Beaming with the Light of Millions of Suns

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

A Caltech-led astronomy team is homing in on the nature of extreme objects known as ULXs.

In the 1980s, researchers began discovering extremely bright sources of X-rays in the outer portions of galaxies, away from the supermassive black holes that dominate the centers. At first, the researchers thought these cosmic objects—called ultraluminous X-ray sources, or ULXs—were hefty black holes with more than 10 billion times the mass of our sun. But observations beginning in 2014 from NASA's NuSTAR (Nuclear Spectroscopic Telescope Array) and other space telescopes are showing that some ULXs, which glow with X-ray light equal in energy to millions of suns, are actually neutron stars—the burnt-out cores of massive stars that exploded. Three such ULXs have been identified as neutron stars so far.

Now, a Caltech-led team using data from NASA's Chandra X-ray Observatory has identified a fourth ULX as being a neutron star—and found neutron stars to be among the objects that can shine so brightly.

Neutron stars are extremely dense objects—a teaspoonful of neutron star material can contain about a billion tons, or as much as a mountain. Their gravity pulls so strongly that material from companion stars onto them; when this material is triggered on, it heats up and flows with X-rays. But as the neutron stars "feed" on the matter, there comes a time when the powerful X-ray light pushes the matter away. Astronomers call this point the point at which the objects cannot accumulate matter any faster and cannot give off any more X-rays—the Eddington limit.

"In the same way that we can only eat so much food at a time, there are somehow breaking this limit to give off such incredibly bright X-rays, and we don’t know why."

In the new study, the researchers looked at a ULX in the Whirlpool galaxy, also known as M51, which lies about 28 million light-years away. They analyzed archival X-ray data taken by Chandra and discovered an unusual dip in the ULX’s light spectrum. After ruling out all other possibilities, they figured out that the dip was from a phenomenon called cyclotron resonance scattering, which occurs when charged particles—either positively charged protons or negatively charged electrons—circle around a magnetic field. Black holes don’t have magnetic fields, but neutron stars do, so the finding revealed that this particular ULX in M51 had to be a neutron star.

"If the cyclotron line is from protons, then we would know that these magnetic fields around the neutron star are extremely strong and may in fact be helping to break the Eddington limit," says Brightman. "Such strong magnetic fields could reduce the pressure of X-rays from clumping the matter away—allowing the neutron star to consume more matter than is typical and shine with the extremely bright X-rays.

"The discovery that these very bright objects, long thought to be black holes, can be neutron stars, is a huge scientific surprise," says Fiona Harrison, Caltech’s associate director of the NASA’s Chandra X-ray Observatory. "Now we might actually be getting firm physical clues as to how these small objects can be so mighty."

The Nature Astronomy study, titled "Magnetic field strength of a neutron-star-powered ultraluminous X-ray source," was funded by NASA and the Ernest Rutherford Fellowships. Other authors include F. Fürst of the European Space Agency/Astronomy Centre; M.J. Middleton of University of Manchester; D.J. Walton and A.C. Fabian of University of Cambridge, United Kingdom; D. Stern of NASA’s Jet Propulsion Laboratory; M. Heida of Caltech; and the European Southern Observatory’s Centro nacional de la recherche scientifique and University of Tum’s Istituto Nazionale di Astrofisica.

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Cells Communicate in a Dynamic Code

LORI DAJONE
Caltech Strategic Communications

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

A critically important intercellular communication system is found to encode and transmit messages between cells, coordinating their activities in order to proliferate and differentiate. Deciphering the language of intercellular communication has long been a central challenge in biology. Now, Caltech scientists have discovered that cells have evolved a way to transmit more messages through a single pathway, or communication channel, than previously thought, by encoding the messages rhythmically over time.

The work, conducted in the laboratory of Michael Elowitz, professor of biology and bioengineering, Howard Hughes Medical Institute Investigator, and executive officer for Biological Engineering, is described in a paper in the February 8 issue of Cell.

In particular, the scientists studied a key communication system called "Notch," which is used in nearly every tissue in animals. Malfunctions in the Notch pathway contribute to a variety of cancers and developmental diseases, making it a desirable target to study for drug development.

Cells carry out their conversations using specialized communication molecules called ligands, which interact with corresponding molecular antennae called receptors. When a cell uses the Notch pathway to communicate instructions to its neighbors—telling them to divide, for example, or to differentiate into a different kind of cell—the cell sending the message will produce certain Notch ligands on its surface. These ligands then bind to Notch receptors embedded in the surface of nearby cells, triggering the receptors to release gene-modifying molecules called transcription factors into the interior of their cell. The transcription factors travel to the cell’s nucleus, where the cell’s DNA is stored, and activate specific genes. The Notch system thus allows cells to receive signals from their neighbors and alter their gene expression accordingly.

Ligands prompt the activation of transcription factors by modifying the structure of the receptors into which they dock. All ligands modify their receptors in a similar way and activate the same transcription factors in a similar manner. Many developmental biologists generally assumed that the receiving cell should not be
**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.osacconservation.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.


The Caltech Y Social Activism Speaker Series

**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 an opportunity for 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 3rd | 2:30 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 Benys, Jasper Johns, Cindy Sherman, Robert Rauschenberg, and more, 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 Blvd., 128).

“Her combination of projected animation and contemporary shadow play have a magical quality in which the convergence of the common everyday world with the fantastical create an immersive dreamlike effect.”

$30 (general admission) / $10 Youth

Free Parking

Calltech’s Beckman Auditorium

www.events.caltech.edu • 626.395.4652

**Meeting: Myth & Infrastructure / This World Made Itself**

Friday, March 9, 2018 • 8 PM

MIWA MATREYEK

Caltech's Beckman Auditorium

**In Focus: Women in Science**

Mixing Myth & Infrastructure / This World Made Itself

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.

**Art of The Broad: Basquiat, Kruger, Twombly**

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 Benys, Jasper Johns, Cindy Sherman, Robert Rauschenberg, and more, 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 Blvd., 128).

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$30 (general admission) / $10 Youth

Free Parking

Calltech’s Beckman Auditorium

www.events.caltech.edu • 626.395.4652

**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 2:30 pm. We will be staying for two hours, then ubering back to the Caltech Y. Although tickets are free, we are offering transportation for $5.**

**Caltech Y Social Activism Speaker Series**

**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 could 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.
A Critically Important Intercellular Communication System is Found to Encode and Transmit More Messages Than Previously Thought

Continued from page 1

able to reliably determine which ligand had activated it, and hence which message it had received.

"At first glance, the only explanation for how cells distinguish between two ligands, if at all, seems to be that they must somehow accurately detect differences in how strongly the two ligands activate the receptor. However, all evidence so far suggests that, unlike mobile phones or radios, cells have much more trouble precisely analyzing incoming signals," says lead author and former Elowitz lab graduate student Nagarajan (Sandy) Nandagopal (PhD ’18). "They are usually excellent at distinguishing between the presence or absence of signal, but not very much more. In this sense, cellular messaging is closer to sending smoke signals than texting. So, the question is, as a cell, how do you differentiate between two ligands, both of which look like similar puffs of smoke in the distance?"

Nandagopal and his collaborators wondered whether the answer lay in the temporal mechanism enabled the two ligands activated individual receptors in a sustained manner, sending a constant trickle of single transcription factors down to the nucleus all at once, like a smoke signal consisting of a few giant puffs. On the other hand, Delta4 ligands activated clusters of receptors simultaneously, sending a sudden burst of transcription factors to the nucleus, like a steady stream of smoke. These two patterns are the key to encoding different instructions to the cell, the researchers say. In fact, this mechanism enabled the two ligands to communicate dramatically different messages. By analyzing chick embryos, the authors discovered that Delta activated abdominal muscle production, whereas Delta4 strongly inhibited this process in the same cells. "Cells speak only a handful of different molecular languages but they have to work together to carry out an incredible diversity of tasks," says Elowitz. "We've generally assumed these languages are extremely simple, and cells can basically only grunt at each other. By watching cells in the process of communicating, we can see that these languages are more sophisticated and have a larger vocabulary than we ever thought. And this is probably just the tip of an iceberg for intercellular communication."

The paper is titled "Dynamic Ligand Discrimination in the Notch Signaling Pathway." In addition to Nandagopal and Elowitz, other Caltech co-authors are Leah Santant, who is also a Howard Hughes Medical Institute Investigator, and Marianne Brunnier, the Albert Billings Ruddock Professor of Biology. Additional co-authors are Lauren Lebon of Calico Life Sciences and David Sprinzak of Tel Aviv University. Funding was provided by the Defense Advanced Research Projects Agency, the National Institutes of Health, the National Science Foundation, and the Howard Hughes Medical Institute.

2018 CALTECH UNDERGRADUATE WRITING PRIZES

Each year the division of Humanities and Social Sciences awards a number of prizes for undergraduate writing. Consider submitting your work to be recognized and rewarded for your work as a writer.

Submit your writing this year for these prizes:

MARY A. EARL MCKINNEY PRIZE IN LITERATURE
Awarded to the best original poetry and fiction. Submit up to three poems. Fiction should not exceed 12,000 words – one submission.
Prize amount: $500.00/each category

GORDON MCCLURE MEMORIAL COMMUNICATIONS PRIZE
Awarded to the best academic writing in three categories: English, History and Philosophy. No length limit. Please include prompts for all essays composed in courses. Essays written for courses may be revised before submission.
Prize amount: $500.00/each category

HALLETT SMITH PRIZE
Awarded to an outstanding essay related to the work of Shakespeare.
Prize amount: $500.00

Copies of last year’s prizewinning writing are stored in CaltechTHESIS, and they can be viewed by following links from this writing center webpage: http://writing.caltech.edu/community/prizes

Submission Guidelines:

Deadline: April 6th, 2018

Only currently enrolled full-time students may submit. Entries should be double-spaced PDFs. Winners will be announced in June, and winners’ names will be in the commencement program. Winning writing will be archived using CODA through the Caltech Library. Email entries to Cecilia Lu at cecilia@caltech.edu, noting the prize to which you are applying in the email subject and filename.
EMOTIONAL WELLBEING SERIES 2018

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POSITIVE PSYCHOLOGY

JANUARY 24
EMOTION REGULATION STRATEGIES

JANUARY 31
GRIEF AND LOSS

FEBRUARY 14
HEALTHY RELATIONSHIPS

FEBRUARY 21
SEXUAL HEALTH CALL FOR AN APPOINTMENT

FEBRUARY 28
PROCRASTINATION

MARCH 7
ALCOHOL & DRUGS

APRIL 11
COPIING WITH ADHD

APRIL 16
HEALTHY ADVICE RELATIONSHIPS

APRIL 25
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MAY 9
STRESS MANAGEMENT

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Face The Fear Learn how to hang in there with difficult situations and emotions without having to avoid them.
Friday, February 16th and 23rd

Just show up! Fridays 4:00 - 5:00, 326 Sherman Fairchild Library
Kawashima wins SCIAC Ducey Award

LAGUNA NIGUEL, Calif. (Feb. 23, 2018) – Senior wing David Kawashima will depart the Caltech men’s basketball program with the prestigious SCIAC Ducey Award, as voted on by the conference’s coaches. The Ducey is an all-encompassing award reserved for senior players of high character on and off the court and players who use their free time to give back to the community. Kawashima is the first Caltech player to win the award since K.C. Emuze’16.

“I really appreciate all of the support from the Caltech community throughout my career here, as I simply could not have thrived without my teammates, coaches, or the best fans in the SCIAC,” Kawashima said. “I would like to thank everyone who supported me and our team these past four years.” Kawashima finished the 2017-18 season averaging 8.7 points per game, 4.3 rebounds to go with a .540 field goal percentage. The senior’s .466 field goal percentage ranks sixth in program history.

Peng named to Second All-SCIAC

LAGUNA NIGUEL, Calif. (Feb. 22, 2018) – For a second year in a row, sophomore guard Grace Peng of the Caltech women’s basketball team earned SCIAC recognition, this time for Second Team All-SCIAC. The sophomore received the SCIAC Newcomer of the Year honor in 2017.

Men’s team scores favorably at SCIAC’s Day 2

LAGUNA NIGUEL, Calif. (Feb. 23, 2018) – A handful of new records and personal improvements allowed the Caltech men’s swimming & diving team to score enough points to hold steady in the middle of the standings on the second day of the 2018 SCIAC Championships. The Beavers are currently sitting in the middle of the field in fifth place.

Freshman Adam Kogan began the evening with a new personal best in the 500 Free, lowering his pre-race record from the morning by six-tenths of a second. The freshman touched the wall in 4:37.02, crushed his previous top time by nearly 20 seconds and broke the Caltech record previously held by junior Dylan Lu. The freshman got it done with steady splits throughout the race, with his second-fastest 50 split coming on the final lap. The subsequent event, the 200 IM, saw two Beavers participate in the ‘B’ final and earn their team some meaningful points. Freshman Alex Janosi improved on his previous top 200 IM time by nearly seven seconds and won the race in 1:53.11 to

A fish out of water.

Men’s team scores favorably at SCIAC’s Day 2

LAGUNA NIGUEL, Calif. (Feb. 22, 2018) – For a second year in a row, sophomore guard Grace Peng of the Caltech women’s basketball team earned SCIAC recognition, this time for Second Team All-SCIAC. The sophomore received the SCIAC Newcomer of the Year honor in 2017.

Peng finished seventh in the conference in scoring, seventh in steals, eighth in field goals per game and ninth in assists, in addition to ranking second in minutes per game. Additionally, the point guard is currently on pace to be the Beavers’ most accurate three-point shooter in school history (32.2 percent) and is already Caltech’s 10th all-time leading scorer. Perhaps her best game came on Jan. 3 when the Beavers picked up their first SCIAC win under first-year Head Coach Bridgette Reyes at Pomona-Pitzer Colleges. Peng scored 21 points, knocked down two three-pointers and handed out a pair of assists.

With Peng manning the point guard position, the Beavers picked up three SCIAC wins for the first time ever, two of which came against the University of La Verne which marked the first time the Beavers have swept the Leopards. The three wins brought Caltech to an eighth-place conference finish.
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 626-395-6399, OR BY EMAIL TO DLEWIS@CALTECH.EDU. WE LOOK FORWARD TO HEARING FROM YOU!

STUDENT OFFICE HOURS FOR WINTER TERM 2018:

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.
Minutes for February 23, 2017. Taken by Dana He.

Meeting Adjourned:

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.
HUMOR

REVENGE OF THE NERDS

HEY NEEEERD! YOU'LL NEVER AMOUNT TO ANYTHING!

SOMEDAY I’LL GET MY REVENGE...

TWENTY YEARS LATER...

I SAID NO PICKLES!

Answers to current crossword (pg 7)

http://puzzlechoice.com