

FOCUS

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HYDROGEN ON DEMAND

A new method will make it possible to produce renewable energy cost-effectively, safely, and efficiently

Technion researchers have developed a new approach to the production of hydrogen from water using solar energy. Published in *Nature Materials*, this approach will make it possible to produce hydrogen in a centralized manner at the point of sale (for example, at a gas station for electric cars fueled by hydrogen) located far from the solar farm. The new technology is expected to significantly reduce the cost of producing hydrogen and shipping it to customers.



(l-r) Prof. Gideon Grader, Avigail Landman, and Prof. Avner Rothschild

The study was led by Avigail Landman, a doctoral student in the Nancy and Stephen Grand Technion Energy Program (GTEP), and Dr. Hen Dotan from the Electrochemical Materials & Devices Lab, along with Dr. Gennady Shter from the Wolfson

Faculty of Chemical Engineering. Landman is working on her doctorate under the guidance of Prof. Avner Rothschild from the Faculty of Materials Science and Engineering, and Prof. Gideon Grader, Dean of the Wolfson Faculty of Chemical Engineering.

Hydrogen is considered one of the most promising energy carriers for vehicles and various other uses due to its following advantages:

- Hydrogen can be produced from water, and therefore production does not depend on access to non-renewable natural resources.
- Using hydrogen fuel would reduce dependence on fossil fuels such as oil and natural gas, whose availability depends on geographical, political, and other factors.
- Unlike diesel and gasoline engines that emit considerable pollution into the air, the only byproduct of hydrogen fuel is water.

Because of the advantages of hydrogen fuel, many countries – led by Japan, Germany, and the US – are investing vast sums of money in programs for the development of environmentally friendly (“green”) technologies for the production of hydrogen. Most hydrogen is currently produced from natural gas in a process that emits carbon dioxide into the air, but it is also possible to produce hydrogen from water by splitting the water molecules into hydrogen and oxygen in a process called electrolysis.

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The Brain's Learning Orchestra

Decoding dyslexia and the often complex mechanisms underlying learning difficulties, new faculty member Prof. Tzipi Horowitz-Kraus seeks to present the early diagnosis and treatment that could unlock unfathomable talent among people otherwise judged as having a disorder.

When a child has a learning difficulty, the impact can go beyond the practical tasks of reading and writing, affecting self-image, life choices, and the fundamental sense of belonging in one's environment.

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FROM THE PRESIDENT



Technion President **Prof. Peretz Lavie**

Welcome to the latest issue of FOCUS. Just as the beacon of scientific progress and education holds so much promise, the challenges facing us collectively in globalization, health, the environment, and energy are also escalating. At Technion, we remain loyal to the vision of serving as a channel of knowledge, inspiration, and skill, in order to make the world a better place for all.

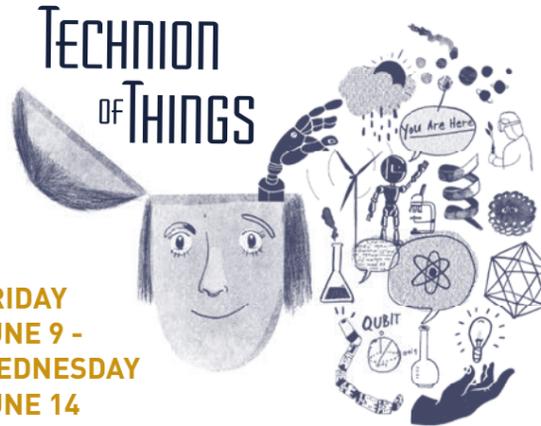
Technion research is making an impact on tangible realities from civil engineering, water contamination, and human health, to the finest frontiers of pure research, where matter vanishes into formulas, and where phenomena such as quantum entanglement can be game-breakers.

In 2016, Technion became the only Israeli representative

in the Nature Index of Rising Stars. This prestigious ranking affirmed a 40 percent increase in Technion publications in leading scientific journals. Putting Technion in 26th place worldwide, the list includes 100 academic institutions from around the world. The index is further evidence of Technion's academic excellence, incessant improvement in the achievements of its researchers, and our constant progress in realizing Technion's vision: to be one of the world's ten leading science and technology research universities.

On Roosevelt Island in New York City as well as in Guangdong, China we are presently laying the foundations of global cooperation in education in science and technology. These structures will affect generations to come and will consolidate Israel's position as a source of light, inspiration, and progress for the whole of humanity.

Peretz Lavie



BOARD OF GOVERNORS MEETING

2017

FRIDAY
JUNE 9 -
WEDNESDAY
JUNE 14

HIGHLIGHTS

Panel: Technion of Things
Moderator: **Prof. Deborah Estrin**, Cornell Tech

Dedication of the A B David Charity Immunity Research Lab - a Gift of Valerie Collis

Adelis Foundation Brain Research Award
Prof. Asya Rolls

Dedication of the Taub Family Terrace

Modai Lecture
Maj. Gen. (res.) Amos Yadlin – Israel's National Security 2017: The Balance Sheet

Official Opening and Dedication of the Ronald S. and Jo Carole Lauder Student Dormitory

Technion, Israel, and the World in the 21st Century: Fulfilling the Technion Vision

Dr Hiroshi Fujiwara
Dr Andrew and Aviva Goldenberg
Ronald S. and Jo Carole Lauder
The Mauerberger Foundation Fund
The Sagol Family
The Henry and Marilyn Taub Foundation

Special Board Event
VIP Tour: Naharayim on the Jordan River

HONORARY FELLOWS

Ilene and Steve Berger, USA
Mark Gaines, USA
Dr Terry Gardner, USA
Prof. Yossi Leshem, Israel
Arnold Seidel, USA
Susan Raymer and Benjamin Wygodny, Canada

HONORARY DOCTORS

Prof. Bernard Amadei, USA
Dr Joseph Ciechanover, Israel
Prof. David L. Donoho, USA
Prof. Odile Eisenstein, France
Emanuel Zvi Liban, Israel
Martin Paul Moshal, UK
Joseph Neubauer, USA
Prof. L. Rafael Reif, USA

HARVEY PRIZE WINNERS

Prof. Karl Deisseroth, Stanford
Prof. Ronald Drever, CalTech (posthumous)
Prof. Peter Hegemann, Humboldt
Prof. Kip Stephen Thorne, CalTech
Prof. Rainer Weiss, MIT

FOCUS

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NOTICE OF NONDISCRIMINATORY POLICY AS TO STUDENTS

The Technion admits students of any religion, gender, race, color, national and ethnic origin to all the rights, privileges, programs, and activities generally accorded or made available to students at the school. It does not discriminate on the basis of religion, gender, race, color, national and ethnic origin in administration of its educational policies, admissions policies, scholarship and loan programs, and athletic and other school-administered programs.

Technion in Space



Summer 2016 saw Technion host the first ever International Space University (ISU) in the Middle East. A festival of lectures, distinguished guests, space innovation, and international participants suffused the campus with an atmosphere of wonder, adventure, and infinite possibility.

Over 100 participants from 24 countries parading their national flags, many wearing national costumes, were all cheered by a diverse audience of dignitaries and guests. Thus began the 29th session of the ISU's Space Studies Program, hosted by Technion's Asher Space Research Institute (ASRI) in conjunction with the Municipality of Haifa.

Dr Peter Diamandis, one of the three founders of ISU, greeted the participants by video, noting that their arrival at Technion was a pageant of visionaries – a gathering of individuals from around the world who share a passion for space.

Among those who led sessions over the two-month program were US astronauts Buzz Aldrin, Jeff Hoffman, and Jessica Meir; Israeli astronaut Ilan Ramon's widow, Rona Ramon; Russian cosmonaut Sergei Krikalev; Canadian astronomer David Levy, who discovered Comet Shoemaker-Levy 9; and aerospace engineer and science-fiction writer Eric Choi. Other events included a robotics competition, a rocket launch at Kibbutz Gal'ed, and the first SpaceUp unconference in the Middle East. The energy-charged summer event included a collective selfie of SSP participants at the heart of the Technion campus, taken by satellite.

The France-based ISU provides graduate-level training in all disciplines related to space programs and enterprises, such as space science, space engineering, systems engineering, space medicine, space policy and law, business and management, and space and society.

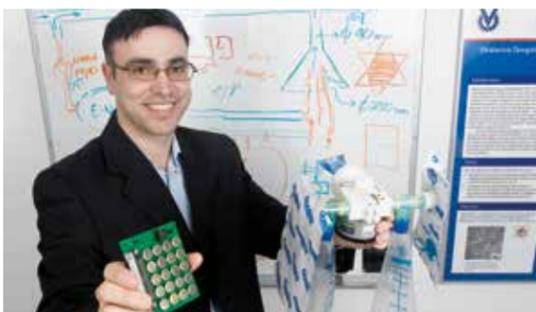
MOOC GENERATION

Massive Open Online Courses have become the cyber world's answer to the need to reach out from the ivory tower of academia and to share, proliferate, and diffuse - to educate people everywhere, regardless of location.

On the front line of this digital revolution in educational outreach, Technion has already established five MOOCs: three from Prof. Emeritus Shlomo Maital in entrepreneurship and innovation, and two from Prof. Hossam Haick in nanotechnology and nanosensors – offered in both English and Arabic.

Now, Technion is broadening its MOOC reach in multiple directions, including courses titled *Medical Cannabis & Pain*; *Traditional Herbal Medicine for Cancer Care: A Practical Approach to Tailor Patient Treatment*; and *New Horizons in Reproduction - Gamete In Vitro Regeneration: Fantasy or an Option?*

Technion leadership has made MOOC development a top strategic goal for the coming decade. "This is part of going global. All the major universities are there," explains Ronit Lis-Hacohen, Project Manager at the Office for Strategic Projects, pointing out that a MOOC is not a repetition of the traditional class given in the lecture hall but a whole new educational form. MOOCs have an important impact, explains Lis-Hacohen: not only online, but also in traditional teaching sessions. Increasingly, the online course brings focus and precision to course conceptualization, while students have the option of studying in and around their curricular activities. There is even the possibility, demonstrated by Prof. Daniel Lewin, to flip the classroom: giving the MOOC as homework, and leaving the space of direct interaction with students in person for problem solving, discussion, and in-depth exploration of the subject matter.



Prof. Hossam Haick



Eisenberg's MOOC

Medicinal Marijuana

While for many marijuana is still controversial, evidence for its medical benefits of the treatment of certain diseases is accumulating. This MOOC targets health professionals, care givers, and patients with a vision to provide knowledge and clarity on the subject of medical marijuana for pain control from a professional and reliable source. World pain expert Prof. Elon Eisenberg, Deputy Dean of the Ruth and Bruce Rappaport Faculty of Medicine, is pioneering the course. "The course provides coherent information for health care providers - as well as for a broad audience," explains Ronit Lis-Hacohen.



Architects Eli Kramer, Shiri Motes-Levin, and the Free Architects Board 314 Architecture Workshop (FAB314AW) won first prize in the competition to design Technion's new medical student dormitories on Allenby Street in downtown Haifa.

CRISP MED Dorms

Technion announced a competition in order to provide its students with new, comfortable, and spacious dormitories in close proximity to Technion's Ruth and Bruce Rappaport Faculty of Medicine. Fifty-five architects and six students submitted proposals. Many aspects were considered in the competition, including originality, creativity, the building's contribution to students and the public, urban renewal, elegance, and layout variety.

The judges noted that the winning bid is "an interesting and innovative building that offers quality of life and community, and leverages urban renewal."

The Technion Academic Accessibility Support Center was established with the support of Israel's National Insurance Institute (NII) and will serve hundreds of students with physical and sensory needs. The center includes accessible computer workstations, a workshop room, rooms for computerized tests, and space for the academic accessibility coordinator.

"The Technion has come full circle after having championed the principle of equal opportunities ever since its establishment," said Technion President Prof. Peretz Lavie. "Its doors have always been open to students, regardless of religion, race or gender, and today Technion is helping people with disabilities succeed without compromising academic standards."

According to then-Dean of Students Prof. Moris Eisen, "The number of students with disabilities at Technion is increasing, mainly due to their desire to integrate into the labor market. The inauguration of the Center is an important step in the absorption of these students."

ACCESSIBILITY at Technion



Students at the "Experiencing Accessibility" event on campus

"The purpose of the new center is to concentrate services provided to students with disabilities under one roof, and to raise awareness of these disabilities among faculty members," explained Sarah Katzir, Head of the Beatrice Weston Unit for the Advancement of Students at Technion.



(l-r) Technion President Prof. Peretz Lavie; Shmuel Weinglass, Director of the NII Fund for Service Development for the Disabled; Adva Lerner and Hava Baumart, Senior Rehabilitation Supervisors at NII

ISEF Foundation Celebrates 40 Years:

The Technion - A Significant Partner



Prof. Shenhav Cohen

"Technion has been one of the ISEF Foundation's most important partners throughout its 40 years of existence," says Nina Weiner, President of the Foundation since its inception in 1977. Over the years of partnership, the Foundation has granted around 2,000 scholarships to students at Technion.

The ISEF Foundation, established by a group of philanthropists headed by the late Edmond J. Safra, his wife, Lily Safra, and Nina Weiner, works to reduce social inequality by providing access to higher education to demobilized soldiers from outlying areas. The Foundation fosters community projects carried out with partners such



as the Perach Tutorial Project and the Israeli Ministry of Education. This year the Foundation is celebrating 40 years of activity, and the main event will take place on June 23 at the Shuni Amphitheater in Binyamina, Israel.

Roni Degani, director of the Technion and ORT Braude Program at the Foundation, notes, "Over the years, strong ties have developed between Technion and the Foundation, and Technion is a partner in the generous assistance package given to each student who participates in the program. We work with the Personal Assistance Unit at the Office of the Dean of Students at Technion; we have an excellent relationship, and coming to Technion is like coming home."

Students accepted to the program enjoy not only a scholarship throughout their years of study, but also individual support and participation in the Foundation's leadership program. As part of the program, they meet twice a month for a group process devoted to education in the first year, society and economy in the second, leadership in the third, and independent activity in the fourth.

Concurrently with their studies, each year they spend 120 hours volunteering in the community.

"Our students are chosen with great care," says Degani. "Out of every thousand candidates, we choose fifteen. Since creating a first generation of higher education is one of the Foundation's goals, priority is given to young people from families without an academic background."

The Foundation, originally established to assist Sephardic Jews, now supports students from all sectors, including Ethiopians, Russian-speakers, and Druze. "ISEF is the oldest private scholarship foundation in Israel," says Weiner. "We grant scholarships throughout all the years of undergraduate, graduate, doctoral, and postdoctoral studies, and support around 500 students every year. Each year, around twenty-five students benefit from the Foundation's support for their studies at leading universities abroad. The investment in our students comes back to the community when they return to their communities or to other communities as influential adults."

Dr. Eitan Yaakobi, an Assistant Professor at Technion's Faculty of Computer Science and an expert in information and coding theory, is among many ISEF success stories. One of four children from a working-class family, he has been an ISEF scholar since 2002, his first year at Technion. He was also an International ISEF Fellow from 2006 to 2013, for both his doctoral and postdoctoral studies.



(l-r) ISEF founders Lily Safra, Edmond J. Safra, and Nina Weiner

"ISEF is more than just a scholarship - it is a family," he says. "You know that if you have a problem, they will help, and this includes academic and personal problems as well as financial. In the US, ISEF's support was even more important. Firstly, because studies and life there are so much more expensive and secondly, it was hard for me to be away from friends and family."



Prof. Eitan Yaakobi

Dr. Shenhav Cohen of Technion's Faculty of Biology heads her own research laboratory, exploring the mechanisms of muscle atrophy to develop measures to ease patient discomfort caused by a number of diseases and illnesses. She became an ISEF scholar during her post-doctorate studies at Harvard and has nothing but praise for the assistance she received. "When we first arrived in Boston, we were surprised by the high cost of living, especially for a family with four children. Jewish education for our children was very important to us but it was prohibitively expensive. That is when ISEF stepped in. Their support enabled me to continue without having to sacrifice my children's education or my work," she says.

EXCELLENCE DISCERNED



This year's Scholarship Ceremony of the Rothschild Scholars was hosted by a famous graduate of the program, Prof. Alex Bronstein

Sponsored by the Rothschild Caesarea Foundation, the Technion Excellence Program fosters leadership and academic achievement among outstanding students. Known since 1992 as the Technion Excellence Program, following a generous donation by the Rothschild Caesarea Foundation the name has now evolved to the Rothschild Scholars Program.

Back at the turn of the millennium, Technion students Alex Bronstein and his identical twin brother Michael made world headlines with the development of an innovative 3D face recognition system that was so accurate it could tell the identical twins apart. The Bronstein brothers were invited to present their research at the White House in Washington in 2002. After graduating the Excellence Program, Alex Bronstein went on to establish a startup that was later sold to Intel. Recently, he rejoined Technion as a faculty member.

Each year, the Rothschild Caesarea Foundation awards scholarships to the tune of NIS 2.1 million to finance tuition fees, living stipends, and dormitory housing for about 50 outstanding students.

"Our students are very involved with a wide variety of occupations and hobbies. These are students who perceive Technion as a challenge, an infinite playground, and not as a burden or a task that must be completed in order to earn a degree," said Program Head Prof. Michael Elad.



The City of Haifa Recognizes Its Nobel Laureates

The Nobel Laureates Square was inaugurated on April 2, 2017 in the Ramat Al Mogi neighborhood of Haifa in honor of Technion's three laureates, Distinguished Professors Avram Hershko, Aaron Ciechanover, and Dan Shechtman. Haifa Mayor Yona Yahav, Technion President Prof. Peretz Lavie, President of Haifa University Prof. Ron Rubin, and Director General of the Rambam Medical Center, Prof. Rafi Beyar, were in attendance.



(l-r) Prof. Dan Shechtman, Haifa Mayor Yona Yahav, Prof. Aaron Ciechanover, and Prof. Avram Hershko



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However, since electricity production itself is an expensive and polluting process, researchers at Technion and around the world are developing a photoelectrochemical (PEC) cell that utilizes solar energy to split water into hydrogen and oxygen directly, without the need for an external power source.

pair of auxiliary electrodes made of nickel hydroxide, an inexpensive material used in rechargeable batteries, and a metal wire connecting them. "According to our cost estimate, our method could successfully compete with existing water splitting methods and serve as a cheap and safe platform for the production of hydrogen," says Landman.

The main challenges in the development of PEC solar farms for the production of hydrogen are 1) keeping the hydrogen and oxygen separate, 2) collecting the hydrogen from millions of PEC cells, and 3) transporting the hydrogen to the point of sale. The Technion team solved these challenges by developing a new method for PEC water splitting. With this method, the hydrogen and oxygen are formed in two separate cells – one produces hydrogen, and another produces oxygen. This is in contrast to the conventional method, in which hydrogen and oxygen are produced within the same cell, and separated by a thin membrane that prevents them from intermixing and forming a flammable and explosive mixture.

The method developed at Technion for separating hydrogen production and oxygen production was the basis for the development of the new two-stage electrolysis technology. This technology, developed by Dr. Hen Dotan, enables hydrogen production at high pressure and with unprecedented efficiency, thus significantly reducing hydrogen production costs. The new technology is now in its pre-industrial development stage.

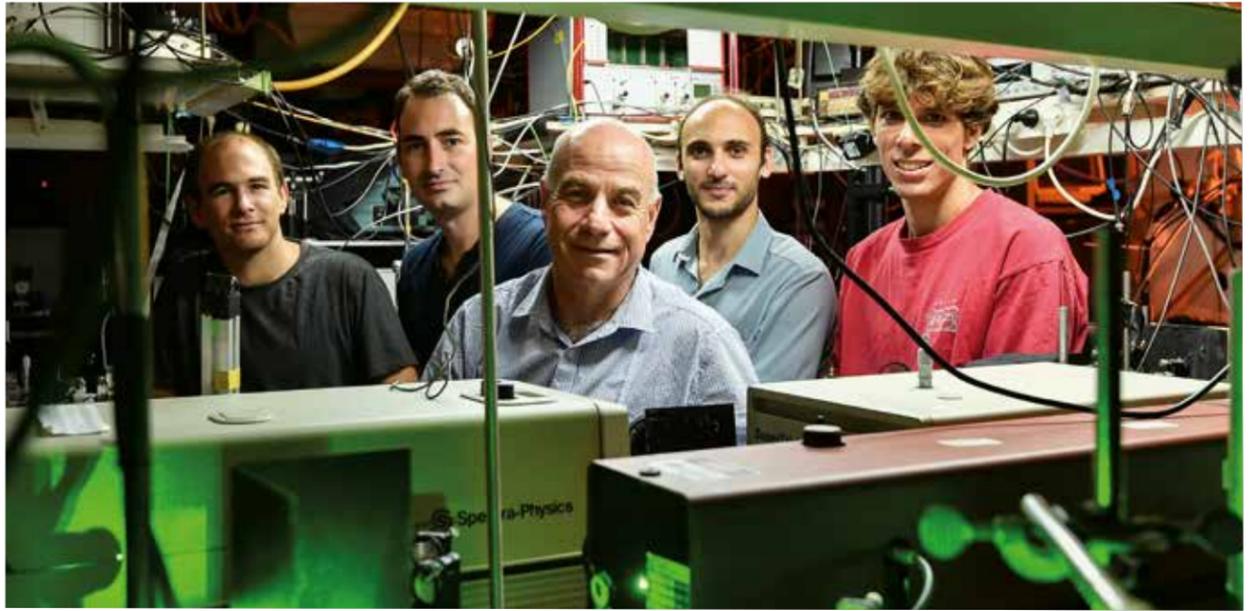
In October 2016, Avigail Landman won first place in the energy category in the Three Minute Thesis (3MT) competition held in Australia. At the competition, held on the initiative of the University of Queensland, participants are required to present groundbreaking research in just three minutes.

The new process allows geographic separation between the solar farm consisting of millions of PEC cells that produce oxygen exclusively, and the site where the hydrogen is produced in a centralized, cost-effective, and efficient manner. They accomplished this with a

The study was supported by the Israeli Centers of Research Excellence (I-CORE) for Solar Fuel Research; the Ministry of National Infrastructures, Energy, and Water; the European Fuel Cells and Hydrogen Joint Undertaking (FCH JU); the Grand Technion Energy Program (GTEP); Ed Satell; and the Adelis Foundation.

Qubits Unlimited

Hailed as a breakthrough in quantum computing, a cannon to supply entangled photons on demand has been introduced by researchers at the Faculty of Physics.



(l-r) Ido Schwartz, Dan Cogan, Prof. David Gershoni, Yaroslav Don, and Prof. Netanel Lindner

The tremendous power of quantum computing can only be unlocked through insight and knowhow within the field of quantum entanglement. Called by Einstein “spooky action at a distance,” entanglement is the means by which units communicate, irrespective of distance.

Technion scientists have made a major breakthrough in quantum computing research, introducing a cannon for the production of large clusters of entangled photons (light particles) on demand. Published in *Science*, the research was conducted at the Faculty of Physics by Prof. David Gershoni with doctoral students Ido Schwartz, Dan Cogan, and Prof. Netanel Lindner.

The conceptual idea of a cannon, or quantum machine gun, to ensure supply-on-demand entangled

photons was first suggested by Lindner and Prof. Terry Rudolf of Imperial College London in a groundbreaking 2009 paper. Now at Technion, Lindner and the team are making fast progress.

“In effect, we demonstrated how to develop a device that ‘shoots’ entangled photonic pairs on demand,” explains Prof. Gershoni. “This discovery is an important milestone bridging current classical technology and future quantum technologies.”

“We outline a novel route for constructing a deterministic source of photonic cluster states using a device based on semiconductor quantum dot,” announces the paper’s abstract. “Our preliminary demonstration presents a

breakthrough in quantum technology. It may have revolutionary prospects for technological applications as well as to our fundamental understanding of quantum systems.”

For some, quantum computing is still a distant dream, but Prof. Gershoni is sure of the target. “I believe that our discovery will advance the field of quantum information processing,” he said, “and that in the near future we will be able to see genuine applications of quantum technologies in broad use.”

“In effect, we demonstrated how to develop a device that ‘shoots’ entangled photonic pairs on demand.”

Beyond the Horizon

Is a black hole the birth of a universe or the end of it? What happens when matter disappears at the event horizon? Some answers are unfolding through observation of an analogue black hole at the laboratory of Prof. Jeff Steinhauer at Technion.



Prof. Jeff Steinhauer

In 1974, the Cambridge physicist Stephen Hawking suggested that black holes should thermally create and emit sub-atomic particles, known today as Hawking radiation. Evidence of this radiation recently came home to Technion, in the laboratory of Prof. Jeff Steinhauer, where the scientist constructed a sonic black hole - an analogue of the real thing - and published the first observation of Hawking radiation in *Nature Physics*.

“We observe a thermal distribution of Hawking radiation, stimulated by quantum vacuum fluctuations, emanating from an analogue black hole,” says Steinhauer. “This confirms Hawking’s prediction regarding black hole thermodynamics.”

Pairs of phonons (particles of sound) appear spontaneously in the void at the event horizon of the analogue black hole. One of the phonons travels away from the black hole as

Hawking radiation, and the other falls into the black hole. The pairs have a broad spectrum of energies. It is the correlations between these pairs that allowed Steinhauer to detect Hawking radiation. “We saw that such high-energy pairs were entangled, while the low energy pairs were not. This entanglement verifies an important element in the discussion of the information paradox as well as the firewall controversy,” explains Steinhauer.

This observation of Hawking radiation, performed in a Bose-Einstein condensate, verifies Hawking’s semi-classical calculation, which is viewed as a milestone in the quest for the graviton - a fundamental particle of matter which ought to exist but hasn’t yet been found.

Steinhauer has been working exclusively on the proof since 2009 in his hand-assembled lab at Technion, replete with lasers, mirrors, lenses, and magnetic coils to simulate

a black hole. Motivated by an overriding curiosity regarding the laws of physics since he was a child, he says that evidence for the existence of quantum Hawking radiation brings us one step closer to uncovering the laws of our universe.

Steinhauer’s research earned him the 2017 Henry Taub Prize for Academic Excellence, to be awarded at the Board of Governors event in June.

Did you know?

Black holes are massive collections of mass – with gravity so strong that nothing can escape, not even light. Stellar-mass black holes appear when massive stars explode. Supermassive black holes exist in the hearts of galaxies and usually contain the mass equivalent of millions of suns.

The Brain's Learning Orchestra

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Growing up with two brothers with learning impairments, Horowitz-Kraus witnessed the mysteries – and the suffering – of children for whom the tasks of reading and writing are not intuitive. After an MSc in Neurobiochemistry at Tel Aviv University, Horowitz-Kraus went on to complete a PhD in Learning Disabilities at the University of Haifa. Today, she is Director of the new Educational Neuroimaging Center at the Faculty of Education in Science and Technology at Technion.



Prof. Tzipi Horowitz-Kraus (far left) with her children and colleagues

Today, Horowitz-Kraus is channeling this wealth of experience and know-how to Technion, which is pivoted to be a national pioneer in understanding and treating learning disorders. "The field of Pediatric Neuroimaging is still under development in Israel," she says. "Reading difficulties are not limited to dyslexia. Children with psychiatric, auditory processing, language, and neurological disorders all have reading problems, each with a different source. Reading is a human invention – an unnatural ability in biological terms. In order to support reading, the human brain has to

efficiently coordinate several neural systems such as vision and hearing. The treatment of reading difficulties should be tailored to their causes; I regard it as an example of personalized medicine."

"I'm a hardcore biologist," says Horowitz-Kraus. "Out of personal interest, I began studying how the brain works when language or reading are not acquired in a typical way. Individuals who have language or learning impairments may in fact be very intelligent and this inability to read presents itself as a striking discrepancy compared to spatial, mathematical, or other non-linguistic abilities. These difficulties are not restricted to the academic field; they affect social and emotional aspects, self-esteem, and the professions they choose – even how my brothers raise their children."

is during childhood. Everyone can achieve improvements – even in adulthood. However, the younger the child is the better their chances of coping with this challenge."

Merging neurophysiology with clinical work, Horowitz-Kraus pursued her PhD in order to understand how the brain of an individual with learning difficulties works, using electroencephalography. "I found specific biomarkers that signify the inability of the brain to recognize reading errors, due to which dyslexic readers do not learn from making mistakes. The optimal window for change and intervention

The search for a holistic way to unravel the many threads of learning disorders brought Horowitz-Kraus to one of the best children's hospitals in the US, Cincinnati Children's Hospital, as a Fulbright Scholar. It was, she says, "the ideal place to dig into the field of reading difficulties, due the diverse pediatric population and availability of child-friendly MRI scanners dedicated to research." After completing her post-doctoral training, she established the Reading and Literacy Discovery Center at Cincinnati and became Program Director. The challenge was to design the best center of its kind in the US, and through this experience, she says, she met "all of the leading researchers in the world exploring the neurobiological origins of dyslexia and learning difficulties. The Center was built on the clinical premise of our work."

Horowitz-Kraus describes her challenge using the metaphor of a headache: a pill might alleviate the symptoms, but it risks leaving the varying causes of headache untreated.

Part of Horowitz-Kraus's mission is to save the brilliance hidden behind every learning "disorder" – the kind of brilliance channeled through Technion faculty once labelled as dyslexic, and perhaps in future Nobel Laureates from Israel. For this, she envisions acquiring the critical Magnetic Resonance Imaging (MRI) scanner which, when acquired, will be the first dedicated MRI of its kind in Israel. "What MRI gives us is the ability to look beneath the tip of the iceberg, at the underlying mechanisms of an impairment. It provides an objective way of looking at the impaired neural circuits within the reading orchestra."

7 | Young Faculty

— THE WATER-ENERGY NEXUS —



Prof. Guy Ramon (second from left) in the lab with students

At the Faculty of Civil and Environmental Engineering, the sciences of energy and water are powerfully interconnected in protection of the environment.

"The bottom line is that the environment is important to me," says Australian-born Prof. Guy Ramon. "My research covers two large topics – water and energy – and the link between the two. We are looking to develop technologies that will reduce the cost of water treatment and desalination. These include methods of treating wastewater to make it potable, as well as enabling the reuse of wastewater for irrigation purposes or for replenishing groundwater. The technology must be accessible to everybody, not just rich economies; desalination is still very much a first-world technology."

The key to reducing costs is to make technology more energy-efficient. "When you consider a desalination plant,

"The common feature is understanding microscale phenomena. I then try to link it all to environmental applications."

40% of the costs come from the energy consumed," Ramon explains. "Another 40% is the capital needed just for building the plant. In our research, we are still using membranes to sift stuff out of the water, but we are looking at them on the microscale, to come up with better solutions."

The Achilles' heel of membrane separation is fouling, says Ramon. "We have to accept that it is going to happen, but we want it on our terms so that we can reverse it. In other words, it's going to get dirty, but can we get it clean again?" One of the major types of fouling is biological. "Bacteria are resilient and immensely successful at multiplying," cautions Ramon. "Biofilms – which comprise bacteria and their support system – are adaptive and even communicate amongst themselves."

"There's a lot in common in seemingly different applications," concludes Ramon. "The common feature is understanding microscale phenomena. I then try to link it all to environmental application. That's why I'm here."

Fracking and Lacking

Fracking, the hydraulic fracturing of shale to extract oil and natural gas, is an activity subject to environmental controversy as a means of energy harvesting. Fracking uses huge amounts of water, which must be transported to the fracking site and is later released in large volumes of extremely contaminated and hard-to-treat wastewater, posing a large risk and significant environmental cost. Environmentalists say carcinogenic chemicals may escape and contaminate groundwater around fracking sites. Ramon is working with researchers in Hong Kong to find the most energy-efficient way to treat the wastewater from this oil harvesting technique. "The use of fracking is going to grow worldwide," he predicts, "with China and Russia following the US lead. We are also trying to answer an open-ended question: What will be the flowrate and volume of contaminated water that will eventually come back up from the fractured shale?"

The Power of Sound

One of Ramon's main research avenues is acoustic energy conversion. "We can use sound as a means of transduction. Think of it as thunder and lightning," Ramon says. "Lightning heats up the air, which expands, and propagates a sound wave – that's the thunder that you hear. We are trying to get the same effect at 80°C as can now be achieved at 500 to 600°C. As far as I know, we are the only ones in the world trying to do this," says Ramon. "What is really exciting," he continues, "is that once you know what to do, these devices are so simple and so cheap to build. A capable 12-year-old could build one."

My Lab at Sea

Boat developers take Technion President Prof. Peretz Lavie and invited guests out for a spin in the Haifa bay



In the 1930s, Technion was the first university in the Middle East with a nautical school, owing to Haifa being the home to an international port. Now, Technion professors are closing a historical circle by designing a boat made out of new materials and based on new engineering principles.

Called the Dganit, the innovative Technion speedboat is lighter, faster, and more durable than anything that has come before.

"I consider this achievement to be no less significant than the microsatellite launched by Technion some years ago," said Prof. Daniel Rittel, Deputy Senior Vice President and a member of the Faculty of Mechanical Engineering. "This boat is lighter and faster than what has gone before."

We are experimenting with a special coating that makes the boat impervious to water, should it sustain structural damage. This project challenges the current standards. It is a prime example of Technion's ability to think outside the box. Israel has a huge advantage over more conservative cultures because we are not afraid to challenge the status quo. Sometimes you fail, but sometimes you succeed."

"Eventually it can be autonomous," says graduate student Oren Rijensky. "It can travel beyond speeds comfortable for a human crew."

"My lab is the sea," smiles designer Prof. Nitai Drimer, who has been working on marine structures since the age of fourteen. "This boat is the best example of the limits of research. It was already understood by boat operators that a lighter boat can be built. When I came to Technion, I had the opportunity to do this research. I cooperate also with industry, namely Sela Ltd. – led by Benny Danino – who built the boat." The test boat, fittingly, is named after Danino's wife Prof. Dganit Danino of the Faculty of Biotechnology and Food Engineering.

"Designing a fast boat for the open seas has special challenges. When you sail at high speeds, the boat jumps and hits the wave. This is a phenomenon known as slamming. Slamming induces extreme stresses on the hull and this is critical; we found that design standards over-assess the stresses by a factor of three. If you build using our rational method, you can achieve a structure that is lighter by at least 20% - this is significant for all applications. Lighter means faster, or that you can install less fuel to achieve the same speed. This way we can also improve on existing boats."

"An unmanned, light boat has a further advantage. There is no limit imposed by a crew who needs to withstand the slamming, so you can push these methods to their limits. You still have the risk of failure and fatigue, but there are no people at risk, only equipment."

"At Technion, if you have an idea, you can go ahead and research it. If it is only theoretical, you can work on it alone. If you want to prove the idea with a real product, the name of Technion and its history of success is an

"A prime example of Technion's ability to think outside the box."

asset. It is far easier to get funding when it's a Technion researcher who has an idea."

Drimer gives credit to his industrial partner. "The initial idea of using aluminum and polyurea came from Benny Danino. This coating affords the boat a second skin. It is our safety net so that we could do our tests."



BIG DATA in the Service of Holocaust Victims

Technion and Hewlett-Packard Upgrade Yad Vashem's Search Engine

languages (Hebrew, German, Polish, and others), different levels of geographical identification (village name vs. district name), birth date errors, and vague information about the fate of victims. Yad Vashem has preferred redundancy to the absence of a victim from the database.

It is estimated that approximately 40% of the eight million records in the database are duplicates. The purpose of this project was to streamline data without losing information, which means using an advanced algorithm in the field of Entity Resolution to identify various records relating to the same person.

The algorithm, called MFIBlocks, was initially developed in the research group of Prof. Avigdor Gal of the Davidson Faculty of Industrial Engineering and Management at Technion, together with Dr. Batya Kenig of the Faculty of Computer Science. In contrast to other algorithms, in

which the identification key is determined by experts or using machine learning methods, here it is derived only from the data itself. The research was led by Technion alum Dr. Tomer Sagi on behalf of the Hewlett-Packard Research Lab, who adapted the algorithm to the Yad Vashem search engine.

An article describing the new development for Yad Vashem was presented in June 2016 at SIGMOD, the leading research conference in the field of data management. An extensive article on the subject was published in the prestigious *Information Systems* journal.



(l-r) Prof. Avigdor Gal and Dr. Tomer Sagi

Yad Vashem is developing a new version of its search engine for the Holocaust victims archive, which uses an algorithm developed by Technion and Hewlett-Packard labs in Israel. The algorithm enables location of records not only of individuals but also by nuclear family, extended family and community.

The database of Holocaust victims is based largely on survivors' reports, which were recorded manually in the 1950s and later on electronically. One of the challenges of the database is the existence of multiple reports about the same person. There are many reasons for this phenomenon, including the use of different