

## Cosmic Magnifying Lens Reveals Inner Jets of Black Holes

Whitney Clavin  
Caltech Media Relations

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

Astronomers using Caltech's Owens Valley Radio Observatory (OVRO) have found evidence for a bizarre lensing system in space, in which a large assemblage of stars is magnifying a much more distant galaxy containing a jet-spewing supermassive black hole. The discovery provides the best view yet of blobs of hot gas that shoot out from supermassive black holes.

"We have known about the existence of these clumps of material streaming along black hole jets, and that they move close to the speed of light, but not much is known about their internal structure or how they are launched," says Harish Vedantham, a Caltech Millikan Postdoctoral Scholar. "With lensing systems like this one, we can see the clumps closer to the central engine of the black hole and in much more detail than before." Vedantham is lead author of two new studies describing the results in the Aug. 15 issue of *The Astrophysical Journal*. The international project is led by Anthony Readhead, the Robinson Professor of Astronomy, Emeritus, and director of the OVRO.

Many supermassive black holes at the centers of galaxies blast out jets of gas traveling near the speed of light. The gravity of black holes pulls material toward them, but some of that material ends up ejected away from the black hole in jets. The jets are active for one to 10 million years—every few years, they spit out additional clumps of hot material. With the new gravitational lensing system, these clumps can be seen at scales about 100 times smaller than before.

"The clumps we're seeing are very close to the central black hole and are tiny—only a few light-days across. We think these tiny components moving at close to the speed of light are being magnified by a gravitational lens in the foreground spiral galaxy," says Readhead. "This provides exquisite resolution of a millionth of a second of arc, which is equivalent to viewing a grain of salt on the moon from Earth."

A critical element of this lensing system is the lens itself. The scientists think that this could be the first lens of intermediate mass—which means that it is bigger than previously observed "micro" lenses consisting of single stars and smaller than the well-studied massive lenses as big as galaxies. The lens described in the new paper, dubbed a "milli-lens," is thought to be about 10,000 solar

masses, and most likely consists of a cluster of stars. An advantage of a milli-sized lens is that it is small enough not to block the entire source, which allows the jet clumps to be magnified and viewed as they travel, one by one, behind the lens. What's more, the researchers say the lens itself is of scientific interest because not much is known about objects of this intermediate-mass range.

"This system could provide a superb cosmic laboratory for both the study of gravitational milli-lensing and the inner workings of the nuclear jet in an active galaxy," says Readhead.

The new findings are part of an OVRO program to obtain twice-weekly observations of 1,800 active supermassive black holes and their host galaxies, using OVRO's 40-meter telescope, which detects radio emissions from celestial objects. The program has been running since 2008 in support of NASA's Fermi mission, which observes the same galaxies in higher-energy gamma rays.

In 2010, the OVRO researchers noticed something unusual happening with the galaxy in the study, an active galaxy called PKS 1413+135. Its radio emission had brightened, faded, and then brightened again in a very

*Continued on page 6*

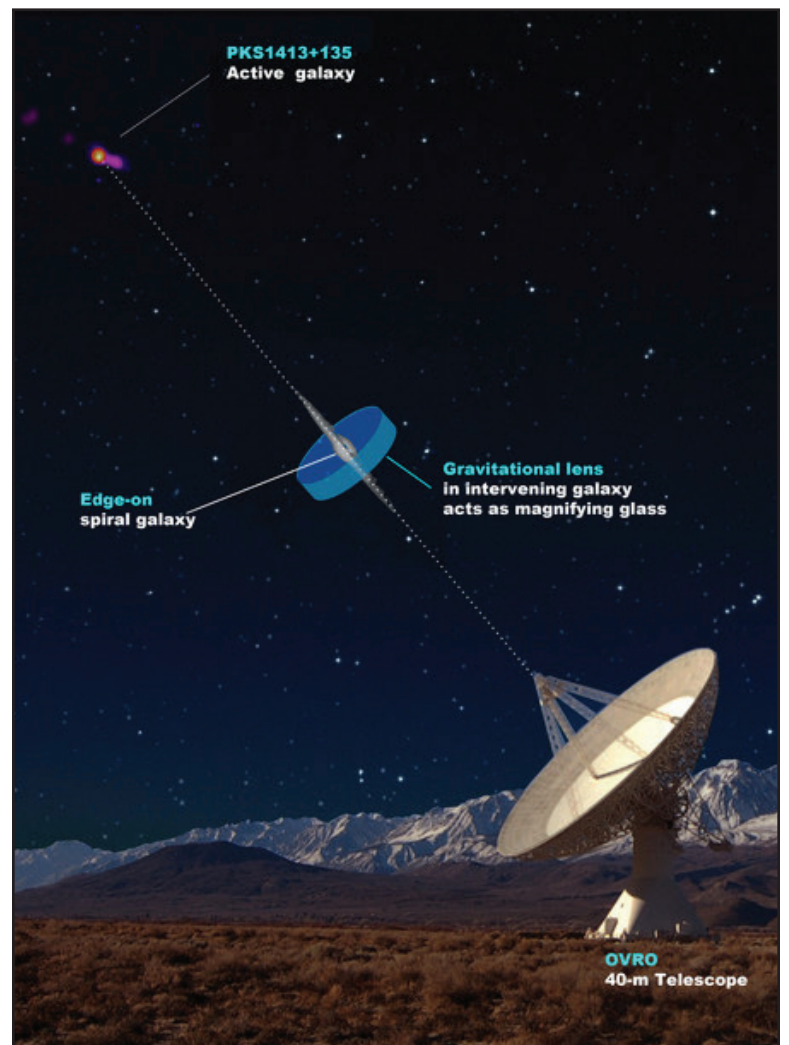


Illustration shows the likely configuration of a gravitational lensing system discovered by OVRO. The "milli-lens" is located in or near the intervening spiral galaxy. The lens is magnifying blobs of jet material within the active galaxy PKS1413+135, but the blobs are too small to be seen in the radio image (top left), taken by MOJAVE. Only when the blobs move far away from the yellow core do they expand and are visible as the pink blobs in the image.

Image Courtesy of Anthony Readhead

## Feminist Club Interviews Professor of Philosophy Fiona Cowie

Jake Mattinson  
Feminist Club

### What is feminism?

I think feminism is partly a political struggle: doing away with laws that discriminate women and implementing laws to avoid it where it's happening. It's partly an ideological movement. Part of what it needs to do is change how people think about women and gender. That's not a matter of making legislation. That's a matter of well-conversation. Courses on feminism. It's a matter of women speaking up, women's voices being heard. One encouraging thing that's happening is in Hollywood and in TV about the visibility of women: producers, actors, stories with real, believable women with brains, not just decorative or show. It's a desire to change how women are perceived and their abilities.

### Have you seen change in your time here?

More attention is being paid in the administration and the implementation (e.g. diversity office) to ensuring that women and minorities are able to live at Caltech without giving up their identity and

conforming to a stereotype of "the Caltech student" who used to be, and maybe still is, a geeky white guy.

I think that there's not overt discrimination anymore in the way that there was when I was your age. When I was in undergraduate, it was pretty much expected that male professors slept with their students. Overtly refusing to have women working in your lab. There is still a lot of unconscious biases that show up. For instance, the Feynman prize has been going maybe 25 years but it has only once been awarded to a woman professor. And I'm sure it's not the case that people are thinking "I won't nominate her because she's a woman" but there are stereotypes about how male and female professors are and when a male is nurturing and its violating a stereotype and it's noticed. But females acting the same way are not noticed because female stereotypes are nurturing and loving. It is a constant fight. One is subject to oneself.

### What do you say to those who feel like feminists are misandrist?

The assumption underlying that argument is that it is a zero-sum game and that if you raise the status of women, in whatever way, there's a similar drop for men. Most forms of affirmative action are not going to do that. It's not a zero sum game. In cases where it is, like admissions to Caltech, what exactly is wrong with that? Something would only be wrong if the men had some type of right to be there and you were violating their rights. But no one has a right to be admitted and the idea that men do have a right and that their right is being violated by a woman's acceptance is an expression of unconscious privilege that is attached to being a white male in this culture.

Generally, though, I think you need to detach the role from the occupant of the role. For example, there's the role of president but the occupant changes from time to time. One can be against a certain set of social arrangement such as where white men are privileged, women and people of color are subordinated relative to men – you can be against that without against any of the occupants of that particular role. And there've always been feminists who don't

like men and there've always been non-feminists who don't like men. Criticizing the role of men in society does not to me seem to have any implication on how someone views the class of men.

### Can you discuss how impostor syndrome impacts women differently?

I was dismayed to hear that around Caltech undergrads there is still a perception that it is 'easier for women to get in'. People think women are only here because they are women. I was so horrified to hear that that is still a thing. It's absolutely not true. There has been a change.

Why is it that a greater proportion are here now than 30 years ago? The tempting answer is lowering the bar for women. That's just not true. Two things explain why there are more women than there used to be. One is that admissions works very hard both to have women apply- working on STEM in high school, that kind of outreach- and to encourage women who've been admitted to actually accept. The other reason that there has perhaps been a change is that the bar has not been lowered but

our criteria of what kind of person to admit has changed over the years. For example, we don't just look at STEM and grades in admissions. We want to have a student body, people excited about science, who are collaborative, who show a real passion for STEM. I don't think that's a lowering of the bar. I think it's a sideways shifting of the bar. As a consequence of looking at other features, more women are being admitted, not because they're women, but because they're the people we are looking for.

### So what should feminists do?

Women your age have grown up where things have been very good for women. They don't think they have to be a feminist or an activist anymore. I hope things aren't going backwards, but I fear they might. There's still a lot of work to do – still a gender pay gap, men still want to impose women's reproductive rights, abortion rights, and with the new courts, Roe V Wade may get overturned. I think unfortunately women are going to start fighting again. Even basic matters. Man the barricade – I guess woman the barricade.

IN THIS ISSUE

ANNOUNCEMENTS | PAGE 3  
FEYNMAN PRIZE NOMINATIONS OPEN

SPORTS | PAGE 5  
WALKER ASSISTS ON 16 KILLS AT WHITTIER

SPORTS | PAGE 5  
COMO SAVES 9 AT WHITTIER

SPORTS | PAGE 5  
WOMEN'S XC TEAM BESTS 4 SCIAC TEAMS AT MULTI-DUALS



## Caltech Y Column

CALTECH Y

### Upcoming Events

#### Adventure 101: Great Hikes in the Greater LA Area

Wednesday | October 4th | 12:00 - 1:00 PM | Lunch Provided, Space is limited

RSVP Required: <https://goo.gl/forms/pQ87dqLyGxXMGDgp1>

The greater Los Angeles area has a vast array of wonderful hiking - from the immediate San Gabriel Mountains or Griffith Park areas to the Santa Monica Mountains near the beach - there is a seemingly unending supply of hiking options. Come learn from Y-Outdoors Student Leaders as they share from personal experience about some of the great venues you might want to explore on your own. Location of the talk will be included in the confirmation.

#### The Caltech Y Social Activism Speaker Series: Connecting Nuclear Weapons with Climate Change: Managing Eisenhower's "Fearful Atomic Dilemma"

Dr. Victor Reis, former Senior Advisor U.S. Department of Energy

Thursday | October 5th | 12:00 - 1:30 PM | Beckman Institute Auditorium

Lunch Provided | RSVP Required: <https://goo.gl/forms/oKNANGVv877eulBF3>

Join the Caltech Y Social Activism Speaker Series for our first seminar of the year with Dr. Victor H. Reis presenting a story of politics, people, science, economics, theology, and imagination.

In a recent New Yorker article, "The Atomic Origins of Climate Science: How arguments about nuclear weapons shaped the debate over nuclear warming" Harvard Professor Jill Lepore suggests that the campaign to make known the threat of a nuclear winter destroyed the concept of nuclear deterrence, but the faulty models and rhetoric used ultimately undermined environmental science. Having been in the White House Office of Science and Technology Policy in the early 1980's, Dr. Reis will review the then ongoing nuclear debate and suggest an alternate story to Lepore's involving the nuclear freeze movement and the Catholic Church.

There is a more fundamental connection between nuclear weapons and climate change mitigation, echoing Eisenhower's 1953 Atoms for Peace Speech to the United Nations. He will try to connect those dots into a coherent story.

Dr. Victor H. Reis retired on March 1, 2017 as Senior Advisor, U.S. Department of Energy, where he worked on national

security and nuclear energy issues for the Secretary of Energy and the Undersecretaries of Energy for National Security and Science. His previous government appointments include serving as Director of the Defense Advanced Research Projects Agency (DARPA), Director of Defense Research and Engineering (DDR&E) at the Pentagon and Assistant Director for National Security and Space, Office of Science and Technology Policy, Executive Office of the President, (OSTP). He is well known as the architect and sponsor of the U.S. nuclear Stockpile Stewardship Program and its Accelerated Strategic Computing Initiative, which resulted in the creation of several new generations of government-sponsored supercomputers. Reis chaired and served on numerous government and laboratory advisory committees for the DoD, CIA, NASA, U.S. Strategic Command, NNSA, U.S. Navy and Los Alamos, Sandia, Argonne and Idaho National Labs.

#### Pinnacles National Park Camping Trip

October 13th - 15th | Sign up at the Caltech Y | Cost \$85 due on sign up

Do you want to traverse rocky terrain to high peaks and through deep caves? Come along on a camping trip to Pinnacles National Park with the Caltech Y! Pinnacles was born from a lava field split by the San Andreas Fault, and thus supports diverse terrain and wildlife. We'll be completing a 9 mile loop around the park to High Peaks and Balconies Cave, as well as a shorter stint to Bear Gulch Reservoir. The trip departs Friday, October 13th at 1pm and returns Sunday, October 15 by 8pm. Transportation, campsites, and most meals are included. All experience levels are welcome. For more information on Pinnacles National Park, visit the National Park web site at <https://www.nps.gov/pinn/index.htm>.

To secure your spot on this trip you must sign up and pay the fee (\$85) in person at the Caltech Y (505 S. Wilson the house, just north of the Credit Union). Spaces are limited. Priority may be given to those who can share the in the driving

#### Rise Tutoring Program

Monday - Thursday | 4:00 - 6:00 PM | Chandler Cafeteria

The Caltech Y Rise Program is currently accepting new tutors for the fall term. The Rise Program is a afterschool math and science tutoring program for public school students between grades 8 and 12. The program is in its twelfth year and helps students who are struggling in math or science (getting a C or below). The tutoring takes place on the Caltech campus Monday-Thursday from 4pm-6pm. Tutors

## Caltechlive!

Saturday, October 14, 2017 • 8 PM

\$42, \$37, \$32 / \$10 Youth

### Lily Cai Chinese Dance Company



"Elegant, innovative and captivating, the company melds ancient Chinese forms with modern dance in an artistic and inventive marriage of styles."

—Broadway World

Free Parking  
Caltech's Beckman Auditorium  
[www.events.caltech.edu](http://www.events.caltech.edu) • 626.395.4652

Cosponsor  
 CALTECH EMPLOYEES  
Proudly Sponsors

work with 1-2 students and when possible work with the same student(s) throughout the year. The program is designed to help students gain greater competency in math foundations, improve skills in math and science and prepare students for college-level math and science.

Tutoring with the Rise Program is a great way to give back to the community and work with local school students to help them succeed in math and science. For more info and to apply go to [https://caltechy.org/programs\\_services/tutoring/Resources/index.php](https://caltechy.org/programs_services/tutoring/Resources/index.php).

#### Caltech Y Office Closed

Thursday | September 28th | 9:00 AM - 1:00 PM

The Caltech Y Office will be closed the morning of Thursday, September 28th until 1:00 PM due to maintenance work in our office. For inquiries during this time please contact us at [caltechy@caltech.edu](mailto:caltechy@caltech.edu).

#### Hathaway Sycamores

Every Wednesday | 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](mailto:egallmei@caltech.edu). Eligible for Federal Work Study.

#### Beyond the Y

##### Help Parents and Children Reunite as a Family

Coach-Monitor Training on October 21st - 22nd, 27th - 28th

Become a trained volunteer coach-monitor and provide court-ordered supervised family visits so that children, removed from the care of their parents, can visit their parents in a physically and emotionally safe setting filled with toys, games, books and art materials. These visits are an essential service to increase the family's chances for reunification and reduce the children's anxiety while in out-of-home placement. To learn about the importance of visitation, the role of a coach-monitor and the upcoming training, contact: [inbox@fostercareproject.org](mailto:inbox@fostercareproject.org).

## NOMINATE YOUR FAVORITE PROFESSOR FOR THE FEYNMAN TEACHING PRIZE!!!

Here's your chance to nominate your favorite professor for the 2017-18 Richard P. Feynman Prize for Excellence in Teaching! You have from now until December 15, 2017 to submit your nomination package to the Provost's Office to honor a professor who demonstrates, in the broadest sense, unusual ability, creativity, and innovation in undergraduate and graduate classroom or laboratory teaching.

The Feynman Prize is made possible through the generosity of Ione and Robert E. Paradise, with additional contributions from an anonymous local couple. Nominations for the Feynman Teaching Prize are welcome from faculty, students, postdoctoral scholars, staff, and alumni.

All professorial faculty of the Institute are eligible. The prize consists of a cash award of \$3,500, matched by an equivalent raise in the annual salary of the awardee. A letter of nomination and detailed supporting material, including, but not limited to, a curriculum vitae, course syllabus or description, and supporting recommendation letters should be emailed to [kkerbs@caltech.edu](mailto:kkerbs@caltech.edu) or directed to the Feynman Prize Selection Committee, Office of the Provost, Mail Code 206-31, at the California Institute of Technology, Pasadena, California, 91125. Nomination packages are due by December 15, 2017.

Additional information including guidelines for the prize and FAQ may be found at <http://provost.caltech.edu/FeynmanTeachingPrize>. Further information can also be obtained from Karen Kerbs (626-395-6039; [kkerbs@caltech.edu](mailto:kkerbs@caltech.edu)) in the Provost's Office.

## WRITE FOR THE CALIFORNIA TECH!

WE ACCEPT REVIEWS,  
OPINION PIECES,  
RESEARCH, NEWS  
STORIES,  
COMICS, AND MORE!

WE PAY FOR  
SUBMISSIONS, SO JOIN  
THE STAFF TODAY!

EMAIL  
[TECH@CALTECH.EDU](mailto:TECH@CALTECH.EDU)  
WITH QUESTIONS.

## VICE PROVOST OFFICE HOURS

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 IN THE OFFICE OF THE VICE PROVOST, PARSONS-GATES ROOM 104, EXT. 6339 OR BY SENDING AN EMAIL TO [dlewis@caltech.edu](mailto:dlewis@caltech.edu). WE LOOK FORWARD TO HEARING FROM YOU!

### STUDENT OFFICE HOURS FOR FALL TERM 2017:

10/6/17 FRIDAY 11:00 A.M.-12:00 P.M.  
10/11/17 WEDNESDAY 9:00-10:00 A.M.  
10/19/17 THURSDAY 11:00 A.M.-12:00 P.M.  
10/26/17 THURSDAY 10:00-11:00 A.M.  
11/1/17 WEDNESDAY 11:00 A.M.-12:00 P.M.  
11/7/17 TUESDAY 9:00-10:00 A.M.  
11/16/17 THURSDAY 11:00 A.M.-12:00 P.M.  
11/21/17 TUESDAY 10:00-11:00 A.M.  
11/27/17 MONDAY 10:00-11:00 A.M.



## Procrastination workshop

A 1-hour workshop offered 2 times this term:

**Friday, October 13th, 4:00 - 5:00**

**Friday, November 3rd, 4:00 - 5:00**

**326 Sherman Fairchild Library**

- Learn tools for coping with procrastination and work avoidance.
- Learn practical, behavioral strategies for responding differently to old habits.
- Respond differently to unhelpful thoughts like "I can just get up early and do this tomorrow."
- Optional text-based reminder system to keep the lessons fresh in the week after the workshop is over!

**More information: [counseling.caltech.edu](http://counseling.caltech.edu)**

## EMOTIONAL INTELLIGENCE TOOLKIT

3 modules / 2 weeks each / 1 awesome skillset

### Emotional Awareness

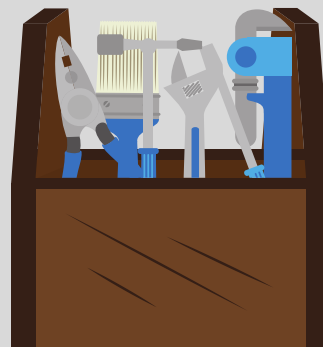
Get better at knowing what you're feeling, and see how your thoughts and feelings affect each other. **October 9th and 16th**

### Open-Mindedness

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

### Face The Fear

Learn how to hang in there with difficult situations and emotions without having to avoid them. **November 6th and 13th**



**Just show up!**

**Mondays 4:00 - 5:00**

**326 Sherman Fairchild Library**

**[counseling.caltech.edu](http://counseling.caltech.edu)**

# Join the Meditation Mob!

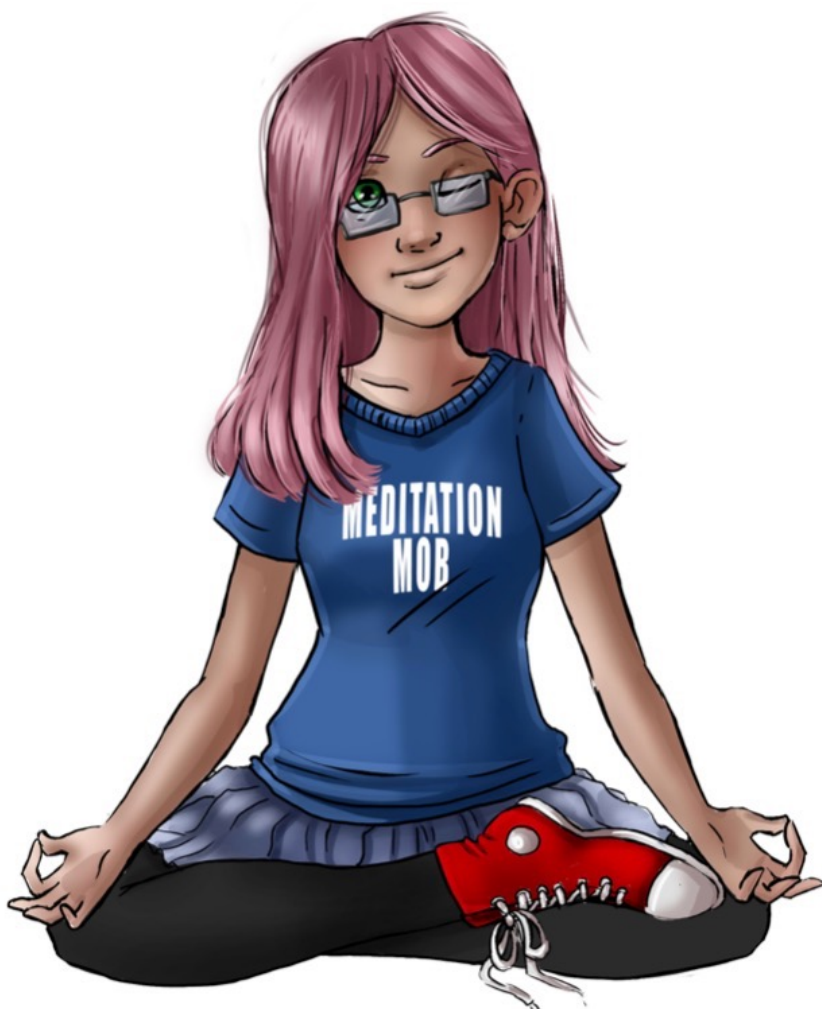
**Tuesdays, 12:00 - 12:50**

Want to learn more about mindfulness meditation? It's a great way to improve your attention and to become more grounded in the present moment.

There's no religious component. We use secular, evidence-based meditation techniques.

We meet in the study room on the **9th floor of Millikan Library**. All students are welcome, from total beginners to experienced meditators.

Mailing list and MP3 archive:  
[counseling.caltech.edu/students/meditation](http://counseling.caltech.edu/students/meditation)





## Walker Assists on 16 Kills at Whittier

**GOCALTECH.COM**  
Actual Sports Content Editor

WHITTIER, Calif. (Sept. 29, 2017) – Sophomore Ellie Walker (Minneapolis, Minn. / Blake School) set her fellow teammates up for 16 kills when Caltech Volleyball traveled to Whittier College on Friday evening.

The 16 assists were a game-high for Walker in 2017. Among the team's two key setters, Walker finished the day with five digs while freshman Krystyna Maruszko (Redondo Beach, Calif. / Marymount), the team's other primary setting option led the Beavers with seven digs.

The Beavers started off the match strong, leading 6-5 in the first set following a service ace from junior Sakthi Vetrivel

(Redmond, Wash. / Overlake School). The Poets proceeded to go on a brief run before Caltech countered with a scoring run of its own. Caltech won nine of the set's final 16 points but ran out of real estate to potentially steal the set. Caltech also started fast in the second set, opening scoring on a 5-3 run following two attacking errors from the Poets. Sophomore Alexa Lauinger (Ortonville, Mich. / Brandon) led the Beavers with eight kills and freshman Christine Yu (Fremont, Calif. / Mission San Jose) followed up with seven kills of her own.

Head Coach Tom Gardner and the Beavers won't have to wait long before returning to action on Saturday, Sept. 30 at home against California Lutheran University.



*I thought this article was going to be a lot darker than it turned out.*

-gocaltech.com

## Como Saves Nine at Whittier

**GOCALTECH.COM**  
Actual Sports Content Editor

WHITTIER, Calif. (Sept. 27, 2017) – Freshman goalkeeper Joe Como (Glen Cove, N.Y. / Friends Acad.) had a busy day in net, turning away nine shots in Caltech's men's soccer clash at Whittier College on Wednesday. Como and the Caltech defense held the Poets scoreless over the game's final 22 minutes.

Sophomore Kevin Yu (Park Ridge, N.J. / Park Ridge) and freshman Charles Thut (Dover, N.H. / Berwick Acad.) each had one shot on goal for the Beavers. Yu also registered a team-high three total shots. The Beavers had their most offensive success in the first half when they pressured the Poets into two corner kicks.

Head Coach Phil Murray and the Beavers will return to action when they travel to Chapman University (3-4-3 overall) on Saturday, Sept. 30 for a 7 p.m. meeting.



*I'm working on a horror movie script, "What Happened at Whittier".*

-gocaltech.com

## Women's XC Bests Four SCIAC Teams at Multi-Duals

**GOCALTECH.COM**  
Actual Sports Content Editor

LOS ANGELES (Sept. 30, 2017) – The Caltech Men's and Women's Cross Country teams competed at the SCIAC Multi-Duals in La Mirada Park on Friday, where the women posted the best overall team finish in program history, beating four SCIAC schools for the first time ever.

"Today showed that we're heading in the right direction, but there's plenty of season left," Head Coach Ben Raphelson said. "Everyone in the conference is focused on using the next four weeks to get better. Our goal is to work hard but also smart and arrive at the Championship Meet a stronger team than we were today."

While the Beavers' last meet in Riverside saw freshman Molly Crotteau (Chicago, Ill. / Payton) lead the team with fellow freshman Claire Hu (Palo Alto, Calif. / Henry M. Gunn) just seconds behind, the two runners reversed roles on Friday, this time with

Hu finishing first (23:03.35) and 18th overall in a field of 119 runners. Crotteau finished 21st, clocking in at 23:16.59. Freshman Krystal Brodsky (Redmond, Wash. / Redmond) placed fourth for Caltech (24:25.07). As for the team's overall finish, the Beavers finished right in the middle of the field, ahead of regionally-ranked Whittier College, the University of La Verne, Chapman University and California Lutheran University.

With the added pressure of going up against a field comprised entirely of other SCIAC schools, the women's team flourished despite imperfect conditions and a comparatively slower course than the one they ran at Riverside.

"The women responded well to the challenge that today presented, Raphelson said. "They really fought for every place and that lead to a pretty sterling result."

Sophomores Jena Srikanth (Fresno, Calif. / Clovis North) and Skye Reese (Concord, N.H. /

Concord) were the only Beavers on either side to set personal bests coming in at . Having had two years to develop under Raphelson, Reese and Srinkrath, both of whom set their previous top times at Riverside, are beginning to see results in addition to their hard work paying off. Freshman Sirisha Gudavalli (Boulder, Colo. / Fairview) and junior Melissa Gutierrez (Pico Rivera, Calif. / El Rancho) rounded out the top seven on the women's side.

"Skye and Jena have both learned a lot when it comes to taking care of their bodies and preventing injuries," Raphelson said. "We're starting to see their true ability now that they're stringing together consistent weeks of training."

The men, facing the more extreme conditions temperature-wise having gone earlier in the day still fared well in the face of SCIAC competition. Sophomore Simon Ricci (Chicago, Ill. / Latin School of Chicago) led the way once again, working his way up through the field to cross the finish line at



*Did I leave the oven on???*

-gocaltech.com

27:09.70, good for 21st out of 113 competitors. Fellow sophomore Tanner Moore (Roseville, Calif. / Oakmont) turned in another steady performance as well, finishing just 21 seconds off of Ricci. Freshman Matthew Earney (San Diego, Calif. / Del Norte) continued his emergence as one of the team's top runners, coming in at 28:31.12. Junior Rohan Choudhury (Cupertino, Calif. / Monta Vista), freshman Davis Tardif (Roswell, Ga. / Roswell) sophomore Bhairav Chidambaram (San Diego, Calif. / Canyon Crest Acad.) and freshman Spencer Morgenfeld (Palo Alto, Calif. / Palo Alto) rounded out the top seven for the Beavers.

"We had many men run solid today, including a large pack that managed to move steadily through the field together," Raphelson said. "That lead to some strong results, but we'll need to tighten up the gaps between our top seven in order for us to meet our goals this season."

Raphelson and the Beavers will have the next two weeks to cool down before participating in the Pomona-Pitzer Invitational where they will be competing against many of the same schools they competed against on Saturday. The meet is scheduled to begin at 7:45 a.m. and the men will be racing first.



## New radio observations show clumps of gas streaming from supermassive black hole

*Continued from page 1*

symmetrical fashion over the course of a year. The same type of event happened again in 2015. After a careful analysis that ruled out other scenarios, the researchers concluded that the overall brightening of the galaxy is most likely due to two successive high-speed clumps ejected by the galaxy's black hole a few years apart. The clumps traveled along the jet and became magnified when they passed behind the milli-lens.

"It has taken observations of a huge number of galaxies to find this one object with the symmetrical dips in brightness that point to the presence of a gravitational lens," says coauthor Timothy Pearson, a senior research scientist at Caltech who helped discover in 1981 that the jet clumps travel at close to the speed of light. "We are now looking hard at all our other data to try to find similar objects that can give a magnified view of galactic nuclei."

The next step to confirm the PKS 1413+135 results is to observe the galaxy with a technique called very-long-baseline interferometry (VLBI), in which radio telescopes across the globe work together to image cosmic objects in detail. The researchers plan to use this technique beginning this fall to look at the galaxy and its supermassive black hole, which is expected to shoot out another clump of jet material in the next few years. With the VLBI technique, they should be able to see the clump smeared out into an arc across the

sky via the light-bending effects of the milli-lens. Identifying an arc would confirm that indeed a milli-lens is magnifying the ultra-fast jet clumps spewing from a supermassive black hole.

"We couldn't do studies like these without a university observatory like the Owens Valley Radio Observatory, where we have the time to dedicate a large telescope exclusively to a single program," said Readhead.

Additional authors of *The Astrophysical Journal* studies are: Vikram Ravi of Caltech; Walter Max-Moerbeck (MS '08, PhD '13) and Anton Zensus of the Max Planck Institute for Radio Astronomy; Talvikki Hovatta of University of Turku and the Aalto University Metsähovi Radio Observatory; Anne Lähteenmäki and Merja Tornikoski of the Aalto University Metsähovi Radio Observatory; Mark Gurwell (MS '92, PhD '96) of the Smithsonian Astrophysical Observatory; Roger Blandford of Stanford University; Rodrigo Reeves of the University of Concepción; and Vasiliki Pavlidou of the University of Crete.

The two studies, titled, "Symmetric Achromatic Variability in Active Galaxies: A Powerful New Gravitational Lensing Probe?" and "The Peculiar Light Curve of J1415+1320: A Case Study in Extreme Scattering Events," are funded by NASA, the National Science Foundation, the Smithsonian Institution, the Academia Sinica, the Academy of Finland, and the Chilean Centro de Excelencia en Astrofísica y Tecnologías Afines (CATA).

THEATER ARTS CALTECH PRESENTS

LEARN MORE  
tacit.caltech.edu

CONTACT  
BRIAN BROPHY  
brophy@caltech.edu

she  
kills  
monsters  
a play by qui nguyen

If you are prepared for  
a comedic adventure  
through the worlds of  
Dungeons & Dragons...

ENTER THE FANTASY  
OPEN AUDITIONS  
Saturday, October 7  
11 am – 5 pm at Ramo Auditorium

You chose one of the  
most trusted institutions  
in **SCIENCE**.



Now choose one of the  
most trusted institutions  
in **FINANCE**.



When you want unsurpassed stability, integrity and value for your money, Caltech Employees Federal Credit Union offers an honest alternative. There are no gimmicks. No annual fees. No harsh penalties.

Just some of the lowest lending rates and highest savings rates in the nation... and a state-of-the-art eBranch for easy, convenient online and/or mobile access to your account. We're the overwhelming choice for financial services among the entire Caltech family. If you haven't yet joined, call or visit us online or in person today. You belong here.



**Sm**arter **S**olutions. **Pr**oven **Re**sults.

**Campus Office** 515 S. Wilson Ave. (physical address) • **Campus ATMs** Winnett Center & Keith Spalding Building  
626/395-6300 • 800/592-3328 • [www.cefcu.org](http://www.cefcu.org)

Must qualify for CEFCU membership to join. Minimum \$5 deposit and one-time \$5 membership fee due upon opening any CEFCU account. Federally insured by NCUA.

## ASCIT Minutes

Meetings are every week in SAC 13

### ASCIT Board of Directors Budget Meeting

Minutes for 27 September 2017. Taken by Dana He.

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

**Guests:**

**Call to Order:** 12:13 pm

### President's Report (Sakthi):

- Would like to bring back freshman dinners.
- ASCIT will have table at Club Fair with food. Possibly have social team bake cookies.

### Officer's Reports:

#### V.P. of Academic Affairs (Kavya):

- Course capture fully funded by Vice Provost so no need for ASCIT funding.
- Would like to increase ARC budget to cover general costs (seminars, etc.) and make take professor to lunch twice per term.

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

- Will allow Bechtel focus groups to use some of IHC budget to encourage attendance.
- Could get rid of multi-house event funding and instead have houses apply for funding in slush fund. Will consult with IHC.
- Fleming Feptathalon and Page Trivia Night canceled.

#### Director of Operations (Sara):

- Not in attendance.

#### Treasurer (Sarah):

- Budget needs to be done by September 30<sup>th</sup>, but amount allotted to each specific club can be done later.
- \$14,700 budgeted for clubs last year, but only \$4,000 has been used.
- In favor of having Little t sign up as a club to receive funding.
- Increasing budget for ASCIT Teaching Awards from \$2,500 to \$3,500, as they have historically gone over budget.
- BoC has not used any of their budget, will talk to BoC Chair.
- Will send out email reminding houses about interhouse budget.

#### Social Director (Alice):

- Would like to increase budget for ASCIT formal from \$5,000 to \$15,000. Also gets funding from MHF.
- Would like to do something along the lines of renting out Six Flags, will try to get MHF funding for it.

## Crossword

### Across

- Postage token
- Hit with something flat
- Line made from twisted fibers
- Private instructor
- Expect and wish
- Finished
- Positively charged electrode
- Tall story
- Flock
- Revoke
- Kind of mineral
- Regret
- Sprocket
- Not as heavy
- Extreme excess
- Pasture
- Former currency of Italy
- Animal feet
- Adult male duck
- From a great distance
- Informal photographs
- Desiccated
- Bird shelters
- Genuine
- Make vocal music
- Assistance
- Form a mental image
- Sore

- Small cask or barrel
- Type of tree
- Clean-cut
- Debris
- Hints
- Give off
- Pointer
- Assist in wrongdoing
- Storage tower
- Inexperienced
- Plant with pendulous flowers
- Cook slowly in liquid
- Ire

### Down

- Celestial body
- Melody
- At the peak
- Method
- Deliver a sermon
- Diffident
- Rich soil
- Month
- Writing implement
- Adult male swan
- Open
- Variety show
- Appliance for removing moisture
- Closed circuits
- Matured
- Monetary aid
- Annoy continually

- Scale drawing
- Animation
- Divisions of geological time
- Plaid
- Mindful
- Mettle
- Song for solo voice
- Chess piece
- Boundary
- Cut
- Sieve
- Compulsory force or threat
- Tropical lizard
- Part of a corolla
- Form of legal defense
- Urge or force
- Restrict or confine
- Unit of length
- Food from the husks of cereal grains
- Two-masted sailing vessel
- Score of zero in squash
- Pitcher
- Pig pen
- Drag behind

1	2	3	4	5		6	7	8	9		10	11	12	13
14						15					16			
17						18					19			
20					21		22			23		24		
				25		26		27			28			
29	30	31	32				33		34					
35					36			37		38		39	40	41
42					43				44		45			
46				47		48					49			
			50		51		52			53				
54	55	56				57		58						
59				60			61		62		63	64	65	66
67			68		69			70		71				
72					73					74				
75					76					77				



Local cat owner attempts putting cat's face in bread



Answers to current crossword (pg 7)

R	E	G	N	A	W	E	S	L	L	L
E	V	I	N	O	S	I	L	T	B	B
W	R	R	A	R	M	E	S	P	S	T
E	B	B	R	U	M	R	I	T	M	E
			G	K	E	L	F	N	F	P
E	G	A	S	V	E	N	D	A	I	
G	S	I	N	E	T	R	S	T	S	N
D	A	R	I	S	P	A	S	N	A	R
E	A	K	D	R	A	S	P	A	W	L
			E	A	L	E	A	R	H	P
R	E	R	T	H	L	I	G	C	O	
E	R	U	E	A	C	A	M	L	E	P
Y	B	E	V	N	A	R	N	E	D	A
R	O	V	E	R	P	E	H	O	R	T
O	R	D	C	O	P	S	L	A	P	S

-<http://puzzlechoice.com>

### The California Tech

**Editors-in-Chief**  
Jon Cotler  
Katherine Guo

**Page Editors**  
Noelle Davis  
Ramya Deshpande  
Tanvi Gupta  
Maitreyi Nair  
Rona Yu

**Contributing Writers**  
Tim Liu  
Richard Zhu

**Circulation Manager**  
Mason MacDougall

**Advisor**  
Richard Kipling

Caltech 40-58, Pasadena, CA 91125  
Contact [tech@caltech.edu](mailto:tech@caltech.edu)

*The Tech* is published weekly except during vacation and examination periods by the Associated Students of the California Institute of Technology, Inc. The opinions expressed herein are strictly those of the authors and advertisers.

Letters and submissions are welcome; e-mail submissions to [tech@caltech.edu](mailto:tech@caltech.edu) as plain-text attachments, including the author's name, by Friday of the week before publication. *The Tech* does accept anonymous contributions under special circumstances. The editors reserve the right to edit and abridge all submissions for any reason. All written work remains property of its author.

The advertising deadline is 5 p.m. Friday; all advertising should be submitted electronically or as camera-ready art, but *The Tech* can also do simple typesetting and arrangement. All advertising inquiries should be directed to the business manager at [tech@caltech.edu](mailto:tech@caltech.edu). For subscription information, please send mail to "Subscriptions."

The California Tech  
Caltech 40-58  
Pasadena, CA 91125