lines.

For Leti partners planning to fabricate their future circuits on the 310 nm platform, the PKD is a real time-saver. The main target applications are datacoms, telecoms, LiDAR, HPC, and neuromorphic chips. Leti and Mentor Graphics are working together as part of the IRT Nanoelec alliance.

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A state-of-the-art vibration-energy harvesting circuit

Leti presented an integrated vibration-energy harvesting circuit at ISSCC in San Francisco in February. The circuit, which is connected to the energy-harvester output, boasts never-before-seen levels of performance. It regulates the impedance at the input to the interface that optimizes the extraction yield (in excess of 95%). The circuit's architecture boosts conversion yields (also in excess of 95%). The interface delivers 95.9% end-to-end power efficiency*, establishing a new state of the art. It can harvest up to 50 mW.

The technology is protected by two patents and is mature enough to be transferred quickly to a manufacturer. It is designed for demanding applications (high temperatures, impacts) or for use in difficult-to-access locations (such as to power sensors on train wheels).

**extraction efficiency/conversion efficiency ratio*

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Energy harvesting: Resonance tuning boosts efficiency

Leti and SYMME* developed a standout piezoelectric energy harvester. The researchers increased bandwidth by an impressive 446% and achieved near-state-of-the-art total efficiency of 94%. The device's excellent performance can be attributed to a smart interface that dynamically tunes the resonance frequency to the environment's vibration frequency. This allows the device to harvest energy beyond what its intrinsic vibrational characteristics would allow. It takes around 1µW to tune the resonance frequency, but the device harvests between a hundred and a thousand times that.

The energy harvester, which will target the aeronautics and automotive industries, is protected by three patents. It is also possible to develop a miniature version of the system for medical applications. This novel device is simple enough to give batteries a run for their money: It requires no initial calibration or maintenance.

**Savoie Mont-Blanc University*

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Active interposer supercharges high-performance circuits

Some IC designers prefer to distribute their circuits' functions across several physical bricks interconnected by a passive interposer. The approach is not new, but now the interposer is. Leti recently added logic (such as clock, I/O, voltage conversion, and other functions), making the interposer active. The institute designed, fabricated, assembled, and tested one with advanced 3D interconnects with a pitch of 20 µm. This world-first earned a Leti researcher a Best Paper Award at the last ECTC conference in Las Vegas.

Leti's solution, which is designed for high-performance computing circuits, increases bandwidth and reduces energy consumption. Leti has filed several patents to protect the innovation. The institute is now working on a photonic interposer as part of an EU IPCEI project.

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Neuromorphic memory: LMGP joins forces with MIT

MIT issues a call for projects every year. In January of this year the school launched a 20-month partnership with LMGP. The partners will investigate new types of neuromorphic memory in which the resistance does not vary between two states, but rather between a minimum and maximum level separated by one to two orders of magnitude. The principle mirrors how the brain's synapses work. Cerium, hafnium, and zirconium oxides will be placed between two electrodes that will communicate by ionic (anion or cation) motion.

The French-American team of six scientists will select materials and combinations of materials, fabricate the devices (at the CEA upstream technology platform, or PTA), and characterize them to gain an understanding of the structural and chemical phenomena at work.

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Magnetic tunnel junction sets new speed record

Researchers at Irig developed an ultra-fast magnetic tunnel junction (MTJ) that could be used to log events captured by stroboscopic photography. They used a terbium-cobalt layer whose magnetization can be switched using a femtosecond laser. A second magnetic layer is made from a material whose magnetization is not switchable. The magnetizations of these two layers (which are either the same or opposite) control an electrical current measured at the output.

The laser pulses are a million times faster than electrical pulses and use much less energy. The research that led to this advance was part of an EU project that will be completed in 2020. Ultimately, the goal is to build a demonstrator of this spintronic device with optical write and electric read capabilities.

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First steps toward a spin valve with electrical insulators

Researchers at Irig collaborated with an international team to obtain dynamic coupling between two magnetic layers (yttrium iron garnet) separated by a gadolinium-gallium garnet substrate. These materials are all very good electrical insulators. The spin information can cross the substrate (which is neither magnetic nor electrically conductive) when the information is carried by chiral photons, which are elastic deformations of the circularly-polarized crystalline lattice.

The coupling obtained here is much more efficient than coupling with metal. Not only does the coupling require less energy, it also eliminates the Joule effect. This new spin valve could be used for qubit-to-qubit communication in tomorrow's quantum computers.

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A step toward controlled Al/Ge quantum disks?

Researchers at Irig used a transmission electron microscope to observe the behavior of aluminum (Al) heated to temperatures in excess of 250 °C when it comes into contact with a germanium (Ge) nanowire. So, what did they see? Well, the Al propagates in the nanowire along a well-defined front; the Ge is pushed back and escapes through the surface.

They also noted that propagation speed is constant insofar as the temperature applied is also constant and the diameter of the nanowire is regular. A drop of just a few degrees halts the process with no inertia. In this way, it is possible to obtain a nanodisk (less than 10 nm) of Ge with Al on each side. The resulting object makes an excellent quantum disk that combines a semiconductor and two very-low-resistivity metal contacts.

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LIVE FROM MINATEC

June 4: A day to make the solo commute a thing of the past

In 2003 80% of CEA employees drove to work. By 2019, that figure had fallen to just 29%. So, alternative mobility is possible! To keep driving the number of solo commuters down, the CEA is dedicating June 4 to raising employees' awareness through role-plays and other activities. Participants will learn to troubleshoot their bikes, discover electric bikes and scooters, take a test drive on a simulator, have their vision checked by an optician, and more. People will also be able to report any hazards they have noticed on campus so that they can be secured.

June 4 is also the day of the Auvergne Rhône-Alpes regional mobility challenge. The goal is to come to work at the CEA by any means other than alone in a car! Arrivals will be tallied up at the campus entrances in the morning. Are you up for the challenge?

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BHT1 gets new lounge for work and play

Some 250 people come to work at the BHT1 building (bldg. 52) every day. But the building is sorely lacking meeting rooms and other places staff can gather. To improve quality of life at work and create a friendlier environment, the people at MINATEC Entreprises came up with a plan for an extension. Construction started in late February and is expected to be completed in early September.

Located near the entrance, the contemporary 120 sq. m space is flooded with natural light. There are two separate areas where staff can come together to work in small groups or take a relaxing break. A green wall will serve as the backdrop for a lounge area with sofas. Bar-height tables near the vending machines will provide a spot for coffee and snack breaks.

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Y.Spot, where open innovation takes shape

The Y.Spot building, which opened its doors in late January, is all about open, agile innovation. End users and uses are fully integrated into design processes and scientists and professionals from a wide range of disciplines and industries can bring a concept to the prototype stage in just eighteen months. The 300 sq. m building has a showroom, a prototyping lab, a variety of modular spaces, collaborative work tools, and office space for CEA Grenoble innovation support staff.

A dozen test projects were completed with companies like Rossignol and Sade in 2019. The goal for 2020 is to double the number of projects. Starting in 2022, companies that would like to benefit from Y.Spot's open innovation model will be eligible to move into Y.Spot Partners, 10,000 sq. m building outside the CEA campus not yet built.

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DAY BY DAY

FD-SOI: Leti's transistor model recognized as a standard semiconductor device

Leti's FD-SOI transistor model, used by companies like Samsung and STMicroelectronics, was recently recognized by the Si2 Compact Model Coalition, a working group made up of 30 international semiconductor industry stakeholders. The fact that Leti's L-UTSOI model is now recognized as a standard model guarantees that it will be maintained and updated to meet the changing needs of the industry. Leti plans to pursue its model development work.

To be recognized as a standard, the model had to make it through four rounds of voting on the exhaustiveness, precision, robustness, and compliance of its code with a certain level of formalism. L-UTSOI is integrated into the main commercial CAD tools to enable the effective simulation of multi-transistor ICs.

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Hard-hitting campaign raises student awareness of the dangers of party culture

Grenoble Institute of Technology-Phelma student government rolled out a hard-hitting campaign at MINATEC and on the university campus during the recent student elections. The student officers produced ten posters designed to raise student awareness of the dangers of partying. The posters very directly addressed drug and alcohol use, sexual assault, and violence.

The incisive taglines on the posters were effective, but perhaps not as much as the faces of actual students in the campaign photography. The fact that students were able to identify their peers in the campaign jolted many into talking about the hazards of party culture. The newly-elected student government would like to play an active role in raising student awareness of this issue and is currently brainstorming on a follow-up to this campaign.

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eLichens monitors air quality in San Francisco

Grenoble startup eLichens finished rolling out 30 air quality monitoring stations in San Francisco in March. The stations' sensors monitor fine particles, carbon dioxide, nitrogen dioxide, ozone, and methane in real time. And, because they are installed 2 meters to 3 meters off the ground, the stations monitor the air that people are actually breathing.

The technology in eLichens' solution leverages algorithms to determine the optimal position for each monitoring station, and then map and forecast area-by-area results. The solution is much more cost-effective than conventional air quality monitoring networks. The startup, which also has monitoring stations in Grenoble, Paris, and Milan, is pursuing its R&D partnership with Leti. Its new pollen sensor is expected to launch very soon.

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Leti's Emmanuel Sabonnadière to head nonprofit Jessica France

Emmanuel Sabonnadière, CEO of Leti, a CEA Tech institute, was recently appointed Chairman of nonprofit organization Jessica France. Jessica France has been managing the Cap'Tronic program to support the digital transformation of small and mid-sized businesses since 1991. With a team of 24 technology consultants nationwide, Cap'Tronic helps more than 3,000 companies make the leap to digital technology every year. Cap'Tronic services can take a variety of forms, from seminars and training courses to audits, consulting, help writing specifications, assistance with technology projects, and more.

The program has a strong reputation among small-business owners, who come to Cap'Tronic for help implementing IoT, 5G, cybersecurity, cyberphysical systems, and embedded AI, for example. And, with research covering all of these technologies, Leti is well-positioned to work with Cap'Tronic on joint initiatives.

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HORIZONS

Adentis consulting becomes Grenoble Institute of Technology-Phelma partner

Phelma signed a three-year partnership agreement with Adentis last December. Adentis is an engineering firm that specializes in embedded systems and other new technologies. The company provides services to industries (automotive, energy, space, biomedical electronics, telecoms) that align closely with the school's degree programs.

Adentis will open its doors to Phelma students through career opportunities and overseas placements through a French government program. The company will also give lectures, attend Partners Day, and conduct mock recruitment interviews with students and will sit on the academic committees of the majors related to its lines of business.

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ISKN, now AMI, embarks on ambitious new strategy

ISKN changed its name to AMI at the end of last year. And the name is not the only thing that is new. The startup, founded in 2014 to develop an augmented interaction technology invented by Leti, is also rolling out an ambitious new strategy. Moving forward, the company will aim to make the technology a standard

YOULA MORFOULI
Grenoble Institute of Technology-Phelma:

"Our students are vitally concerned with the environmental impacts of their future careers."

MINA-NEWS: At the end of January, you ran a day-long workshop on sustainable electronics for the 40 students in the Nanotech Master's program. What were you aiming to achieve?
Youla Morfouli: Increasingly, our students want to know what the environmental impacts of their future careers are. Sometimes, the answer is hard for them to hear. We wanted to support them through this awakening with the help of our partners IRT Nanoelec, Leti, Grenoble Ecole de Management, and STMicroelectronics. A total of four executives and two engineers participated in the entire day-long workshop.

MINA-NEWS: Was it really a workshop or just PR?
YM: It was a hands-on workshop with a role-play activity. The students played the roles of employees of a fictitious company, Grenoble Green Phone. Their mission was to design a new generation of smartphones with minimal environmental impacts. They were able to seek guidance from experts from STMicroelectronics and Leti, who provided insights into their own practices and challenges

MINA-NEWS: A day doesn't sound like much time to grapple with such a complex topic.
YM: The students did learn that sustainable electronics is a rapidly-growing practice in industry, albeit for regulatory compliance or supply chain reasons in some cases. I think they came away feeling better about their career choices. That being said, we are going to do more. Other Phelma majors and some PhD students will do the workshop this summer; it will also be integrated into our continuing and executive ed programs. ■

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and, in the process, make it available to high-tech and traditional (toys, stationery, etc.) markets navigating the transition to digital products. AMI also announced that it has set up an augmented interaction alliance that counts Leti, STMicroelectronics, Paragon ID, and Germany-based Rutronik among its members.

The scope of the alliance will position AMI to make augmented interaction a flagship European technology. At the same time, the company will continue to develop and commercialize its own products.

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Medytec to showcase the Grenoble-Alpes medtech industry

The Grenoble-Alpes medtech industry will soon have a 150 sq. m promotional and event space all its own at Biopolis, near Grenoble University Medical Center. The new space, called Medytec, will be home to a showroom and conference and meeting facilities. Around 30 events are scheduled to take place at Medytec between now and September.

Medytec is financed by the Auvergne Rhône-Alpes Regional Council, Greater Grenoble Intermunicipal Authority, and Grenoble-Alpes University. It was designed by a group of local medtech stakeholders. It will be coordinated by cluster Medicalps, which counts more than 100 members (from industry, research, and government), including Leti and MINATEC startups (like Avalun, Fluoptics, and Eveon), who will now have access to meeting facilities near the medical center.

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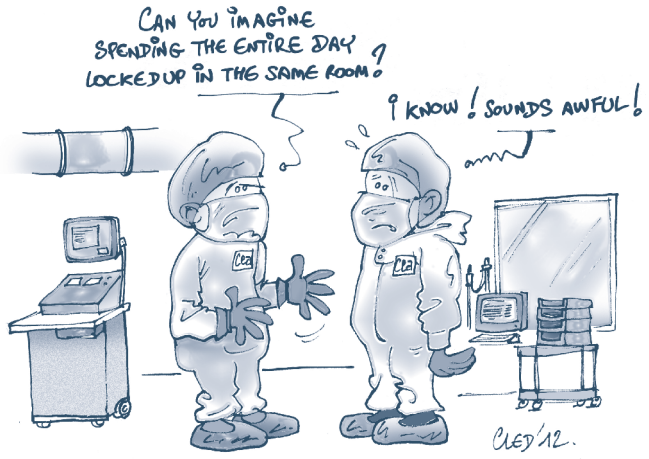
BEHIND THE CURTAIN



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