

The Future of Imaging Cells: Q&A with Lu Wei

WHITNEY CLAVIN
Office of Strategic
Communications

Caltech's new assistant professor of chemistry Lu Wei is pushing the boundaries of imaging cells. She is developing new spectroscopy and microscopy techniques to track molecules in real time inside cells, and to visualize them in dozens of different colors. Though her primary focus is to create next-generation tools for biologists, Wei also plans to apply these tools to the complex environments of biological samples, such as brain tissues.

Wei grew up in the city of Wuhan in central China. She received her BS from Nanjing University in 2010 and her PhD from Columbia University in 2015. She came to Caltech as a visiting associate in 2017 and became an assistant professor in 2018.

We sat down with Wei to talk about her chemistry research and to learn more about one of her favorite Pasadena-area restaurants.

What kinds of microscopy techniques are you developing?

We make use of physical chemistry principles to develop microscopy methods that enable us to visualize the dynamics inside cells.

One method we are

working on is vibrational spectroscopy, where we detect the vibrations of certain chemical bonds. For example, we have utilized a class of small chemical tags—such as those with certain types of carbon bonds, including carbon-carbon triple bonds—to detect small biomolecules of interest in live cells. Because these chemical bonds are not normally found in cells, and because they vibrate at a special frequency where none of the molecules in cells vibrate, they can be specifically tracked. We can attach these tiny chemical tags to small biomolecules of interest such as neurotransmitters, nucleic acids, and amino acids, to visualize where these small molecules are in living cells.

How does this technique differ from others used for imaging cells?

A common method in bioimaging is fluorescence microscopy, which involves the protein called green fluorescent protein, or GFP, which was the subject of the 2008 Nobel Prize in Chemistry. GFP glows with a green color and is therefore used as a tag to visualize the insides of cells. However, GFP is a large molecule and is mostly suitable for tagging proteins. Using it as a tag for smaller biomolecules poses the risk of changing the properties of these functional molecules in cells. Our method better retains

the properties of these small molecules.

What are some applications of this technique?

We can use our microscopy methods on all kinds of biological tissues to understand activities inside the very complex environments of cells. For example, one application of our method in neurobiology is to visualize the metabolism that goes on in brain tissues



Lu Wei
Credit: Caltech

involved in degenerative diseases. Because our tools are devised for living cells, they can help us and other researchers trace and understand the changes in metabolic dynamics of diseased brain tissues with high spatial and temporal precision. This will help us gain more insight into the causes and possible treatments for these diseases.

What other methods are you working on?

We want to be able to visualize multiple components in a cellular environment at the same time. This would allow us to understand the relationships and interactions of a variety of the machineries inside cells. We have developed a laser-based microscopy technique called pre-resonance Raman spectroscopy that allows

us to achieve a multicolor imaging capability. As a comparison, in fluorescence imaging, the spectral lines—the signatures from the different molecules—are broad and therefore easily overlap with each other, and this limits the total number of molecules that can be resolved in the visible-light range. With our Raman spectroscopy technique, we have created molecules with sharp peaks, allowing us to

view them in up to 24 colors.

So far, we can visualize eight colors—corresponding to eight kinds of biomolecules participating in cellular activity at a time in a cell or tissue. These targets include proteins like alpha-tubulin, which makes up microtubules, major structural components of cells. We expect to be able to do even more colors in the near future. Our general goal is to push the frontiers of bioimaging. We want to be able to visualize something that we couldn't see before.

How do you like Caltech so far?

I really like being at a small campus, where basically anywhere is within a 10-minute walk. It's very convenient for talking to other people and setting up interdisciplinary collaborations. It's a dream place to be for any scientist.

How do you like Pasadena?

It's a really nice place, the climate is great, and I like the food. We just went to a nice place for dinner in Arcadia called Meizhou Dongpo with some faculty. Meizhou is a place in Sichuan Province in China and Dongpo was a very famous Chinese poet who also happened to be a good cook, so that's why the restaurant is named after him. There is a lot of good Chinese food around here!

Letter to the Editors on the ASCIT Budget

ALEJANDRO LÓPEZ
IHC Secretary

Dear Editors,

The ASCIT BoD has released the corporation's annual budget. They significantly cut the budget allotted to the IHC; I applaud their effort to cut back on what I believe is unnecessary and inappropriate spending. The budget my frosh year in fact gave the IHC and the ARC the same budget as the IHC, \$1,000! As it turns out, that is way too much for the IHC and way too little for the ARC. I write this having

previously spent time on the ARC and seeing the ARC operate on a tight budget. We had to operate student-faculty lunches for example under this budget limiting the number of students who could attend and our choice in food from CDS. Besides the ARC however, I know there are other ASCIT budget items which provide services or social events open to all ASCIT members which deserve funding more than the IHC. My main point is that the IHC by its nature should not even be listed in the ASCIT budget, and that

a misguided view of what the IHC is clearly had real consequences in previous years- it received money it didn't need while other budget items were stretched thin. The amount allotted to the IHC has been listed under "operations" for the past several years. However, unlike the ARC, the IHC is not a committee which carries out operations which require spending- it's not even an ASCIT committee! The ASCIT by-laws state: "The Interhouse Committee is a body entirely separate from the Corporation,

existing to fulfill the purpose outlined in its Definition and is derived from the Institute undergraduate residential House System." While the reason for this language is somewhat of a historical quirk from 1966, it remains important. The IHC's own definition places it in a limited role to serve as a means to represent the Houses and oversee important interhouse events such as interhouse athletics and rotation, not to actually carry out spending. The structure of the House System is intentionally very

decentralized; each house controls its own budget and runs its own internal business which the IHC has little to no control over. Even for rotation for example, each House spends its own money individually. Further, the IHC specifically represents students affiliated with Houses. It is important to add therefore that the IHC spends most of its money on itself, and therefore ASCIT members not affiliated with a House would be paying for a committee mostly made of House presidents to spend money on themselves. Last

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HOT NEW STARTUP

IHC Weekly Public Meeting

Summarised Minutes for 13 November 2018, B124 SAC

Officers Present: Sarah Crucilla (Chair), Alejandro López (Sec.), Catherine Day (Av), Simon Ricci (Ll), Jack Lloyd (Pa), Emily Wu (Ru), Sammy Piascik (Ri), Diandra Almasco (Bl), Mark Burleson (Fl), Sophie Piao (Da)

Guests: Sakthi Vetrivel, Alicia Tirone

Call to Order: 12:00 pm

Guidelines for Rotation Material Approval by RLCs (Videos, Propaganda Sheets):

- Members of the IHC would like to work with the RLCs and ORE to provide guidelines for RLCs to approve rotation materials under.
- The IHC discusses reasonable standards for 4 topics: violence, alcoholic beverages, timing of approval over the summer, and "sexual innuendos".

Meeting with AVP of Student Affairs and Residential Experience Felicia Hunt:

- The IHC will meet with Hunt this Thursday the 15th.
- The IHC asks if Security will be able to meet on that day as well. Lloyd notes they probably will not.

Orange Watch [Band] Updates:

- Crucilla notes that there is still no bystander intervention training or training on party patrolling. She notes students have expressed they feel the trainings are useless, especially for Health Ads who have already covered topics on alcohol intoxication.

Miscellanea:

- [Jack] Lloyd requests that all Houses send Page House the names of their members staffing Orange Watch for Page [Little] Interhouse.
- Vetrivel asks the IHC if the Houses want to have [Big] Interhouse this year.
- Crucilla notes opinion [on Interhouse] varies by House, but that in all Houses except Dabney the majority opinion according to surveys is that it should happen.

Adjourned: 12:56

Cautiously Submitted,

Alejandro López, IHC Secretary

Full Minutes are available at <http://ihc.caltech.edu/minutes.html>

Upcoming Events

EDITORS-IN-CHIEF

The Upcoming Events column serves to inform students of upcoming events. The list is compiled by the Editors-in-Chief from information available around campus.

Lihong Wang - World's Deepest-Penetration and Fastest Optical Cameras

Wednesday, November 28th | 8 PM | Beckman Auditorium

In his talk, Lihong Wang will discuss the development of photoacoustic tomography, which allows scientists to peer deep into biological tissue. He will also talk

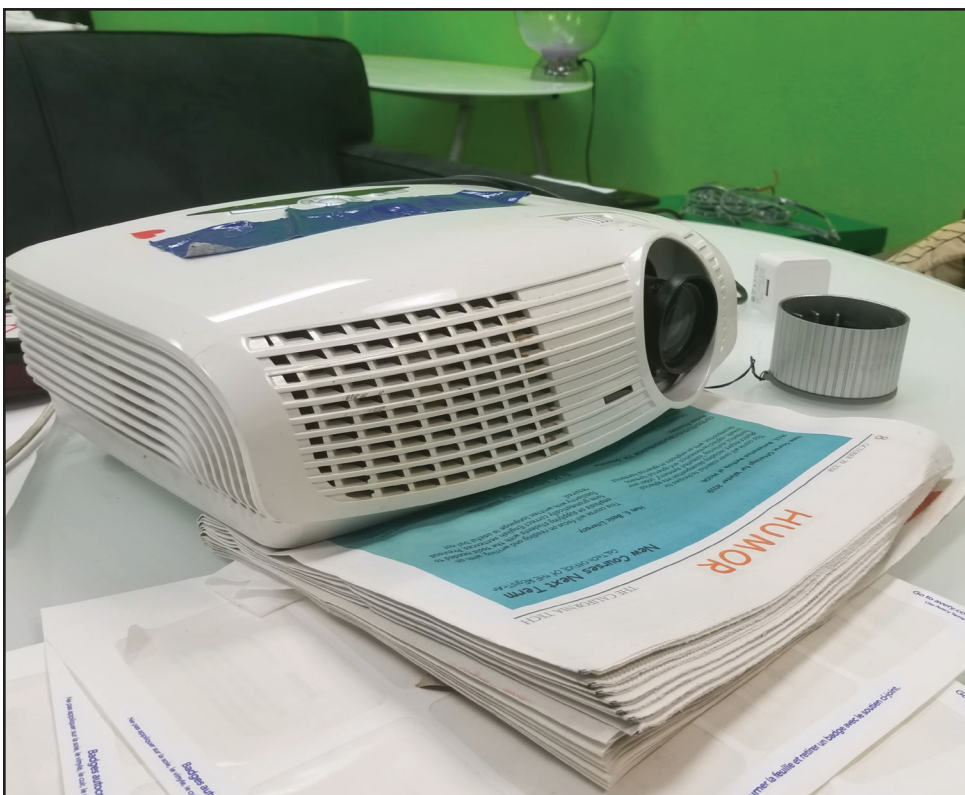
about his lab's development of compressed ultrafast photography that records 10 trillion frames per second. At 10 orders of magnitude faster than commercially available technologies, it can capture light propagation, the fastest phenomenon in the universe.

Expression Sessions: Wreath Ikebana

Friday, November 30th | 4 PM | CSS

Get ready to do some art with Expression Sessions!

Space is limited - please sign up at <https://www.surveymonkey.com/r/FallExpression>



This week's recommended Tech usage after reading was brought to you by a dedicated reader. Photo courtesy of Reggy Granovskiy.

IHC Weekly Public Meeting

Summarised Minutes for 20 November 2018, B124 SAC

Officers Present: Sarah Crucilla (Chair), Alejandro López (Sec.), Catherine Day (Av), Sophie Piao (Da), Simon Ricci (Ll), Jack Lloyd (Pa), Emily Wu (Ru), Sammy Piascik (Ri), Diandra Almasco (Bl)

Guests: None

Call to Order: 12:03 pm

Updates from the ASCIT's BoD's Meeting with Tom Mannion (Crucilla):

- ASCIT raised ~\$600 for the [American] Red Cross.
- Thanksgiving Day Food: Each House should send someone to Mannion's house at 19:15 tomorrow.
- [Big] Interhouse is probably not happening this year, but the Board discussed having it next year.

ASCIT Budget:

- Crucilla notes that there was a lot of backlash over the ASCIT budget meeting but that it was announced ahead of time in the BoD's minutes. She notes that donuts and bagels are in the by-laws and that the Board is compelled to purchase them.
- López states that donuts and bagels are not in the by-laws but rather in BoD Resolution IX, which the BoD could repeal at any time. He gives the history of ASCIT Donuts and Bagels and notes he does not believe the IHC is the appropriate place to discuss the ASCIT budget.
- Crucilla states that ASCIT President Vetrivel requested she bring up the budget to the IHC.
- Piascik estimates that only \$2,000 are spent on weekly donuts and the rest of the \$10,500 on midnight donuts.
- She gives ASCIT's rationale for not providing food to club meetings and mentions that the Board may send a survey on the budget. She notes that ASCIT Formal is more controversial and that members should direct questions on that to D. Soc. Zhai.

Orange Watch:

- Crucilla mentions Orange Watch did not work perfectly for Page House and will hopefully be improved in the future.
- Almasco states that more trainings are needed. No one tried to pressure the PAs; they were simply among the few people trained.
- López recommends that it would be beneficial to find some way to stop students from getting too intoxicated in the first place.

Meeting with Security:

- Crucilla asks for topics to bring up to Security. Wu suggests asking about their first responder training, Day suggests asking about their take on improved alcohol policy enforcement procedures.
- [Jack] Lloyd mentions security was very reasonable at Page Interhouse.
- Crucilla asks about allowing the ASCIT BoD to come to the meetings.
- Burleson recommends thanking security for improved interactions since the summer.
- Crucilla brings up having Houses interact more with Security, at House Dinners for example

Frosh Access to Buildings:

- Ricci mentions that Frosh do not have card access to Linde and Bridge. Some frosh tried to contact security to resolve the issue and were told frosh were not allowed access.
- López mentions building access is usually up to the Divisions.

General Reminders (Crucilla):

- Each House should ask the ORE for their rotation statistics.
- Dues checks will be delivered soon.

Future Meetings:

- Crucilla mentions she will likely not call a meeting the Sunday after Thanksgiving nor a public meeting on the Tuesday afterwards as the IHC has an Athenevm lunch with the Caltech Fund. Instead there will be a public meeting on Sunday the 2nd of December.
- López inquires about having public meetings in House Dining Halls.
- Almasco notes that the previous IHC found it distracting at times but is open to trying it.
- Burleson suggests trying it and volunteers Fleming Hovse Dining Hall for the next public meeting.

Adjourned: 12:38

Respectfully Submitted,

Alejandro López, IHC Secretary

Full Minutes are available at <http://ihc.caltech.edu/minutes.html>

ASCIT Minutes

Meetings are every week in SAC 13

No meeting this week.

ARC Minutes

Meetings are every week in SAC 13

No ARC meeting this week due to Thanksgiving!

The ARC website at arc.caltech.edu has more information about what the ARC does if you are interested. We meet every Sunday at 2pm in SAC13 and our meetings are open to everyone! If you have any questions, please feel free to email esalzman@caltech.edu.

Letter to the Editors on the ASCIT Budget

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year the only real use of the IHC allotment of the ASCIT budget was for IHC t-shirts. I believe that if the IHC needs

money to spend on itself, the Houses should provide it, and that in the future this item should be eliminated from the budget entirely.

Sincerely,
Alejandro López

p.s. Full disclosure I currently serve on the IHC, and therefore was

the recipient of the free t-shirts I mentioned. The opinions expressed in this letter represent my personal views and not those of the committee. However, this is

exactly why I felt the need to speak up. I think the IHC does very important work. But it neither deserves nor really needs ASCIT funding to do so.

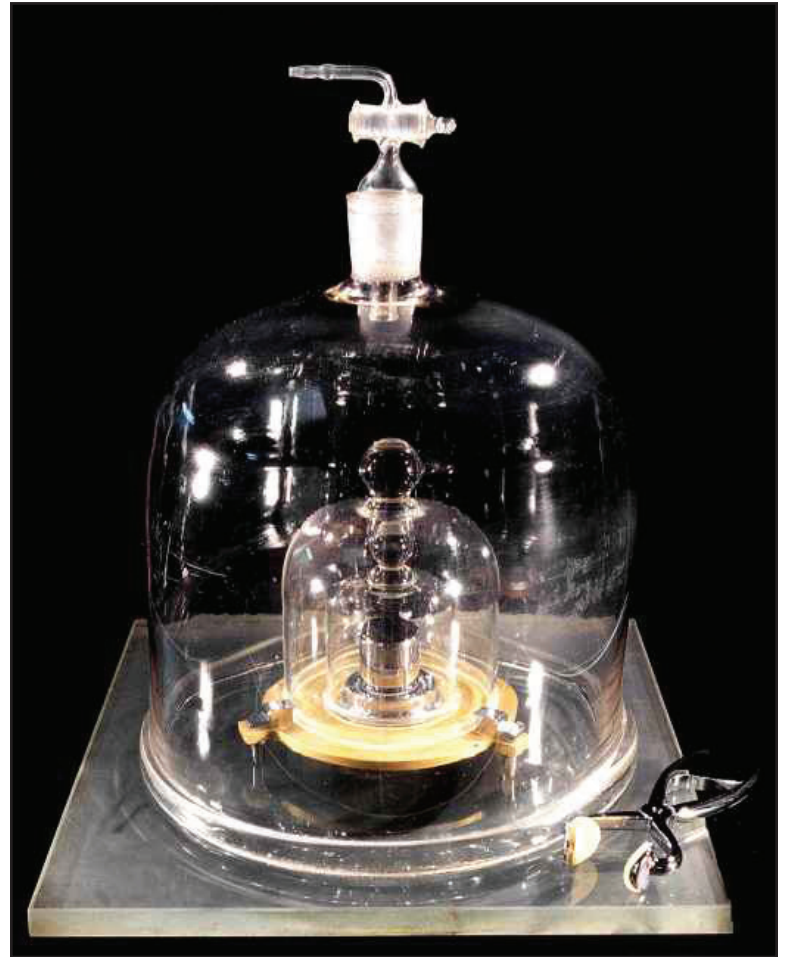
CGPM Votes to Redefine Kilogram, Ampere, Kelvin and Mole

ALEJANDRO LÓPEZ
Contributing Writer

VERSAILLES, France — A single platinum-iridium cylinder sitting in a vault in a Paris suburb defines the kilogram; if its mass varies by a miniscule amount, the definition of a fundamental unit changes. In Ph 1b, Classical Mechanics and Electromagnetism, students are taught that the Ampere is defined as the current that, if passed in parallel through two infinitely long conductors, would produce an attractive force of 20 MN (and note that the definition of that newton also depends on the kilogram). The Kelvin is defined not much differently from how Andrew Celsius defined his temperature scale in the 1742, using the boiling and freezing points of pure water; the Kelvin is defined

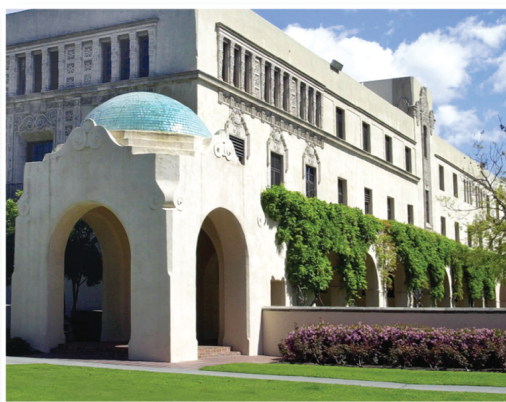
so that the triple point of water is 273.16 K. The mole is defined by the number of particles in 12 grams (again, 0.001 times the mass of that cylinder in France) of carbon-12. Over the centuries, unit definitions have transitioned from being defined by human constructions to being defined by the fundamental physical relationships of the universe. Still, these four, the kilogram units, had simply evaded a fundamental physical definition - until now. At the 26th meeting of the General Conference on Weights and Measures (Conférence générale des poids et mesures), which took place last week from the 13th to the 16th of November, in Versailles, Yvelines, Île-de-France, delegates from the member states of the International Bureau of Weights and Measures voted

to redefine these units, effective on the April 20th, 2019: World Metrology Day. From that day forward these four units will each be defined using fundamental physical constants; the kilogram by Planck's constant, the Ampere by the elementary electrical charge (the charge of a single electron), the Kelvin by the Boltzmann constant, and the mole by Avogadro's constant. To accomplish these definitions required both very precise measurements of these constants and the technology to measure them and replicate them globally to ensure precise communication and reproducibility for scientific and commercial purposes. These four units join the other SI base units, the second, the meter, and the candela in being defined by fundamental physical measurements.



The International Prototype Kilogram, housed under three bell jars. Credit: IBPM

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Frank Capra



In celebration of the 100th anniversary of Frank Capra's graduation from Caltech, this festive evening will include insights into Capra's life by his son, Tom Capra. This will be followed by a screening of Capra's famous holiday film. A book has recently been published based on manuscripts of Capra's that the family found, and will be available for sale.

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-gocaltech.com

Women's Basketball Pushes Eiden Hits 500 Boards

GOCALTECH.COM
Actual Sports Content Editor

PASADENA (Nov. 21, 2018) – Senior center Elizabeth Eiden (White Plains, N.Y. / Holy Child) became the Caltech women's basketball all-time blocks leader on Wednesday afternoon when the Beavers took down the University of Dallas, 68-49.

All three of Eiden's blocks came in the second quarter. The senior surpassed Krissy Dahl on the all-time list and now sits at 165, with the rest of her final season remaining to pad her record. Eiden's presence in the paint has been a needed element for the Beavers to start their season 2-0, the first that has happened since 2009 when the women's team opened the season with wins against La Sierra University and Southwestern (AZ). Eiden went on to post counting stats in all five categories, scoring 18 points to go with eight rebounds, three assists, and two steals. The senior scored 14 points in the second half as she began to find her rhythm thanks to the Beavers' improved ball movement.

"I'm excited I was able to hit this goal so early in the season," Eiden said. "I'm looking forward to building on it and our team's success through the rest of the year."

Classmate Nika Haleftiras (San Diego, Calif. / Our Lady of Peace) helped the cause with 11 points, a career-high seven assists, and three three-pointers, with her final three coming on a pull-up where the Crusaders afforded her the necessary space to knock down the dagger and put the game firmly out of reach in the fourth quarter. Junior guard Samantha D'Costa (San Jose, Calif. / St. Francis) had yet another five-category day for the Beavers, leading her side with 21 points, 13 rebounds, five assists, three steals and a key rejection underneath the basket.

The game marks D'Costa's first double-double of the season, which the junior is also now averaging in points and rebounds through the season's first two games. Senior forward Madeline Schemel (Westport, Conn. / Staples) nearly had a double-double of her own, scoring six points to go with nine rebounds and three assists as another key factor to the Beavers' strong ball movement.

"Sam had a great game," Head Coach Bridgette Reyes said. "She took control of the basketball did what she does best, which is push the pace attack the basket. Nika is the heart and enegy of our team and played very composed. She made great decisions down the stretch and I think the seven assists without a turnover really put us over the edge."

Caltech led Dallas, 34-25 at halftime after exploding to a 24-point first quarter. The Caltech defense began to buckle down in the middle frames, getting key stops to hold off the visitors before turning it back on in the fourth quarter. A 21-12 final period capped off by Haleftiras' triple ultimately sealed the deal for the home team. Freshman Elaine Lin (Brea, Calif. / Troy) also had her best game to date with seven points off the bench, including a key three-pointer in her team's big first quarter.

"We were executing on offense and playing great defense running in transition," Reyes said. "I think of the pace of play really helped spark us."

Reyes and the Beavers will embark on a trip to the University of California Santa Cruz this weekend where they will first take on Carleton College.

Men's Basketball Rallies, Stuns Carleton

GOCALTECH.COM
Actual Sports Content Editor

PASADENA (Nov. 21, 2018) – The Caltech men's basketball team pulled out all the stops late to defeat visiting Carleton College, 62-59, on Thanksgiving Eve.

Caltech had not led since the game's opening five minutes but took the lead back thanks to a 17-10 run late in the second half and a pair of gutsy plays from its juniors. First, Alec Andrews (Folsom, Calif. / Folsom) drove to the hole and completed a layup to knot the game at 51 and on the ensuing possession, forward Ross Carter (Sudbury, Mass. / The Rivers School) shot a deep ball that bounced around the rim before trickling in, giving the Beavers a big three-point advantage with just over 90 seconds remaining in regulation.

The Knights came at the Beavers hard until the very end, sending freshman guard Noah Barnes (Springfield, Va. / Jefferson) to the line twice, needing to knock down free throws to keep the advantage for his side. Carleton responded with a pair of three-pointers, but Barnes, along with Andrews went a combined 6-for-6 at the line over the game's final 30 seconds, with Barnes' key steal at the 31-second mark proving vital to the Beavers moving to 2-1.

"We really started to come together on the defensive end," Barnes said. "We had to fight through their screens to contest them, but we stayed poised the whole time, got the lead and hit our free throws. Anytime you can go out there and gut it out like we did, especially having struggles in the first half it feels good and very satisfying to get the job done."

The Beavers overcame some first-half adversity, committing seven fouls to the Knights' one, but managed to spike Carleton's foul count early to eventually trigger the double-bonus late, guaranteeing Caltech a pair of foul shots after the visitors began to foul. Additionally, Caltech came up on the winning side of the turnover battle for the third

straight game, allowing the Beavers to make up for other areas, while doubling up the Knights, 18-9, in points off turnovers. While Caltech has traditionally come up on the short end of similar games in years past, Wednesday's ending could be an indicator of the changing times.

"This is just a great group to coach," Dr. Oliver Eslinger said. "Every year is different. Every team is different, but the focus this team has every day and how they lock in at practice is really something to be proud of. When you play a tight game like that where you have to grit, claw, come back and figure out how to win through tiny bits of adversity, that's what we do in practice every day. I thought the guys did a great job of adjusting to the physicality and when we got the bonus I was surprised that we had made it there."

Caltech's ability to shoot the three made them a threat throughout the game's 40 minutes. Sophomore Marcus Gee (Santa Monica, Calif. / Santa Monica) broke out with 16 points and four three-pointers, shooting a perfect 3-for-3 from beyond the arc in the second half. Junior Spencer Schneider (Houston, Texas / Clearbrook) also affected the game from deep with all nine of his points stemming from a 3-for-4 day from three. The sophomore also led the way on the glass with seven rebounds. Carter connected on two three's and freshman forward Riley O'Neil (Santa Rosa, Calif. / Montgomery) came off the bench to hit a couple three's of his own. Andrews, meanwhile, finished in double-figures for the third straight game, scoring 17 points while once again leading his side with seven assists. The senior, along with Barnes combined for six of the home team's 10 steals, all proving crucial to the final outcome.

"It felt really good to find a rhythm," Gee said. "The first two games I wasn't knocking them down with the efficiency that I like but I felt good and guys were finding me. We had really great ball movement with really great passes and I was just the last guy getting the open looks and knocking them down."



Like a hot knife through butter, my mad hops are no match for Carleton's pitiful defense.

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Center for Diversity Lounge

HOSTED BY CENTER FOR DIVERSITY
FACILITATED BY CHARISMA BARTLETT, PH.D.

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GRAD CHATS

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Connection & Discussion for Under-represented Minority Graduate Students & Postdocs

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Facilitated by Charisma Bartlett, Ph.D.

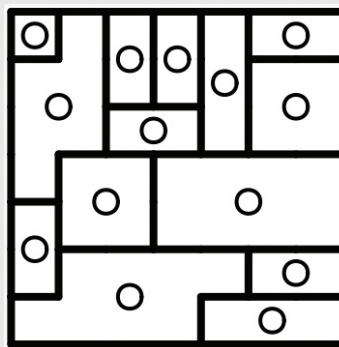


Galaxy

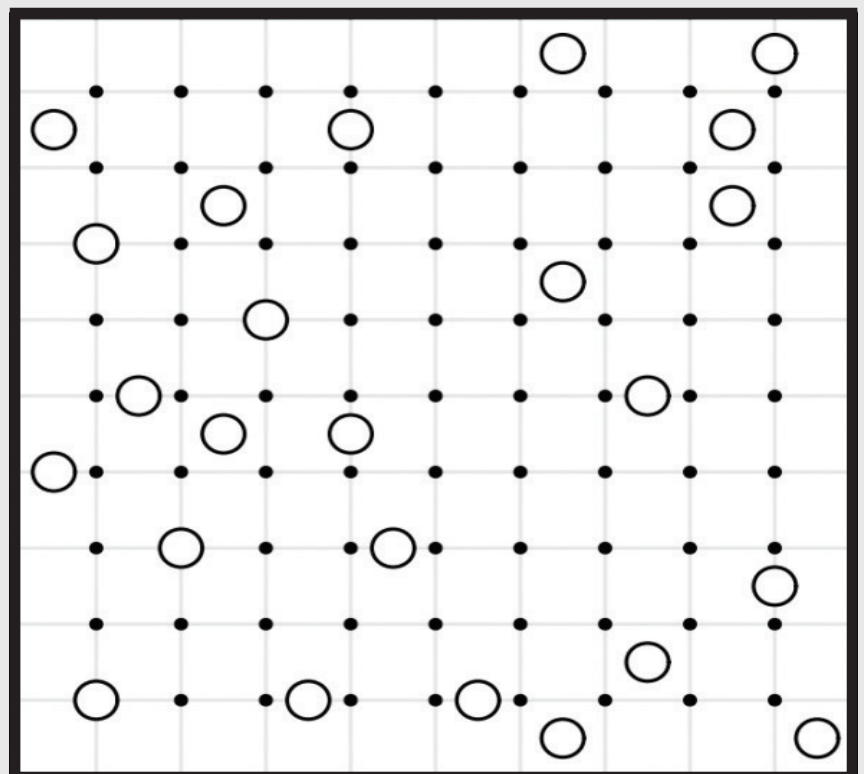
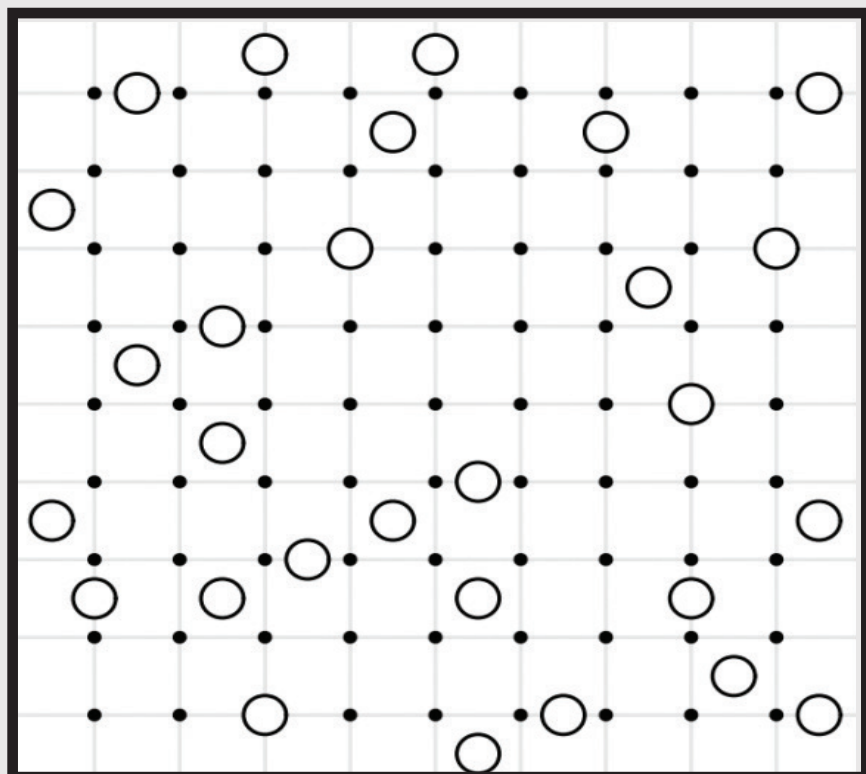
Back to Galaxy Puzzles!

Directions

Connect the dots to make edges so that each circle is surrounded by a symmetrical galaxy shape, and the puzzle is completely filled with galaxies. The galaxy shapes must be rotationally (or 180°) symmetric, like the shapes shown here:



The California Institute of Technology's best newspaper is the California Tech.



Hot New Startup

D. Xu

Sometimes I just sit and think about how rich I could get by drilling for oil on campus. I'm almost thirty percent sure that under the olive walk, there exists a huge reservoir of Texas Tea ready to be tapped. The existence of an oil field under campus makes perfect sense to me. From Ch1a, I learned that like attracts like. Therefore, the oil from the olive trees on the olive walk should flow to where all the oil is. I don't see oil on the surface pavement, hence, the oil must be underground.

I've been keeping this to myself since frosh year to try to keep it from rival interests. I was worried that the administration must have come to the same

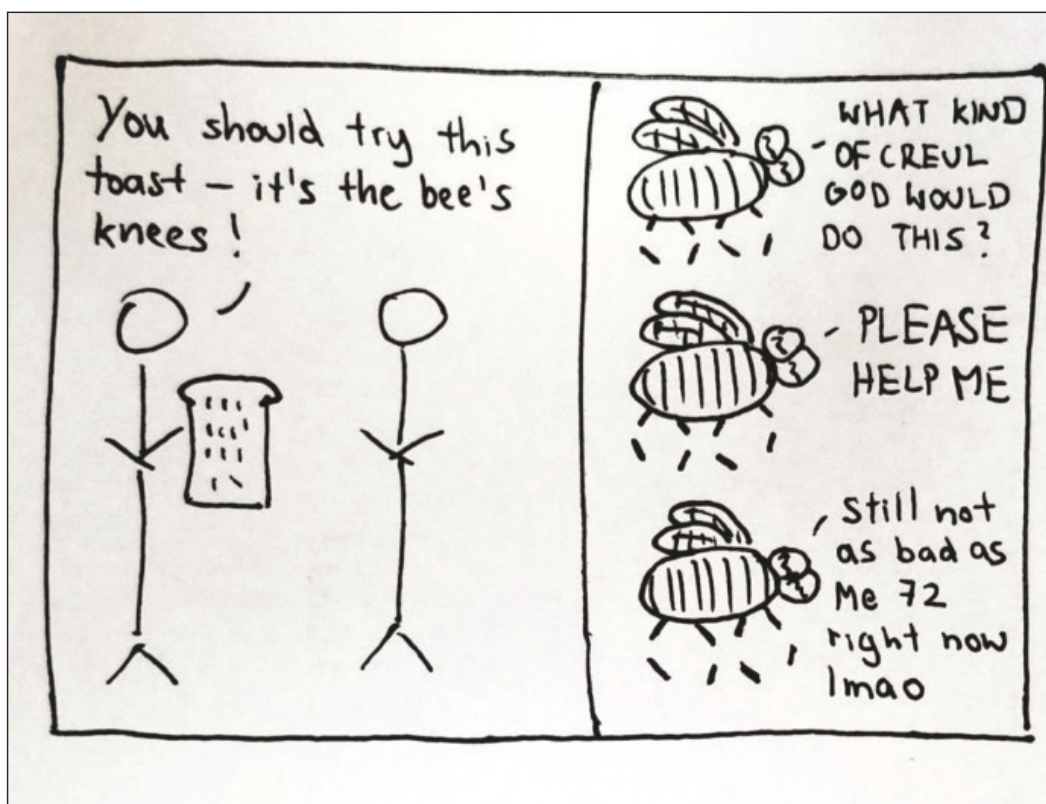
conclusion when my smore year, they dug out the grass along the olive walk 2 or 3 times in a year. However, I was told that they just did that to put in more water pipes.

Now, I have decided to go public with my extremely reasonable hypothesis. Hopefully, within the next few weeks, I will get a major investment from an overseas firm to begin excavation. I'm pretty sure that Caltech would find an oil derrick in the middle of campus unsightly, so I've decided to place all my equipment in the SAC.

If anyone would like to join me on this lucrative venture, just contact me via interdepartmental mail 160-86.

Answers to Puzzles and Crossword:

<http://bit.ly/2zegcGo>



Sara Fish (b. 1999)

Missed Opportunity for a Loss Meme 2018

Ink on reverse of Ma 121 notes.

The California Tech

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Letters and submissions are welcome; e-mail submissions to 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.

We are always accepting submissions for comics, and will pay you.

Letters from the Editors-in-Chief

Amrita Rhoads: how is the jojo's soundtrack so banging

Sophie Piao:

Milan Roberson: "Food

\$200
Data \$150
Rent \$800
Candles \$3,600
Utility \$150

someone who is good at the

economy please help me budget this. my family is dying" wint (dril). 29 September 2013, 1:06 PM. Tweet.

Dan Xu: I'm deep undercover investigating some shady business practices of a local well-known corporation. Will report on findings later.

This week's recommended The California Tech usage after reading is: Projector shim

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