

Caltech and Disney Engineers Collaborate on Robotics

ROBERT PERKINS

Caltech Strategic Communications

This article is adapted from a story that was originally published online at caltech.edu.

New research agreement could yield robots better able to interact smoothly with humans.

Caltech and Disney Research have entered into a joint research agreement to pioneer robotic control systems and further explore artificial intelligence technologies.

The agreement creates a framework that will allow

researchers and engineers at Caltech and Disney Research to easily collaborate on projects of mutual interest. The three-year agreement officially began in August 2017 with projects focused on developing robots with new autonomous movement capabilities and improving machine learning for robots on the move. The goal is to help smooth future human-machine interactions.

Caltech's Pietro Perona will work with Disney roboticist Martin Buehler to create navigation and perception software that could allow robotic characters to safely

move through dense crowds and interact with people. The goal is to design these robots to perceive and understand their surroundings, distinguishing objects from people. They should also be able to make assessments about the people they meet—determining whether someone is looking for directions, for example.

Perona, Allen E. Puckett Professor of Electrical Engineering in the Division of Engineering and Applied Science (EAS), is the cofounder of Visipedia, a Google-funded project that is using advances in machine learning

and computer vision to help classify objects in photographs. Together with colleagues at Cornell University, his team has created a smartphone app that can distinguish among more than 550 bird species in North America.

Meanwhile, Caltech's Aaron Ames, Bren Professor of Mechanical and Civil Engineering and Control and Dynamical Systems in EAS, will work with Disney Research's Lanny Smoot to further explore robot autonomy and machine learning by creating objects that can self-navigate and perform stunts. For example, the engineers

hope to create autonomous robotic balls that will have unique bouncing patterns and teach them how to interact with each other. Ames, who studies robotic walking, arrived at Caltech at the beginning of 2017.

Caltech and Disney Research have a fruitful history of collaboration. Yisong Yue, assistant professor of computing and mathematical sciences, recently worked with engineers from Disney Research on the use of machine learning to analyze the behavior of soccer players and to measure audience engagement.

Scientists Discover Unexpected Side Effect to Cleaning Up Urban Air

ROBERT PERKINS

Caltech Strategic Communications

This article is adapted from a story that was originally published online at caltech.edu.

Sinking levels of an air pollutant may trigger an increase in another potentially harmful class of chemical compounds

An imbalance between the trends in two common air pollutants is unexpectedly triggering the creation of a class of airborne organic compounds not usually found in the atmosphere over urban areas of North America, according to a new study from Caltech.

For decades, efforts to reduce air pollution have led to cleaner air in U.S. cities like Los Angeles, with subsequent improvements in public health. Those efforts have targeted both nitric oxides and hydrocarbons. Nitric oxide is a compound of nitrogen and oxygen emitted from engines (especially those powered by diesel fuel) and from coal power plants. Hydrocarbons, meanwhile, are the family of molecules made from chaining together hydrogen and carbon. These molecules are emitted from many sources including gasoline-powered cars, trucks, solvents, cleaners used both at home and in industrial settings, and even trees.

One way researchers track the changing rates of nitric oxide emissions and hydrocarbon emissions is by examining the ratio of the levels of non-methane atmospheric hydrocarbons to those of nitric oxide (methane, a powerful greenhouse gas, is tracked separately). From 1987 and

1997, that ratio dropped by a factor of two.

Regulations aimed at improving air quality in urban areas like Los Angeles have made rapid progress on reducing nitric oxide and hydrocarbon emissions. As old cars have been taken off the street in favor of cleaner new cars and diesel trucks have been retrofitted or replaced, nitric oxide emissions have dropped rapidly. Compared to 1970 models, new cars and trucks produce about 99 percent fewer common pollutants, according to the Environmental Protection Agency. During the last decade, for example, the amount of nitric oxide in Los Angeles's air has dropped by half.

Air pollution regulations have also led to reductions in hydrocarbon emissions, but these decreases are slowing. Hydrocarbons come from a variety of sources, making it tougher to crack down on them. For example, these compounds are released by the two-cycle engines used in leaf blowers and lawn mowers—equipment that tends to stay in service longer than cars and is subject to fewer regulations.

The sharp drop in nitric oxide levels compared to the slower decline in hydrocarbons is important: according to a new study led by Caltech's Paul Wennberg and the University of Copenhagen's Henrik Kjaergaard, this disparity can lead to the production of chemicals called organic hydroperoxides.

Organic hydroperoxides already exist in nature. In rural areas and other regions that lack large amounts of engine exhaust—and therefore places where nitric oxide

levels are exceedingly low—the molecules can form when trees off-gas volatile organic compounds that then interact with sunlight.

The team led by Wennberg found, however, that there is another chemical pathway for forming organic hydroperoxides—one that occurs at nitric oxide levels substantially higher than can be found in the atmosphere over unpopulated regions. "This is chemistry that does not exist in any of the models of how nitric oxide and hydrocarbons interact," says Wennberg, Caltech's R. Stanton Avery Professor of Atmospheric Chemistry and Environmental Science and Engineering and director of the Ronald and Maxine Linde Center for Global Environmental Science.

Significantly, the atmospheric nitric oxide concentrations over Los Angeles and in urban regions across the country are now dropping to the levels at which this process—called gas-phase autoxidation—occurs.

Gas-phase autoxidation takes place when there are not enough nitric oxide molecules for hydrocarbons to react with. As a result, hydrocarbon molecules react with themselves. Gas-phase

autoxidation has been observed in other settings—for example, the process can form skin-irritating organic hydroperoxides in certain cosmetic products that have gone bad and causes butter to go rancid and wine to spoil. But researchers

gas and aerosol hydroperoxides will impact public health. But we do know that breathing in particles tends to be bad for you," he says.

Wennberg and Kjaergaard's findings will be published online



A smoggy day in Los Angeles in 1973. Decades of efforts to reduce air pollution have led to cleaner air in Los Angeles and other U.S. cities.

Image courtesy of Public Domain

had thought that it could not occur in the atmosphere, given current urban nitric oxide concentrations. Wennberg and colleagues have found otherwise.

"As these nitric oxide concentrations go down by another factor of two over the next five to seven years, we're going to start making more and more organic hydroperoxides in urban areas," Wennberg says. In the air, these hydroperoxides are known to form particulates—aerosols. "The problem is that we haven't seen large concentrations of hydroperoxides in heavily populated areas, so we don't know how the formation of

by the Proceedings of the National Academy of Sciences during the week of December 18. The study is titled "Atmospheric autoxidation is increasingly important in urban and suburban North America." Wennberg's co-authors from Caltech include Brian M. Stoltz, professor of chemistry; graduate student Eric Praske; postdoctoral scholar J. Caleb Hethcox; and staff scientist John D. Crouse (PhD '11). Other authors of the paper include Rasmus V. Otkjær of the University of Copenhagen. This research was funded by the National Science Foundation and the University of Copenhagen.

IN THIS ISSUE

NEWS | PAGE 3
SCIENTISTS DESIGN
METAMATERIALS TO
MANIPULATE WAVES

NEWS | PAGE 3
NEW TECHNOLOGY
WILL CREATE BRAIN
WIRING DIAGRAMS

SPORTS | PAGE 5
GALLUP BREAKS
POOL RECORD AT
CMS

SPORTS | PAGE 5
SUN TAKES ANOTHER
PROGRAM RECORD
AT CMS

Caltech Y Column

CALTECH Y

The Caltech Y Column serves to inform students of upcoming events and volunteer opportunities. The list is compiled by Katherine Guo from information given by the Caltech Y and its student leaders.

Founded by students in 1916, the Y was organized to provide extracurricular activities planned and implemented by students as an opportunity to learn leadership skills and discover themselves. The mission of today's Y remains the same—to provide opportunities that will prepare students to become engaged, responsible citizens of the world. The Y seeks to broaden students' worldviews, raise social, ethical, and cultural awareness through teamwork, community engagement, activism, and leadership. More information about the Caltech Y and its programs can be found at <https://caltechy.org>. The office is located at 505 S. Wilson Avenue.

Upcoming Events

Costa Rica Alternative Spring Break Trip

Saturday, March 17th through Sunday, March 25th (9 days) | Cost: \$950

Applications Due: by Noon on November, 22nd

The Caltech Y is excited to seek applicants for our 2017 Alternative Spring Break trip to Costa Rica. Join other Caltech students for a conservation focused spring break trip this year. On the Costa Rica trip we will be working with a host organization OSA Conservation www.osaconservation.org – which is dedicated to protecting the globally significant biodiversity of Costa Rica's Osa Peninsula. Don't miss out on this fantastic opportunity to explore another part of our planet and make a tangible difference in the world.

Trips fees include transportation, lodging, and most food. The Costa Rica Alternative Spring Break trip is coordinated by the Caltech Y and has been made possible thanks to generous funding from the Frank and Elsie Stefanko Fund, the George Housner Fund, Caltech Student Affairs, and the Caltech Y. Spaces are limited.

Visit http://caltechy.org/programs_services/areas/asb/ for applications and more information.

The Caltech Y Social Activism Speaker Series presents:

Solving Climate Change: From Policy to Personal

Thursday | November 30th | 4:00 to 6:00 PM | Location: TBD

The Caltech Y Social Activism Speaker Series is hosting a panel with members of the Citizens' Climate Lobby, a non-partisan volunteer organization dedicated to national policy to address climate change.

Climate change is one of the most pressing issues facing humanity. While the impacts of emissions up to now will be felt potentially for decades, significant policy changes are required in the immediate future to address greenhouse gas emissions and reverse the warming

trend in the long term. Passing legislation to deal with this pressing issue however, remains a problem. CCL campaigns for the passage of a Carbon Fee and Dividend bill designed to tax carbon emissions and return carbon dioxide to its pre-1990s levels. This discussion will feature a panel of CCL members from a variety of backgrounds each of whom will bring their perspective to this issue. Each panel member will talk about their views and then take questions from the audience.

Presentations are intended to introduce one perspective in order to stimulate thought and to provide a forum for respectful dialogue and examination. The views expressed by speakers are solely those of the speakers. Presentations do not necessarily reflect the opinion of the California Institute of Technology or the Caltech Y and should not be taken as an endorsement of the ideas, speakers or groups.

Decompression 2.0

Friday | December 1st | 3:00 to 5:00 PM | Center for Student Services

We made the move... Decompression is now an end of the week stress reliever with activities, snacks and entertainment. Don't go into finals week stressed out. Join us at the end of class week for a little break before studying. A variety of drinks and snacks, entertainment and activities will be provided.

Caltech Y Explore LA Series The Broad Museum

Sunday | December 3rd | 2:30 PM | Cost: \$5 | Transportation Included

Sign-up starting Thursday, 11/16 at the Caltech Y

Join us on a visit to The Broad with the Caltech Y! The Broad is a contemporary art museum founded by philanthropists Eli and Edythe Broad. Designed by Diller Scofidio + Renfro in collaboration with Gensler, the museum is home to 2,000 works of art from the Broad collection, which is among the most prominent holdings of postwar and contemporary art worldwide, and presents an active program of rotating temporary exhibitions and innovative audience engagement. The 120,000-square-foot building features two floors of gallery space and is the headquarters of The Broad Art Foundation's worldwide lending library, which has actively loaned collection works to museums around the world since 1984. With in-depth representations of influential contemporary artists like Jean-Michel Basquiat, Barbara Kruger, Cy Twombly, Ed Ruscha, Kara Walker, Christopher Wool, Jeff Koons, Joseph Beuys, Jasper Johns, Cindy Sherman, Robert Rauschenberg, and more, plus an ever-growing representation of younger artists, The Broad enriches, provokes, inspires, and fosters appreciation of art of our time. This offer is for students only; however, students purchasing tickets are permitted to purchase tickets for up to one guest each – and that guest can be a non-student. Explore LA is coordinated by the Caltech Y. The Caltech Y is located in the Tyson House 505 South Wilson (Bldg. 128).

Caltechlive!

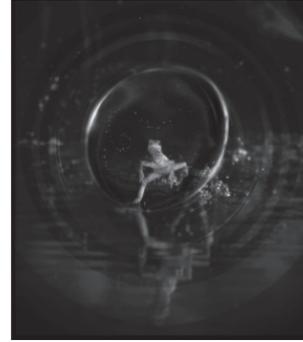
SCIENCE SATURDAYS

SATURDAY, JANUARY 27, 2018 • 4 PM

Beckman Auditorium • \$10 (general admission)
Recommended for all ages

Life: Challenges of Life

A BBC/Discovery/SKAI/Open University co-production in association with RTI Spa.



Discussion Leader: **Christopher Spalding**

Caltech Geological & Planetary Sciences Ph.D. Student

Introducing the extraordinary things animals and plants must do in order to survive and reproduce. Key animals include brown-tufted capuchins, dolphins, cheetahs, chameleons and killer whales.

Free Parking

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www.events.caltech.edu • 626.395.4652

Cosponsor:



* Participants will need to meet at the Caltech Y at 2:30 pm to pick up tickets and coordinate rides. We have a timed entry of 3:30 pm. We will be staying for two hours, then uber'ing back to the Caltech Y. Although tickets are free, we are offering transportation for \$5.

Pasadena LEARNS

Every Friday | 3:00 - 5:00 PM | Pasadena

Come volunteer at Washington Middle and Elementary STEAM School! We are partnered with the Pasadena LEARNS program and work with their Science Olympiad team or do regular tutoring along with occasional hands-on science experiments. Transportation is provided.

For more information and to RSVP, contact azhai@caltech.edu. Eligible for Federal Work Study.

Hathaway Sycamores

Every Monday | 5:45 - 8:00 PM | Highland Park

Volunteer at Hathaway Sycamores, a group that supports local underprivileged but motivated high school students. There are a variety of ages and subjects being tutored. The service trip includes about 40 minutes of travel time and 1.5 hours of tutoring. Transportation is included.

For more info and to RSVP email Elisabeth at egallmei@caltech.edu. Eligible for Federal Work Study.

Mentors for L.I.F.E

Volunteer times: 2:45 - 5:00 PM at various locations in Pasadena

Stressed out by school? Step outside the Caltech bubble and mentor tweens who've yet to even consider college. Things you could do: Build a baking soda and vinegar volcano, read a book aloud, play sports or board games, teach the alphabet of another language, do a craft. Having a mentor makes an at-risk student 55% more likely to attend college, 78% more likely to volunteer regularly, and 130% more likely to hold a leadership position. Interested? If you have 180 seconds, you can watch this video and be inspired. If you have an hour a week, you can mentor someone and be their inspiration. If you feel unqualified, don't worry. Ultimately, mentoring is about being a consistent, dependable friend—not a surrogate parent or psychiatrist.

To get started, contact noelle@caltech.edu.

Building Blocks to Create Metamaterials

ROBERT PERKINS

Caltech Strategic Communications

This article is adapted from a story that was originally published online at caltech.edu.

New design method could unlock the potential of materials that manipulate waves.

Engineers at Caltech and ETH Zürich in Switzerland have created a method to systematically design metamaterials using principles of quantum mechanics.

Their work could pave the way for wider use of metamaterials in more mainstream applications by creating a purpose-driven framework for their design.

Metamaterials are engineered materials that exploit the geometry of their internal structure to manipulate incoming waves. For example, a metamaterial that manipulates electromagnetic waves might bend light in an unusual way to create a cloaking device. Meanwhile, a wafer-thin acoustic metamaterial might reflect incoming sound waves to soundproof a room.

This ability to control waves derives from how the material is structured, often on a microscopic scale. In 2010, Caltech researchers developed an optical metamaterial that uses a surface coated with three-dimensional structures to redirect light as desired. More recently, engineers at Caltech

showed that flat surfaces coated with tiny pillars of silicon could focus light like a lens.

Picture a crystal—a solid whose physical properties are determined by the way it is built from a repeating series of atomic structures. Carbon atoms structured in flat plates create crumbly graphite, while carbon atoms structured in tetrahedra create ultra-hard diamonds. Similarly, metamaterials are constructed from a repeating series of nano- and micro-scale structures that give them their unique properties.

Despite their promise and wide array of possible applications, metamaterials will not be used widely unless engineers can design them to have particular desired properties. While much progress has been made in the design of metamaterials that interact with electromagnetic waves, overall, the design of mechanical metamaterials—those that influence mechanical waves, such as sound waves or seismic waves—remains a scattershot affair, says Chiara Daraio, a professor of mechanical engineering and applied physics at Caltech.

“Before our work, there was no single, systematic way to design metamaterials that control mechanical waves for different applications,” she says. “Instead, people often optimized a design to fulfill a specific purpose, or tried out new designs based on something they saw in nature, and then studied what properties would

arise from repeated patterns.”

To address this, a team led by Daraio and consisting of graduate students Marc Serra Garcia and Antonio Palermo, postdoctoral scholar Katie Matlack, and professor Sebastian Huber at ETH Zürich, turned to the field of quantum mechanics. On the surface, the choice was an unlikely one. Quantum mechanics governs the often-counterintuitive behavior of subatomic particles, and would seem to have no bearing on the micro- and macro-scale designs of the metamaterials studied by Daraio’s team.

Quantum mechanics predicts the existence of certain exotic types of matter: among them, a “topological insulator” that conducts electricity across its surface while acting as an insulator in its interior. Daraio’s team realized that they could build macro-scale versions of these exotic systems that could conduct and insulate against vibrations instead of electricity by using principles of quantum mechanics. In quantum mechanics, materials can sometimes be described as an ensemble of interacting particles. “Imagine that each particle is a tiny mass, connected to its neighbors by springs,” she explains. “Each particle reacts to incoming waves in a unique way that is determined, in part, by the reaction of its neighbors. In our approach, we apply this mass-and-spring model to macroscopic, elastic materials, maintaining their characteristic properties.”

Because metamaterials are built from arrays of geometrical structures (that can have building blocks at the nano-, micro-, or macro-scale) that are connected in repeating patterns, Daraio and her colleagues realized that, by representing each repeating structure as an ensemble of particles, it would be possible to design many different types of metamaterials, like waveguides, acoustic lenses, or vibration insulators.

When struck by an incoming wave, each repeating structure in a metamaterial has the potential to deform in a number of different ways. That deformation is governed not only by the geometry of that structure, but also by how the structures are connected and how the other structures around them are reacting. Treating this as a system of masses and springs, Daraio’s team was able to predict how these systems would react, and then engineer them to react in desired ways.

It is complicated, but also predictable—which is the important part.

As a theoretical proof of concept, Daraio’s team designed metamaterials made from a series of rectangular millimeter-scale plates, each loosely connected to one another like a piece of a puzzle. By tuning the design of the plates and how well-connected the plates were, the team created a perfect acoustic lens that focuses sound

without loss of signal. The plates also act as a waveguide that directs and slows the propagation of sound. The method could be used to design many other devices or sensors where high sensitivity, precision, or control are necessary, Daraio says. The work was published in *Nature Materials* on January 15.

Though Daraio’s work is theoretical, validated using computer simulations, her coauthors at ETH used the method to design and build a 10 by 10-centimeter silicon wafer that consists of 100 small plates connected to each other via thin beams. When the wafer is stimulated using ultrasound, only the plates in the corners vibrate; the other plates remain still, despite their connections. The device could be used as a precise waveguide in a communications network. Their work was published in *Nature* on January 15.

The design process described can also be used to design optical metamaterials, antennas, and optical signal processing devices, says Daraio. Their paper is titled “Designing perturbative metamaterials from discrete models.” This work was funded by ETH Zürich and the Swiss National Science Foundation.

New Technology Will Create Brain Wiring Diagrams

LORI DAJOSE

Caltech Strategic Communications

This article is adapted from a story that was originally published online at caltech.edu.

Technique allows for maps of the neural connections of entire insect brains, which was previously not possible with other methods.

The human brain is composed of billions of neurons wired together in intricate webs and communicating through electrical pulses and chemical signals. Although neuroscientists have made progress in understanding the brain’s many functions—such as regulating sleep, storing memories, and making decisions—visualizing the entire “wiring diagram” of neural connections throughout a brain is not possible using currently available methods. But now, using *Drosophila* fruit flies, Caltech researchers have developed a method to easily see neural connections and the flow of communications in real time within living flies. The work is a step forward toward creating a map of the entire fly brain’s many connections, which could help scientists understand the neural circuits within human brains as well.

A paper describing the work appears online in the December 12 issue of *eLife*. The research was done in the laboratory of Caltech research professor Carlos Lois.

“If an electrical engineer wants

to understand how a computer works, the first thing that he or she would want to figure out is how the different components are wired to each other,” says Lois. “Similarly, we must know how neurons are wired together in order to understand how brains work.”

When two neurons connect, they link together with a structure called a synapse, a space through which one neuron can send and receive electrical and chemical signals to or from another neuron. Even if multiple neurons are very close together, they need synapses to truly communicate.

The Lois laboratory has developed a method for tracing the flow of information across synapses, called TRACT (Transneuronal Control of Transcription). Using genetically engineered *Drosophila* fruit flies, TRACT allows researchers to observe which neurons are “talking” and which neurons are “listening” by prompting the connected neurons to produce glowing proteins.

With TRACT, when a neuron “talks”—or transmits a chemical or electrical signal across a synapse—it will also produce and send along a fluorescent protein that lights up both the talking neuron and its synapses with a particular color. Any neurons “listening” to the signal receive this protein, which binds to a so-called receptor molecule—genetically built-in by the researchers—on the receiving neuron’s surface. The binding of the signal protein activates the receptor and triggers the

neuron it’s attached to in order to produce its own, differently colored fluorescent protein. In this way, communication between neurons becomes visible. Using a type of microscope that can peer through a thin window installed on the fly’s head, the researchers can observe the colorful glow of neural connections in real time as the fly grows, moves, and experiences changes in its environment.

Many neurological and psychiatric conditions, such as autism and schizophrenia, are thought to be caused by altered connections between neurons. Using TRACT, scientists can monitor the neuronal connections in the brains of hundreds of flies each day, allowing them to make comparisons at different stages of development, between the sexes, and in flies that have genetic mutations. Thus, TRACT could be used to determine how different diseases perturb the connections within brain circuits. Additionally, because neural synapses change over time, TRACT allows the monitoring of synapse formation and destruction from day to day. Being able to see how and when neurons form or break synapses will be critical to understanding how the circuits in the brain assemble as the animal grows, and how they fall apart with age or disease.

TRACT can be localized to focus in on the wiring of any particular neural circuit of interest, such as those that control movement, hunger, or vision. Lois and his group tested their method by examining neurons within the well-

understood olfactory circuit, the neurons responsible for the sense of smell. Their results confirmed existing data regarding this particular circuit’s wiring diagram. In addition, they examined the circadian circuit, which is responsible for the waking and sleeping cycle, where they detected new possible synaptic connections.

TRACT, however, can do more than produce wiring diagrams. The transgenic flies can be genetically engineered so that the technique prompts receiving neurons to produce proteins that have a function, rather than colorful proteins that simply trace connections.

“We could use functional proteins to ask, ‘What happens in the fly if I silence all the neurons that receive input from this one neuron?’” says Lois. “Or, conversely, ‘What happens if I make the neurons that are connected to this neuron hyperactive?’ Our technique not only allows us to create a wiring diagram of the brain, but also to genetically modify the function of neurons in a brain circuit.”

Previous methods for examining neural connections were time consuming and labor intensive, involving thousands of thin slices of a brain reconstructed into a three-dimensional structure. A laboratory using these techniques could only yield a diagram for a single, small piece of fruit-fly brain per year. Additionally, these approaches could not be performed on living animals, making it

impossible to see how neurons communicated in real time.

Because the TRACT method is completely genetically encoded, it is ideal for use in laboratory animals such as *Drosophila* and zebrafish; ultimately, Lois hopes to implement the technique in mice to enable the neural tracing of a mammalian brain. “TRACT is a new tool that will allow us to create wiring diagrams of brains and determine the function of connected neurons,” he says. “This information will provide important clues towards understanding the complex workings of the human brain and its diseases.”

The paper is titled “Tracing neuronal circuits in transgenic animals by transneuronal control of transcription (TRACT).” Other Caltech coauthors include graduate students Ting-Hao Huang and Antuca Callejas; AMGEN undergraduate visiting scholar Peter Niesman; Khorana undergraduate visiting scholar Deepshika Arasu; research technicians Aubrie De La Cruz and Daniel Lee; and Elizabeth Hong (BS ’02), the Clare Boothe Luce Assistant Professor of Neuroscience. Funding was provided by BRAIN award UO1 MH109147 from the National Institutes of Health.

DON'T PUT IT OFF!

Coping with procrastination

A free workshop for all Caltech students

Friday, October 13 and Friday, November 3rd

4:00 - 5:00, 326 Sherman Fairchild Library

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Open-Mindedness Learn how to be more flexible in the way you see the world! **October 23rd and 30th**

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November 6th and 13th

Just show up! Mondays 4:00 - 5:00, 326 Sherman Fairchild Library

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Monday, January 8th @ 12:00

And again on Friday, January 12th @ 12:00

Annenberg 105 Lecture Hall



- Learn how to make a study plan • Set smart goals •
- Get started even when you're overwhelmed •
- Cut your losses when you fall behind •

Free lunch on a first-come basis

Gallup breaks pool record at CMS

GOCALTECH.COM

Actual Sports Content Editor

CLAREMONT, Calif. (Jan. 20, 2018) – Sophomore men's swimmer Thomas Gallup added oncemoretohisimpressivesophomore resume by swimming an Axelrod Aquatics Center pool record at Claremont-Mudd Scripps Colleges on Saturday morning. The Beavers took on the Stags in addition to Occidental College in a double-dual meet.

Gallup dominated the event, conquering the rest of the field by over one second over multiple heats. He swam a speedy 56.99 to finish nearly two seconds off Caltech's record time for the event, which he holds, though he will have multiple opportunities going forward to pad his record before the season concludes. Gallup also participated in the 200 breast where he finished fourth,



Just keep swimming...swimming...swimming...betcha haven't heard that one before.

-gocaltech.com

and combined with three other Beavers in the 200 medley relay, the first event of the day and an event in which Caltech took the second spot. Alongside freshman Andy Rothstein and juniors Jonathan Willett and Henry Steiner, Gallup and his teammates swam 1:35.52 to finish one and-a-half seconds off the school record set by three out of the four Beavers just one year ago.

Willett, meanwhile came away with two third-place finishes in the 50 and 100 free and twice came within just one second of winning the event. He swam the former event in 21.60 before clocking in for the latter event at 47.91. Freshman Alex Janosi came in half a second off of Willett in the crowded 50 free field. Meanwhile, fellow freshman Adam Kogan earned himself a fifth-place finish in the 200 freestyle.

Sun takes another program record at CMS



Jessica practicing her commercial for a Neutrogena face wash.

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Actual Sports Content Editor

CLAREMONT, Calif. (Jan. 20, 2018) – Freshman swimmer Jessica Sun added another Caltech breast stroke record to her fantastic rookie season at Saturday's Claremont-Mudd-Scripps-hosted double-dual meet with CMS and Occidental College.

The freshman, who came into Saturday owning records in the women's 100 breast, 400 IM and 200 medley relay, added one more when she set a new program record in the 200 breast previously set by

Diane Plummer in 2008 (2:36.49). Sun shattered the record by nearly five seconds to secure her fourth record with the Beavers with two regular season meets still to come before the SCIAC Championships.

Sun was not the only Beaver to secure a top time finish. Junior Teresa Tran and freshman Stella Wang also set best times for themselves throughout the day. Freshman diver Krystin Brown, meanwhile, improved her time in the 3-meter competition by nearly 10 points from one week ago (190.5) en route to fourth-place finishes in both the 3-meter and 1-meter contests.

Men's basketball inches away from historic Cal Lu comeback

GOCALTECH.COM

Actual Sports Content Editor

PASADENA (Jan. 17, 2018) – The Caltech men's basketball team played its part in a historic game that saw several firsts, milestones reached and the Beavers on the positive side of a buzzer-beater Wednesday evening against visiting California Lutheran University.

Aided by an extra 10 points in the overtime frame, the Beavers hit triple figures for the first time since a 2004-05 game against the University of Redlands, while also breaking their own record from just one game ago for the most team three-pointers (17) in a single game. Moreover, Wednesday's game marks the first statistically recorded game in which three Beavers have reached at least 20 points. The trio consisted of freshman guard Marcus Gee - who tied the Caltech single-game three-point record for individuals with seven to go with 26 points - freshman forward Spencer Schneider and senior wing David Kawashima, who notched a career-high 25 points on 10-of-16 shooting to go along with six assists and four rebounds. He also contributed two three-pointers to his team's lofty sum and for Head Coach Dr. Oliver Eslinger, Kawashima's stat line comes as no surprise given his body of work over the last four years.

"He can do things I have neither seen nor coached before," Eslinger said. "A lot of the things he does haven't been taught to him

by us, but we utilize it and maximize it. We've really worked on his shooting and he's become a great basketball player. I'm proud of him too because he hasn't started every game this year, but he's such a great team captain that he'll do whatever he needs to do for the team. Now, he's matured into a great player and leader and he is the typical senior I like to cultivate in this program."

Caltech's 63 second-half points are another record for the men's basketball program. All were necessary, given the Beavers trailed the Kingsmen, 56-30, at halftime and needed to play with a sense of urgency to get back within striking distance. While the hosts may have found their shooting stroke early in the half, it took until the 13-minute mark for Caltech to figure out Cal Lutheran defensively. The



DK embodying the "P" emoji.

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Beavers went on to shoot nearly 60-percent from the field in the second half, and the strong shooting game helped spark the team in other areas. Sophomore forward Calvin Huh followed up a quiet first half with a monstrous second that led to him finishing with 10 points and 12 rebounds for the first double-double of his career.

Trailing by 25 points at the time (and by as many as 28 at one point), the Beavers outscored the Kingsmen 42-19 in the game's final 13 minutes to give themselves a chance to tie or win the game with seven seconds to go. In need of at least two points to extend the game, Eslinger drew up a play for freshman guard Gokul Srinivasaragavan to drive to the hoop with the hope of finishing, drawing a foul or both to set up a three-point play. Instead, the first-year guard got flushed out of the driving lane, and instead put back a jumper from just inside the three-point line

with 0.4 seconds on the clock to tie the game and send it to overtime.

"Gokul was sick the prior night and earlier in the day and wasn't even supposed to play tonight," Eslinger said. "That's another example of the toughness we try to cultivate on this team. When he did show for the game, I knew he was going to help us. I wasn't sure how, especially given how tonight played out, but I was happy for him. It's just too bad he wasn't just a couple more inches back or he would've won it for us."

The Beavers' perimeter offense had their opponents on their heels for the majority of the game and took momentum into the overtime period. The hosts led by as many as three points with just two minutes to go, but the visitors fought back and ultimately went on to claim a victory that nearly slipped through their fingertips. Even in defeat, the Beavers, upbeat about their tremendous showing of tenacity, refused to hang their heads in defeat, and instead are looking forward to the remainder of their SCIAC schedule.

"It feels a lot better to go into overtime than to lose by 30," Eslinger said. "Obviously we want to win every game we play and we did not come out on top on the scoreboard this time, but we made winning plays and we felt what 'winning time' is. In a lot of ways, I feel this game sets us up for a lot more wins in the future. While we didn't win, we were still victorious and there are lessons to be taught in that."

ANNOUNCEMENT:

VICE PROVOST, CHIEF DIVERSITY OFFICER, AND PROFESSOR OF ENGLISH CINDY WEINSTEIN HOLDS REGULAR OFFICE HOURS AS AN OPPORTUNITY FOR UNDERGRADUATE STUDENTS, GRADUATE STUDENTS, AND POSTDOCS TO MEET FOR DISCUSSIONS PERTAINING TO THE COUNCIL ON UNDERGRADUATE EDUCATION; CALTECH ACCREDITATION; THE STAFF AND FACULTY CONSULTATION CENTER; STUDENT-FACULTY PROGRAMS; THE CENTER FOR TEACHING, LEARNING, AND OUTREACH; THE CALTECH DIVERSITY CENTER; AND THE CALTECH LIBRARIES.

THERE ARE FOUR 15-MINUTE APPOINTMENTS AVAILABLE PER OFFICE HOUR. SIGN UP AT THE OFFICE OF THE VICE PROVOST IN PARSONS-GATES ROOM 104, BY PHONE AT 626-395-6339, OR BY EMAIL TO DLEWIS@CALTECH.EDU. WE LOOK FORWARD TO HEARING FROM YOU!

STUDENT OFFICE HOURS FOR WINTER TERM 2018:

1/23/18 TUESDAY 9:00 A.M.-10:00 A.M.
 2/15/18 THURSDAY 9:00-10:00 A.M.
 2/21/18 WEDNESDAY 11:00 A.M.-12:00 P.M.
 2/27/18 TUESDAY 10:00-11:00 A.M.
 3/8/18 THURSDAY 11:00 A.M.-12:00 P.M.
 3/12/18 MONDAY 10:00-11:00 A.M.
 3/19/18 MONDAY 10:00 A.M.-11:00 A.M.

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ASCIT Minutes

Meetings are every week in SAC 13

ASCIT Board of Directors Meeting: VPSA

Minutes for January 18, 2017. Taken by Dana He.

Officers Present: Sakthi Vetrivel, Kavya Sreedhar, Rachael Morton, Sarah Crucilla, Alice Zhai, Dana He

Guests: Kevin Gilmartin, Joe Shepherd, Tom Mannion

Call to Order: 12:11 pm

President's Report (Sakthi):

- Nothing to report.

Officer's Reports:

V.P. of Academic Affairs (Kavya):

- Thinking of introducing course complements to recognize the good in courses. Students can submit recommendations for courses and could possibly tie this to Take a Prof. out to Lunch. Thinking of starting this on a monthly basis to try it out.
- Course capture has begun. Trying it on CS 21.
- Software seminar will be soon to teach Mathematica.
- Trying to bring back research list for professors looking for students during the school year.
- Looking to introduce undergraduate and graduate student research seminars.
- Math 13 course created to teach students multi-variable calculus for Physics 1b analytical. 50 students enrolled. Positive feedback.
- Creating committee for core curriculum revision.

V.P. of Non-Academic Affairs (Rachael):

- COUCH met with Joes last night about Polaris report. Will meet with faculty and staff groups soon.

Director of Operations (Sara):

- Not in attendance.

Treasurer (Sarah):

- Nothing to report.

Social Director (Alice):

- Saturday is a Six Flags Magic Mountain Trip. Used Marsh fund to subsidize tickets for 75 students. Sign-ups filled up in under 5 minutes. Tickets were \$40 each for group tickets. Buses will take students at 10 am and leave at 6 pm. Could talk to Dean's Office to try to get more tickets.
- Would like to use Marsh fund to subsidize tickets for Cirque du Soleil.
- Be a Kid Again Day will be Sunday, February 25.
- ASCIT formal will be at Hotel Alexandria in downtown LA.

Secretary (Dana):

- Nothing to report.

If anyone has any questions or concerns about a section of the minutes please email the appropriate officer. We are happy to answer any questions.

Meeting Adjourned: 12:38 pm

ARC Minutes 1.21.2018

Present: Kavya Sreedhar, Arushi Gupta, Adrian Huang, Michael Yao, Alejandro Lopez, Maggie Anderson, Ryan Han, Allison Tang, Vibha Vijayakumar, Matthew Zeitlin, Erika Salzman, Alice Jin, Shreya Ramachandran

Minutes submitted by: Allison Tang and Shreya Ramachandran

1. Programming

- Student Faculty Lunches (SFLs): 2 SFLs this term, need to finalize dates
- Course Compliments: biweekly cycles, can be anonymous, responses moderated before posting, funded lunch with Prof of the Month. Advertise in a Tech article
- Software Seminars: Mathematica, 1/24, Wednesday 4-6pm in Arms 155
- Research List: list release after SURF deadline, email ready to be sent to profs
- UG+Grad Student Research Seminars: talk to GSC Academics Chair
- Ombuds Training: email core profs to gauge interest for another training
- Course Concerns: none recently

2. Projects

- TQFR Improvement: focus on guide to filling TQFRs this week

3. Miscellaneous

- Add Day - this Wednesday 1/24, 5pm
- ARC turnover - happening soon

The ARC website at arc.caltech.edu has more information about what the ARC does if you are interested. We meet every Sunday at 11am in SAC13 and our meetings are open to everyone! If you have any questions, please feel free to email ksreedha@caltech.edu.



ARC Tip of the Week

Besides TA office hours, most professors also hold office hours where you can discuss lecture material, homework, and even their research.

Crossword

Across

- Possessed
- Blemish
- In addition
- Field game
- Elementary
- Golf course bordering the fairway
- Part of the eye
- Journey
- Patterned silk fabric
- Borders
- Bobbin
- Cook slowly in liquid
- Hideout
- Aroma
- Be in debt
- Fortitude and determination
- Gardening tool
- Watering place
- Admiration
- Catch with a lasso
- Fruit seed
- Spline
- Adipose tissue
- Lubricants
- Soda
- Profit
- Part of a saddle
- Affirmative
- Knocked unconscious
- Nucleus
- Male offspring
- Argot

Down

- Vast multitude
- Bring into coordination
- Measured portion of medicine
- Group of things of the same kind
- Tropical bird
- Flexible twig of a willow tree
- Kind
- Provide with weapons
- Slack
- Legal case
- Fiend
- Multicolored
- Strike with an axe
- Painful
- Circuit
- Lacking brightness
- Very small
- Acquire

Across

- Very spicy
- Skewer for holding meat over a fire
- Tablet
- Part of a church
- Catch sight of
- Wild plum
- Military signal for lights out
- Operated
- Strong and healthy
- Single
- Ooze
- Female relative
- Swindle
- Humanities
- Gambling house
- Direct the course
- Something unusual
- Leg bone
- Satire
- A secret look
- Container
- Redact
- Aspect of something
- Injury
- Swish
- Large vase
- Append

