The California Tech

VOLUME CXIX NUMBER 14 PASADENA, CALIFORNIA TECH@CALTECH.EDU JANUARY 25, 2016

Caltech researchers find evidence of a real ninth planet

KIMM FESENMAIER
Caltech Media Relations

This article was originally published online at caltech.edu.

Caltech researchers have found evidence of a giant planet tracing a bizarre, highly elongated orbit in the outer solar system. The object, which the researchers have nicknamed Planet Nine, has a mass about 10 times that of Earth and orbits about 20 times farther from the sun on average than does Neptune (which orbits the sun at an average distance of 2.8 billion miles). In fact, it would take this new planet between 10,000 and 20,000 years to make just one full orbit around the sun.

The researchers, Konstantin Batygin and Mike Brown, discovered the planet's existence through mathematical modeling and computer simulations but have not yet observed the object directly.

"This would be a real ninth planet," said Brown, the Richard and Barbara Rosenberg Professor of Planetary Astronomy. "There have only been two true planets discovered since ancient times, and this would be a third. It's a pretty substantial chunk of our solar system that's still out there to be found, which is pretty exciting."

Brown notes that the putative ninth planet — at 5,000 times the mass of Pluto — is sufficiently large that there should be no debate about whether it is a true planet. Unlike the class of smaller objects now known as dwarf planets, Planet Nine gravitationally dominates its neighborhood of the solar system. In fact, it dominates a region larger than any of the other known planets — a fact that Brown said makes it "the most planet-y of the planets in the whole solar system."

Batygin and Brown describe their work in the current issue of the Astronomical Journal and show how Planet Nine helps explain a number of mysterious features of the field of icy objects and debris beyond Neptune known as the Kuiper Belt.

"Although we were initially quite skeptical that this planet could exist, as we continued to investigate its orbit and what it would mean for the outer solar system, we become increasingly convinced that it is out there," said Batygin, an assistant professor of planetary science. "For the first time in over 150 years, there is solid evidence that the solar system's planetary census is incomplete."

The road to the theoretical discovery was not straightforward. In 2014, a former postdoc of Brown's, Chad Trujillo, and his colleague Scott Sheppard published a paper noting that 13 of the most distant objects in the Kuiper Belt are similar with respect to an obscure orbital feature. To explain that similarity, they suggested the possible presence of a small planet. Brown thought the planet solution was unlikely, but his interest was piqued.

He took the problem down the hall to Batygin, and the two started what became a year-and-a-half-long collaboration to investigate the distant objects. As an observer and a theorist, respectively, the researchers approached the work from very different perspectives — Brown as someone who looks at the sky and tries to anchor everything in the context of what can be seen, and Batygin as someone who puts himself within the context of dynamics, considering how things might work from a physics standpoint. Those differences allowed the researchers to challenge each other's ideas and to consider new possibilities. "I would bring in some of these observational aspects; he would come back with arguments from theory, and we would push each other. I don't think the discovery would have happened without that back and forth," said Brown. " It was perhaps the most fun year of working on a problem in the solar system that I've ever had."

Fairly quickly Batygin and Brown realized that the six most distant objects from Trujillo and Sheppard's original collection all follow elliptical orbits that point in the same direction in physical space. That is particularly surprising because the outermost points of their orbits move around the solar system, and they travel at different rates.

"It's almost like having six hands on a clock all moving at different rates, and when you happen to look up, they're all in exactly the same place," said Brown. The odds of having that happen are something like 1 in 100, he said. But on top of that, the orbits of the six objects are also all tilted in the same way—pointing about 30 degrees downward in the same direction relative to the plane of the eight known planets. The probability of that happening is about 0.007 percent. "Basically it shouldn't happen randomly," Brown said. "So we thought something else must be shaping these orbits."

The first possibility they investigated was that perhaps there are enough distant Kuiper Belt objects — some of which have not yet been discovered—to exert the gravity needed to keep that subpopulation clustered together. The researchers quickly ruled this out when it turned out that such a scenario would require the Kuiper Belt to have about 100 times the mass it has today.

That left them with the idea of a planet. Their first instinct was to run simulations involving a planet in a distant orbit that encircled the orbits of the six Kuiper Belt objects, acting like a giant lasso to wrangle them into their alignment. Batygin said that almost works but does not provide the observed eccentricities precisely. "Close, but no cigar," he said.

Then, effectively by accident, Batygin and Brown noticed that if they ran their simulations with a massive planet in an anti-aligned orbit—an orbit in which the planet's closest approach to the sun, or perihelion, is 180 degrees across from the perihelion of all the other objects and known planets — the distant Kuiper Belt objects in the simulation assumed the alignment that is actually observed.

"Your natural response is 'This orbital geometry can't be right. This can't be stable over

Continued on page 7

This artistic rendering shows the distant view from Planet Nine back towards the sun. The planet is thought to be gaseous, similar to Uranus and Neptune. Hypothetical lightning lights up the night side.

Photo Courtesy of Caltech/R. Hurt (IPAC)

News briefs from around the globe

A brief list of events from the past week, compiled by the editors

Australia gets closer to becoming a republic

1 leader left to sign document agreeing to make the country a republic [BBC]

2015 was the hottest year in historical record

2016 expected to break global temperature record due to El Niño [NY Times]

More sperm whales wash up on shore in England

3 beached whales found on shores of Skegness, believed to be from same pod that another beached whale (found in Lincolnshire) was from [CNN]

Eastern US gets wrecked by blizzard

4 feet of snow expected in some areas, New York shuts down roads [CNN]

US relies heavily on Saudi money to support Syrian rebels

1,000s of AK-47s and millions of rounds of ammunition bought for Syrian rebels in Eastern Europe [NY Times]

Second mass prison breakout in Brazil this month

40 inmates escaped after bomb used to break wall; some prisoners still on the run [BBC]

Cases of Zika virus confirmed in UK tourists returning from Colombia, Suriname and Guyana

3 people affected; virus usually is not spread by direct contact [CNN]

IN THIS ISSUE

Caltech Y Column

CALTECH Y

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

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

Ongoing and past programs hosted by the Caltech Y:

Alternative Spring Breaks: Costa Rica, New York, Yosemite, San Diego, San Francisco

Make-A-Difference Day: Hillsides Home for Children, LA County Arboretum and Botanic Garden, Children's Hospital Los Angeles (Coachart), Eaton Canyon, Lifeline for Pets

Explore LA: Lakers game, Next to Normal musical, Norton Simon Museum trip

Upcoming Events

1. MLK Commemoration Reception: Diversity, Education, Policy, and Equity in Science a conversation with Dr. Shirley Malcom

Wednesday | January 27th | 4:00 - 5:30 p.m. | Location TBA

Students Only. Spaces limited. RSVP at this link.

Join us for an open and casual conversation on issues of educational access, broadening participation in STEM and related fields, science policy, and diversity and equity from grade school to Caltech.

Dr. Shirley Malcom is the Head of Education and Human Resources at the American Association for the Advancement of Science (AAAS) and a Caltech Trustee. She works to improve the quality and increase access to education and careers in STEM fields as well as to enhance public science literacy. She is a former member of the National Science Board, the policymaking body of the National Science Foundation, and served on President Clinton s Committee of Advisors on Science and Technology. Internationally, she is a leader in efforts to improve access of girls and women to education and careers in science and engineering and to increase use of science and technology to empower women and address problems they face in their daily lives, serving as co-chair of the Gender Advisory Board of the UN Commission on S&T for Development and Gender InSITE, a global campaign to deploy S&T to help improve the lives and status of girls and women. In 2003, Dr. Malcom received the Public Welfare Medal for the National Academy of Sciences, the highest award given by the Academy.

2. Rise Tutoring Program

Monday - Thursday | 4:00 - 6:00 p.m. | Starting January 6th | Winnett

The Caltech Y Rise Program is currently accepting new tutors for the winter term. The Rise Program is an afterschool math and science-focused tutoring program that serves public school students between grades 8 and 12 who are struggling in math and science (receiving a C+ or below in either subject). The tutoring takes place on the Caltech campus Monday-Thursday from 4pm-6pm. Tutors are matched with 1-2 students and will ideally work with the same student for the whole year. Tutors commit to 1-2 days per week for at least 2 terms out of the year. Schedule changes can be accommodated throughout the year. This is a great way to volunteer without having to leave campus. For more information about the program and to apply please visit our website at: https://caltechy.org/programs_services/tutoring/Resources/index.php.

3a. Pasadena LEARNS

Friday | 3:00 - 5:00 p.m. | Madison and Jackson Elementary School | Pasadena

Come volunteer at Madison and Jackson Elementary School! We are partnered with the Pasadena LEARNs program and work with their Science Olympiad team or do regular tutoring along with occasional hands-on science experiments. Transportation is provided. For more information and to RSVP, contact vkkumar@caltech.edu.

3b. Hathaway Sycamores

Wednesday | 5:30 - 8:00 p.m. | 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 an hour of travel time and 2 hours of tutoring. Transportation is included. For more info and to RSVP email Sherwood Richers at srichers@tapir.caltech.edu.

Other Announcements – Beyond the Caltech Y

Girls on the Run Volunteer Opportunity

Come inspire girls to be joyful, healthy, and confident!

Girls on the Run welcomes coaches/mentors and girls of every size, shape, and fitness level. No running experience needed.

Join one of the 90 teams of volunteer coaches throughout LA county to facilitate their fun and easy to follow curriculum with a group of 8-15 girls over the course of 12 weeks (March-May), culminating in a celebratory 5k event on May 22nd. Sign up today! (One-day training event and simple background check required)

Girls on the Run Los Angeles needs passionate people just like YOU to join their team of coaches/mentors in a transformational after school program for girls in 3rd-8th grades. GOTRLA creatively integrates running into character development lessons that inspire girls to love who they are, have healthy relationships, and make a difference in their community.

Caltech students tutor local high schoolers through the Hathaway Sycamores program.

Photo Courtesy of Caltech Y

Moriah Bischann wins annual Perpall Speaking Competition

JON COTLER
Page Editor

Since 1993, Caltech has hosted the annual Doris S. Perpall SURF Speaking Competition. Currently run by Toni Perpall and founded by Robert Perpall, this competition is open to all SURF students. Over 200 entered this year, speaking at 18 different panels in October. Of these, 20 students moved on to the semifinal round in November, and five advanced to the final round on Jan. 21.

This year's winner of the competition, and recipient of $1000, was Moriah Bischann. Bischann's paper, "High Strain-Rate Dynamic Activity of Magnesium and AZ31B," focuses on the search for new materials that are both lightweight and strong. AZ31B is a magnesium alloy that consists of 98 percent magnesium, 1 percent iron, and trace amounts of other elements. Both the AZ31B and pure magnesium were processed by Equal Channel Angular Extrusion (ECAE), and an additional sample of AZ31B was processed by Thermal Rolling. By applying stress and measuring the strain, Bischann concluded that the magnitude, direction and frequency of loading are important factors to consider when designing materials.

Continued on page 4

(From left) Dominic Yurk, Alison Lui, Toni Perpall, Moriah Bischann, Alec Brenner and Sean McKenna gather at the speaking competition.

Photo Courtesy of Jon Cotler

Dealing with academic ineligibility: No phoenix from the ashes

ANDRE COMELLA
Contributing Writer

Earlier this week, *The Tech* published my article about the hardship that comes with being forced onto academic leave. In this article I'd like to focus more on the policies that put me and many others in these kinds of situations. Prior to last year, to remain a student, one had to pass 27 units each term with a 1.4 GPA, pass a total of 99 units every three terms, and maintain a 1.9 GPA (slightly less than a C average). The policies have since changed; each student must now pass 33 units and achieve a GPA of 1.9 each term — clearly a stricter set of requirements.

The change was made for two reasons: to simplify the requirements and to encourage struggling students, particularly frosh, to consider Caltech isn't the right place for them. I've been told that these policies are based on data and were implemented with the best intentions, and for the most part, I don't doubt that. But the idea that we should be using policies like this to weed out students seems wrong. Either we are admitting a substantial number of students who are not capable, in which case a review of admissions is necessary, or we are simply incapable or unwilling to help struggling students. The latter seems more likely, but either way, the answer is not tighter UASH guidelines.

The ineligibility policies make even less sense the closer one looks at them. Largely, this seems to be due to a lack of coordination and foresight. As an example, let's look at the policy for E's and I's. In order to remain eligible, a student must *pass* 27 units, meaning that E's and I's don't count. For example, a student who earns three A's and just one E in 9-unit classes becomes ineligible. Such a student has until Add Day to complete the necessary coursework and change his or her grade to something passing, at which point the student would become academically eligible again, and the ineligibility would disappear — not counting toward the student's total ineligibilities. However, an ineligible student must vacate Caltech housing five days from being notified. It's unclear when this notification would come; it could come in the break between terms. This means likely two or more weeks between when a student can be kicked out for taking an E, and the deadline to complete the course. On top of that, there's a good chance Security will remove a student's card access long before Add Day, adding hassle to the strain of having to finish a class. If all this sounds vague and uncertain, it's because the implementation isn't that well understood, even by the implementers.

The policies are supposedly based in hard data; students who take two terms off after becoming ineligible are substantially more likely to graduate than those who take one or none. But there is another layer to policy: how the policies are actually perceived and reacted to. After the roll-out of the new eligibility requirements, I heard, for the first time, people talking about adding classes to pad their schedules to avoid falling below the threshold. More classes means more work, more stress, and thus more probability to fail any given class. The idea of being told to toss in an art or PE to gather units seems ludicrous, but it's what's happening. These changes may have simplified UASH rules, but they've turned registration into a complex, strategic game. The higher threshold has fostered stress and paranoia in students who clearly don't need more of either. Some may argue this is helpful — that some students should worry more about their grades. But some struggling students won't worry anyway, and worse, many who are academically stable may stress and worry even though they needn't.

> *"Ten-week terms offer little forgiveness. I'll be coming back for four terms terrified by the knowledge that a bad day could yield a bad week, a bad week a bad term, and a bad term an expulsion."*

Along the same theme, imagine what it's like to have already flamed (i.e., become academically ineligible) once. Imagine taking classes on a unit load where failing any class would lead to a second flame, and thus getting kicked out. I found the fear to be entirely debilitating at times. Why bother trying in any class when failing one means the same thing as failing all of them? Keep in mind, even if failing a class wouldn't drop a student below 33 units, it could drop him or her below the required 1.9 GPA. This is especially true if the student is taking some pass/fail classes, since those don't count towards GPA and therefore cannot buffer against an F on grades. Ten-week terms offer little forgiveness. I'll be coming back for four terms terrified by the knowledge that a bad day could yield a bad week, a bad week a bad term, and a bad term an expulsion.

The high stakes lead to high pressure. Sure, some short-term stress can help motivate one to get work done. But long-term stress across a term, or really, years, just wears a person down. When the stress gets turned up even higher, it becomes that much harder to focus or find motivation. This, in turn, leads to poor work output and a higher chance of failing, which means more stress. And so the cycle goes until one either scrapes by miraculously, or gets kicked out.

This, I feel, was a large contribution to my flaming third term. I knew I was stressed, I knew I was losing my grip and I knew I had to do something about it. But the work kept coming, and my need to do it all (and do it well) kept increasing. So I stopped talking to friends as much, and stress went up. I kept putting off seeing a counselor because I didn't have the time. When I did reach out, I had to wait because the Counseling Center is understaffed. I spent more time doing nothing productive to either relieve stress (which never worked) or just hide from the ever-growing mountain of work. I put off talking to my professors about my late and missing work until I had something to show them, but of course, I never found time to do overdue work.

As, perhaps, an expression of mercy, the new policies do allow a student to underload to less than 33 units after Add Day once in their careers. This has been lauded as a far simpler and more useful tool than it actually is. The assumption is that one would use the underload option before becoming ineligible even once. This ignores countless scenarios where underloading would be, or at least feel like, a bad option. For example, one could be taking a class required for graduation or subsequent coursework. Putting it off for another year would be very damaging to the student's current trajectory and might mean graduating late. Or a situation where a student isn't aware of how close he or she is to failing or doing poorly enough to risk an unacceptable GPA. It's alarmingly common to never receive graded work or get midterm grades even though they're technically required. There are also classes for which finals are a massive portion of the grade; some course grades are even entirely determined by the final exam. One could do well on problem sets, reasonably expect to pass, then get blindsided by a final and fail. And ultimately, students are people, and as such, are at times stubborn or unrealistic and stigmatized against dropping classes. It may be flawed behavior, but it's very reasonable behavior to expect and should be more of a consideration in the design and implementation of policies.

One might ask why students who are academically unstable don't underload or take time off. Both are somewhat stigmatized; Caltech has a culture encouraging students to push themselves to extremes, to maximize units taken, minimize hours slept and generally try to be as "successful" and as miserable as possible. This may not always present so extremely, but it does often come as an aversion to doing things the "easy" way and underloading — at least not until senior year. Caltech's tuition policy also comes in as a serious roadblock, as it states, "Students who register for less than 36 units ('Underload') will not receive a reduction of tuition. Full tuition will be charged to underloading students' accounts, and applicable financial aid will be reduced, in underload situations." So unless a student is already paying full tuition, underloading can be far too expensive to seriously consider. Underloading then means a harder term in the future or an additional, and very expensive, term.

Time off can also be financially infeasible. Many students rely on financial aid to pay their living expenses like food and rent. Without remaining registered, these students can't afford to live in the area without finding a job very quickly. Student loans begin accumulating interest, and after a grace period, payment is demanded. Those who lived in Caltech housing would have to find a different place to live too. For those living in non-Caltech housing, consequences extend to those around them, as moving would dump their portion of rent on their roommates. Leaving the area means leaving friends and communities that one has come to rely heavily on for support and guidance.

There are many other circumstances that could exacerbate the problems with taking time off or underloading. Those who are here on student visas would find themselves deported almost immediately if they don't pass the minimum number of units for a full-time student. Students who rely on Caltech for their insurance would lose those benefits if they took time off. Without student status, one can no longer receive medical care or counseling from the Health Center. Additionally, many scholarships require a certain course load per term and don't permit time off.

Time off can be incredibly helpful, and has been for many students. But time off works best when done on a student's own terms. When the Institute forces students out, much of the time that should be spent working, taking classes, or focusing on self-improvement, instead is spent on panic, anger, and desperation of trying to reassemble a life.

It is only fair to acknowledge the possibility that a student who becomes ineligible, especially repeatedly, truly should transfer. Maybe they really can't handle the academic rigor at a level like that at Caltech. But there are other reasons transferring would be the right choice. A student might be struggling with mental health and find Caltech's support inadequate. Or perhaps the student has developed personal conflicts and no longer feels comfortable at this school. Perhaps Caltech is just too expensive to attend compared to other options. Transferring, however, is not as simple or easy as it seems. To transfer to a university of similar caliber, one must be in good academic standing at Caltech. Being on academic leave or probation isn't quite "good academic standing," and thus would prevent one from being eligible to transfer. Additionally, students often cannot transfer beyond a point in their education. Past sophomore or junior year, many colleges and universities won't take transfer students. Freshmen can't transfer easily either since they don't have a GPA until they're off pass/fail.

To say the academic eligibility policies help students requires total lack of understanding of their actual effects. We need policies that actually attempt to help students, rather than tossing them out and hoping, or perhaps not caring if, they sort things out themselves. Caltech has the resources to care about each struggling student — to give individual attention and support. The Institute may not have the personnel, but it does have the money to hire them. After their first ineligibility, students currently chat with a dean and then carry on with no real follow-up. Let's add support from the deans, from RAs, or even new personnel we hire just for this purpose. Encourage or require seeing a counselor a few times, especially if the student cited stress as a reason for poor performance. Wipe away ineligibilities for clearly one-time events such as short-term illness. Work with students with more long-term issues to figure out a reasonable course-load, even if it means taking fewer than 33 units. Follow up with students early and often; a 10-week term doesn't leave much room to get back on track. And reverse the tuition policy changes that make it prohibitively expensive to take extra time.

Most importantly, we need to remove this blanket policy of leave. UASH's job is to decide what students need to succeed academically. If leave is appropriate, then UASH will say so. Forcing a particular response to academic ineligibility takes away UASH's ability to deal with students as individuals in unique circumstances. The implementation of this policy of mandatory leave has taken away one of the most important roles of the UASH committee and has left it as a glorified final barrier to reinstatement. In trying to fix something that was hardly broken, the Institute has instilled fear in its students and crippled one of its most important committees. If we want ineligibility to be handled correctly, let's build an approach that understands students. We need a set of policies born out of open forum discussion with all types of students, instead of the closed-door meetings with a handful of student "representatives." Let's craft a system that understands the habits, struggles and needs of students; only then can we actually help them.

The Power of OK

KSHITIJ GROVER
Contributing Writer

OK is a second-class citizen in our culture.

No one wants to be *just* OK.

What does OK mean? *Average*? Well, that's problematic — take any group, and if you can rank the members by some metric, there will inevitably be people in the 35–65 percent range. These people, by definition, are average. No matter how much we scratch and claw our way out of this range, it won't go away. Importantly, there's nothing wrong with that.

Everyone's felt the same way at some point or another. We feel pressured to feel great. We feel shame when we struggle. We curse ourselves when we perform anything less than excellent. We constantly compare ourselves to others, climbing some imaginary ladder that never ends.

But maybe things can be different. Maybe it wouldn't be so horrible if we thought about being *OK*. Maybe being *OK* means understanding ourselves a little better.

You're not going to be upbeat and at your best 100 percent (or even 50 percent) of the time. There will be let-downs. There will be the bad days, whether others show them or not. Let's not hide them. Let's bite those bullets. Let's let that soak in.

OK brings an unexpected comfort. A comfort you wouldn't expect of a word that has come to be so negative. Adopting the idea that it's perfectly acceptable to be OK lets you project empathy. It helps you understand that you don't need to spend time showing a version of yourself you can't be true to.

Our expectations for ourselves determine our emotions. Granted, we should reach to be the best possible versions of ourselves, but it's easy to take that step too far. Wanting to be the best can take you to great heights, and yet there are places where we need to look back, appreciate the view, stop climbing and breathe.

Enjoying Kshitij's column? You can read more of his writing on his online blog! Check it out at https://medium.com/@kshithappens.

Bischann takes first in Perpall competition

Continued from page 2

In second place, and recipient of $600, was Alec Brenner, who presented on his project titled "Spectroscopic Quantification of Structurally-Bound Water in Pyroxenes and Olivines, with Applications to Meteorites." Brenner first looked at two different earth minerals and found that there was a large amount of water in them. He then investigated pallasites, which come from the mantle-core boundary of proto planets, and determined that there was no water in them whatsoever. Lastly, he investigated a meteorite from Mars called ALH84001, which came from the early Martian crust, and concluded that it contained roughly the same amount of water as modern Earth's crust.

In third place, and recipient of $400, was Dominic Yurk. In his project, titled "Creating a Consistent History of Galaxy Evolution," Yurk found that there is a discrepancy between the main sequence star formation rate and the observed evolution rate. He studied how galaxy mergers helped account for the difference. Yurk also discovered that the rate of star formation was accurately predicted by the model created but that the actual number of stars formed was slightly off.

Sean McKenna and Alison Lui were the other two finalists. McKenna's research, titled "Describing the Spatial Distribution of the Urban Built Environment with Networks," focused on mathematical modeling of cities, and concluded that shops followed a roughly linear distribution as a function of distance from the center, rather than a parabolic distribution as expected. McKenna also created an equation that predicts a city's population as a function of the city's radius.

Lui's project, titled "Characterization of Heavy Crude Oil Fractions by 13C-NMR Spectroscopy," characterized the components of heavy crude oil that has been cracked with supercritical water. Lui used NMR spectroscopy to measure how much energy carbon atoms gave off after receiving a pulse of energy; this information was then used to identify the molecule the atoms came from.

Steiner leads men's swim and dive to win over Whittier

GOCALTECH.COM
Actual Sports Content Editor

WHITTIER, Calif. (Jan. 16, 2016) – Freshman Henry Steiner earned top points in all three individual events to lead Caltech men's swimming and diving to its first dual meet victory over Whittier College since 2008 on Saturday morning.

The Beavers and Poets also competed against Claremont-Mudd-Scripps Colleges in the double-dual format, with the Stags remaining undefeated at 6-0 this season.

The host Poets opened the meet with a clear five-second victory in the 200 Medley Relay to take the lead and held it through the first diving break. Top places in the first two individual events, the 1000 and 200 Free, stretched the margin to 12 points despite Caltech scoring the maximum three swimmers in each. Sophomore Hanzhi Lin picked up the Beavers' first victory in the 100 Back and was flanked by fourth- and fifth-place Caltech finishes to cut the deficit to seven, but Whittier responded immediately with a 14-point 100 Breast to surge back ahead by 16.

Swimming becomes a lot harder when you keep your arms behind you at all times. Why ever would they do it that way?
- http://gocaltech.com

Steiner easily outpaced the field in the 200 Fly as he shaved over a second off his time last month to trim the margin to a meet-low six points, but a 1-2 finish in the 50 Free quickly turned the score back in the Poets' favor by 15. Senior Patric Eck was just out-touched by both Poets to finish in third place by a mere .42 and .08 despite clocking a career-best 22.11. As the only diver between the two teams, sophomore Alexander Bourzutschky earned the maximum nine points for Caltech on the 1-meter board but the Poets claimed their largest lead of the meet (87-70) with a 1-2 finish in the 100 Free.

The Beavers would dominate the second half, however, outscoring the Poets by a whopping 44 points over the next six events to claim victory. Freshman Dylan Lu and Lin posted Caltech's first 1-2 finish of the day in the 200 Back to pick up nine points and freshman chopped just over a second from his 200 Breast time to post the Beavers' highest finish of the day, coming in second overall and earning top points in the Whittier dual as Caltech took a one-point lead at 98-97.

There was no stopping the Beavers at that point, with Lu garnering top points in another second-overall finish in the 500 Free, Steiner claiming the 100 Fly with Lin taking a clutch third place by .51, Bourzutschky tacking on another nine uncontested points on the 3-meter and Steiner capping a brilliant individual day with the top finish in the 200 IM. Caltech led by a meet-high 27 points before the 400 Free Relay, in which the Beavers placed second and third for the final margin of 22 points at 150-128.

Haleftiras shines in huge fourth quarter at La Verne

GOCALTECH.COM
Actual Sports Content Editor

LA VERNE, Calif. (Jan. 23, 2016) – Freshman Nika Haleftiras tied her career high of 13 points and filled out her line with six rebounds and three assists as the Caltech women's basketball team fell at the University of La Verne, 64-47, on Saturday afternoon.

The Leopards put up a quick nine points on their first four shots over the opening three minutes to lead by five and nearly doubled that margin by the end of the first quarter at 19-10. The Beavers hit just one shot over the first six minutes of the second quarter to fall into a 17-point hole that became 20 at halftime and a game-high 33 one minute into the fourth quarter, but Caltech finally clicked over the final nine minutes, outscoring the hosts 21-5 to end the game. Haleftiras and senior Stephanie Wong combined to score 19 of their 30 points in the fourth quarter alone, when the Beavers outshot the Leopards 50-27 percent and forced eight turnovers while committing just two.

Wong led Caltech with 17 points while freshman Madeline Schemel chipped in nine and added seven rebounds, three steals and three assists against just one turnover off the bench. Freshman Madelyn Stroder also dished out one assist without committing a single turnover and pulled down one board in 15 minutes as a substitute.

Guarded by a mysterious headless and footless opponent, Nika Haleftiras proceeds to break her opponent's ankles anyway.
Photo Courtesy of Bob Paz

Record day for Al-Rayes not enough for men's basketball at Chapman

GOCALTECH.COM
Actual Sports Content Editor

ORANGE, Calif. (Jan. 20, 2016) – Junior Nasser Al-Rayes came just two blocks shy of recording the first triple-double in program history as the Caltech men's basketball team dropped just its second SCIAC matchup this season at Chapman University on Wednesday night.

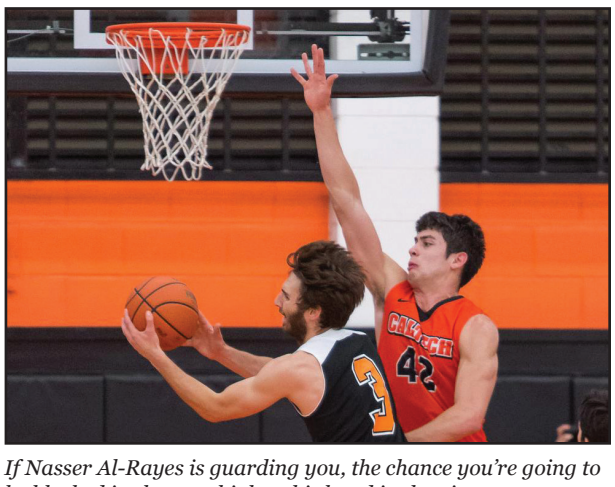
The Panthers' victory pulls them into a four-way tie alongside Caltech atop the SCIAC standings at 4-2. The Beavers have held at least a share of the conference lead for over two weeks, dating back to Jan. 4.

Chapman outshot Caltech 49-39 percent from the field and 35-29 percent from beyond the arc while committing a mere six turnovers against the Beavers' 16 to overcome a six-rebound deficit. The Panthers started hot, jumping out to a 12-4 lead before Caltech scored six unanswered points to pull within two with 12:43 on the clock. Chapman stretched back out to a six-point lead with 10:21 left in the half, but the Beavers stormed back with nine straight points over the next three minutes to take their first lead of the game at 21-18.

The hosts turned the tables soon after, however, as the hot hand of SCIAC scoring leader Cam Haslam fueled the Panthers to score the final 15 points of the half over a three-and-a-half-minute span and carry a 20-point lead into halftime.

Al-Rayes recorded a dominant line of 14 points, 10 rebounds and program-record eight blocks while freshman Brent Cahill and junior Ricky Galliani joined him in double figures with 11 and 10 points, respectively. Senior Robert Anderson stepped in to drill three of four three-point attempts while sophomore David Kawashima dished out three assists against just one turnover.

Caltech quickly put up the first five points of the second half but could not keep pace with Chapman's scorching offense and the Panthers cruised to the 83-60 victory.



If Nasser Al-Rayes is guarding you, the chance you're going to be blocked is about as high as his hand in the picture.
Photo Courtesy of Bob Palermini

Percin, Takahashi smash two more program records

GOCALTECH.COM
Actual Sports Content Editor

ORANGE, Calif. (Jan. 23, 2016) – Freshmen Brittany Percin and Gemma Takahashi each broke another record as the Caltech women's swimming and diving team competed in its final away double-dual meet of the year at Chapman University, along with the University of La Verne, on Saturday morning.

This USP (Unidentified Swimming Person) shows the others how you should swim; namely, using your arms. Seriously though, does anyone know who this is?
- http://gocaltech.com

Both rookies beat the previous program records by over two seconds, with Percin clocking a 4:56.05 in the 400 IM and Takahashi touching first overall in the 200 Back at 2:15.58. Junior Zofii Kaczmarek impressed on the boards, placing second on the 3-meter with a career-high 187.05 and third in the 1-meter.

Senior Grace Lee had a day as well, clocking the first sub-30-second 50 Free of her career and chopping almost four seconds from her personal best 100 Free, coming in at 1:05.97. Senior Tiffany Zhou also shaved a second in the 50 Free (36.91) and knocked off a whopping eight seconds in the 100 Free (1:19.55). Junior Kate Evans recorded a career-best 6:56.25 in the 500 Free as well.

ASCIT Minutes

Meetings are every Wednesday at 4 pm in SAC 13

ASCIT Board of Directors Meeting
Minutes for 20 January 2016. Taken by Kalyn Chang.
Officers Present: Nima Badizadegan, Sean McKenna, Catherine Jamshidi, Annie Chen, Kalyn Chang, Jay Palekar
Call to Order: 4:09 pm
Guests: Chris Dosen
President's Report (Nima):

- Reviewed ASCIT Bylaw amendments proposed by Chris Dosen

Officer's Reports:

- **V.P. of Academic Affairs (ARC Chair: Jay):**
  - ARC passed new bylaws - changed process for appointing freshman reps and reps at large
  - Talked about 12 term tuition policy
  - Presidents of option clubs should email Jay Palekar about hosting events with faculty
- **V.P. of Non-Academic Affairs (IHC Chair: Cat):**
  - Talked to Jon Webster about dining and board so we can make board better for students
  - Emailed Devteam about removing phone numbers for Donut
  - Asked for access to survey results for house presidents and IHC secretary
  - Changed bylaws
- **Director of Operations (Sean):**
  - Nothing to report
- **Treasurer (Kalyn):**
  - Reminder that you can get reimbursed for taking a prof to lunch and multihouse events!
  - Talk to Dimitris/Lorrie about past yearbook payments
- **Social Director (Annie):**
  - Planning ASCIT formal with Tom
  - Spring course schedule will come out sometime after midterms
  - Forgot to do trivia night last week
- **Secretary (Phillip):**
  - ASCIT retreat Feb 5th - Feb 7th

<u>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.</u>
Meeting Adjourned: 5:00 pm

VICE PROVOST'S OFFICE HOURS

Vice Provost, Chief Diversity Officer and Professor of English, Cindy Weinstein, offers weekly office hours. These hours are an opportunity for undergraduate, graduate students and postdocs to meet and discuss what they'd like 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 libraries.
There are four appointments per hour, 15 min. each. Sign up the morning of the office hour in 104 Parsons Gates, Vice Provosts' Offices (x6339).

Winter term hours: 12-1 p.m.
Monday, Feb. 1 *Tuesday, Feb. 9*
Thursday, Feb. 25 *Wednesday, Feb 17*
Wednesday, Mar. 2 *Tuesday, Mar. 8*

Hello graduate students,
Many of you have seen and discussed the recent articles regarding sexual harassment in our community. The Caltech Graduate Student Council Board of Directors, consisting of representatives from the options and graduate students at large, has issued the following statement:

January 19, 2016
We, the Caltech Graduate Student Council Board of Directors, believe that sexual harassment has no place on our campus or in academia. In two letters from Caltech's President over the last few months, we learned that a Caltech professor has been found responsible for gender-based harassment of two graduate students. This professor has been suspended for the remainder of the academic year. Last week, we learned that the two graduate students have chosen to identify themselves, the faculty member, and some details of the harassment in an online article.
We write this statement to applaud the courage and strength demonstrated by our students, Sarah Gossan and Io Kleiser, in both the process of making the Title IX complaint as well as going public with their story. We are proud of them and we support their decision to share their story and to name their offender as Christian Ott. We believe that Io and Sarah's actions are important to our community and science in general because these actions draw more attention to the problem of harassment in science and will take away places for harassers to hide.
We also write this statement to express and offer support to graduate students who have experienced or are experiencing sexual harassment or any other type of discrimination on our campus. Please know that your SC representatives support you and can help connect you to resources on campus. Please also know that we support you whether you come forward publicly or confidentially. If you need to talk to someone, you can seek confidential help and/or speak to our Title IX Coordinator.
And finally, we write this statement to challenge faculty to take action in improving the climate and environment for graduate students on campus. We look forward to the opportunity on February 11, at the Student-Faculty Colloquium, to have faculty and students work together to tackle important issues on campus. Our campus has a lot of work to do. We are optimistic that this campus, with its commitment to providing a quality education for all its students, will continue to move in the right direction and we look forward to working with Caltech students, faculty, and administrators to act on the proposals suggested in the President and Provost's message.

— The Board of Directors of the Caltech Graduate Student Council
Jason Pollack
Chair, Caltech Graduate Student Council

Title IX Office Hours

The Title IX Office is available for all students and employees to discuss and/or report concerns about sex or gender based discrimination. Felicia Hunt will be available on a first come, first served basis at weekly office hours.

Fridays 1:00-3:00 p.m.
205 CSS (second floor)

SHARE Office Hours

(Sexual Health & Assault Response & Education)
The SHARE office is a confidential resource for addressing students who want to talk about sexual harassment and/or violence. SHARE promotes healthy sexuality and relationships. Jenny Mahlum will be available on a first come, first served basis at weekly office hours.

Mondays 2:00-3:30 p.m.
Wednesdays 3:00-4:30 p.m.
248 CSS (second floor)

The California Tech

Editors-in-Chief
Neera Shah
Nehaly Shah

Page Editors
Jon Cotler
Katherine Guo
Ida Huang
Ching-Yun (Chloe) Hsu
Valerie Pietrasz

Contributing Writers
Andre Comella
Kshitij Grover

Circulation Manager
Kit Chinetti

Advisor
Richard Kipling

Caltech 40-58, Pasadena, CA 91125
Contact **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* 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*. For subscription information, please send mail to "Subscriptions."

Konstantin Batygin and Mike Brown discover Planet Nine

Continued from page 1

the long term because, after all, this would cause the planet and these objects to meet and eventually collide,'" said Batygin.

But through a mechanism known as mean-motion resonance, the anti-aligned orbit of the ninth planet actually prevents the Kuiper Belt objects from colliding with it and keeps them aligned. As orbiting objects approach each other they exchange energy. So, for example, for every four orbits Planet Nine makes, a distant Kuiper Belt object might complete nine orbits. They never collide. Instead, like a parent maintaining the arc of a child on a swing with periodic pushes, Planet Nine nudges the orbits of distant Kuiper Belt objects such that their configuration with relation to the planet is preserved.

"Still, I was very skeptical," said Batygin. "I had never seen anything like this in celestial mechanics."

But little by little, as the researchers investigated additional features and consequences of the model, they became persuaded. "A good theory should not only explain things that you set out to explain. It should hopefully explain things that you didn't set out to explain and make predictions that are testable," said Batygin.

And indeed Planet Nine's existence helps explain more than just the alignment of the distant Kuiper Belt objects. It also provides an explanation for the mysterious orbits that two of them trace. The first of those objects, dubbed Sedna, was discovered by Brown in 2003. Unlike standard-variety Kuiper Belt objects, which get gravitationally "kicked out" by Neptune and then return back to it, Sedna never gets very close to Neptune. A second object like Sedna, known as 2012 VP113, was announced by Trujillo and Sheppard in 2014. Batygin and Brown found that the presence of Planet Nine in its proposed orbit naturally produces Sedna-like objects by taking a standard Kuiper Belt object and slowly pulling it away into an orbit less connected to Neptune.

But the real kicker for the researchers was the fact that their simulations also predicted that there would be objects in the Kuiper Belt on orbits inclined perpendicularly to the plane of the planets. Batygin kept finding evidence for these in his simulations and took them to Brown. "Suddenly I realized there are objects like that," recalls Brown. In the last three years, observers have identified four objects tracing orbits roughly along one perpendicular line from Neptune and one object along another. "We plotted up the positions of those objects and their orbits, and they matched the simulations exactly," said Brown. "When we found that, my jaw sort of hit the floor."

"When the simulation aligned the distant Kuiper Belt objects and created objects like Sedna, we thought this is kind of awesome — you kill two birds with one stone," said Batygin. "But with the existence of the planet also explaining these perpendicular orbits, not only do you kill two birds, you also take down a bird that you didn't realize was sitting in a nearby tree."

Where did Planet Nine come from and how did it end up in the outer solar system? Scientists have long believed that the early solar system began with four planetary cores that went on to grab all of the gas around them, forming the four gas planets — Jupiter, Saturn, Uranus and Neptune. Over time, collisions and ejections shaped them and moved them out to their present locations. "But there is no reason that there could not have been five cores, rather than four," said Brown. Planet Nine could represent that fifth core, and if it got too close to Jupiter or Saturn, it could have been ejected into its distant, eccentric orbit.

Batygin and Brown continue to refine their simulations and learn more about the planet's orbit and its influence on the distant solar system. Meanwhile, Brown and other colleagues have begun searching the skies for Planet Nine. Only the planet's rough orbit is known, not the precise location of the planet on that elliptical path. If the planet happens to be close to its perihelion, Brown said, astronomers should be able to spot it in images captured by previous surveys. If it is in the most distant part of its orbit, the world's largest telescopes — such as the twin 10-meter telescopes at the W. M. Keck Observatory and the Subaru Telescope, all on Mauna Kea in Hawaii — will be needed to see it. If, however, Planet Nine is now located anywhere in between, many telescopes have a shot at finding it.

"I would love to find it," said Brown. "But I'd also be perfectly happy if someone else found it. That is why we're publishing this paper. We hope that other people are going to get inspired and start searching."

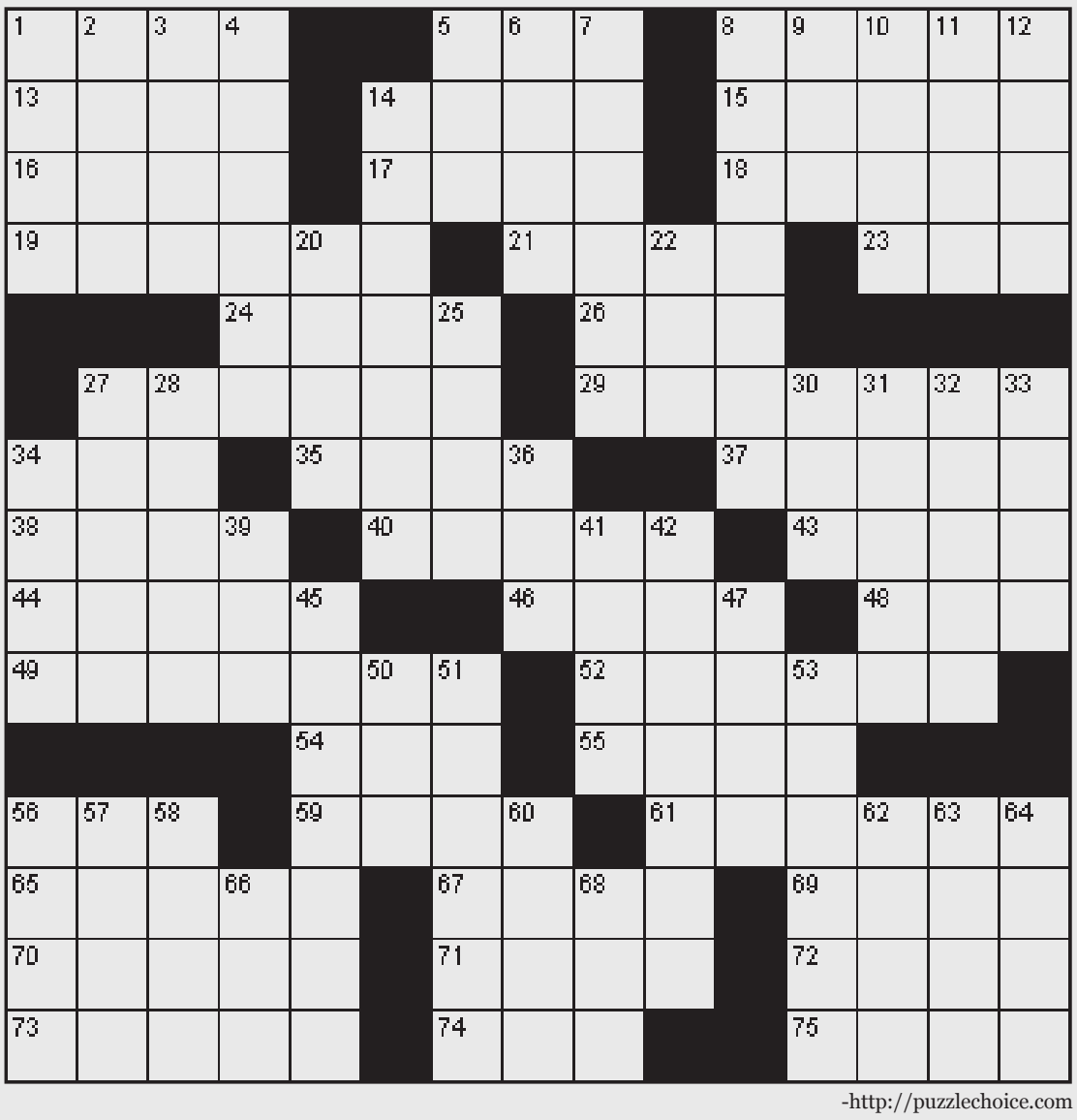
In terms of understanding more about the solar system's context in the rest of the universe, Batygin said that in a couple of ways, this ninth planet that seems like such an oddball to us would actually make our solar system more similar to the other planetary systems that astronomers are finding around other stars. First, most of the planets around other sunlike stars have no single orbital range — that is, some orbit extremely close to their host stars while others follow exceptionally distant orbits. Second, the most common planets around other stars range between 1 and 10 Earth-masses.

"One of the most startling discoveries about other planetary systems has been that the most common type of planet out there has a mass between that of Earth and that of Neptune," said Batygin. "Until now, we've thought that the solar system was lacking in this most common type of planet. Maybe we're more normal after all."

Brown, well known for the significant role he played in the demotion of Pluto from a planet to a dwarf planet adds, "All those people who are mad that Pluto is no longer a planet can be thrilled to know that there is a real planet out there still to be found," he said. "Now we can go and find this planet and make the solar system have nine planets once again."

The paper is titled "Evidence for a Distant Giant Planet in the Solar System."

Crossword



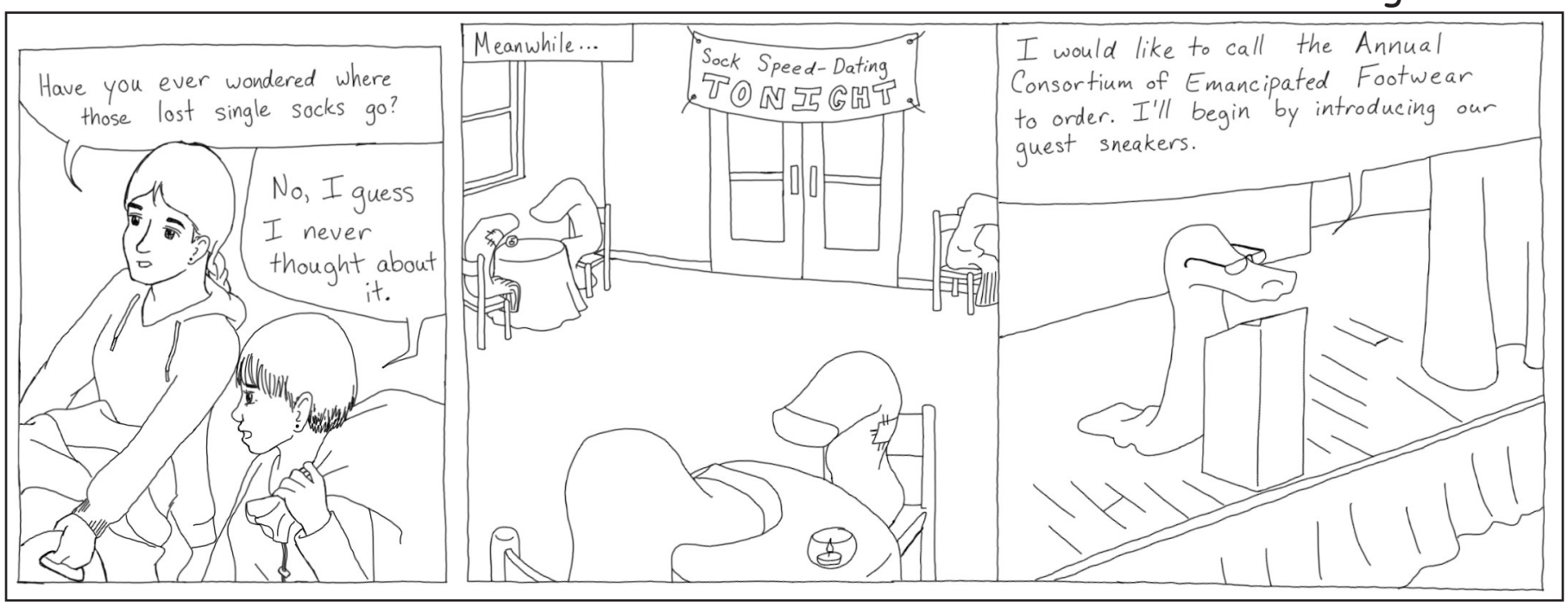
-http://puzzlechoice.com

Across
1. Fastener
5. Female animal
8. Board game
13. Instep
14. Roughage
15. Serf
16. Effect of long use
17. Endure
18. Mindful
19. Martial art
21. Homework, in short
23. Fresh
24. Transmit
26. Creative activity
27. Order of business
29. Introductory music in opera
34. Large African antelope
35. Narrate
37. Refresh
38. A division of quantity
40. Scope
43. Barb
44. Relating to the sun
46. Resitance to motion through a fluid
48. Belonging to us
49. Supply water or liquid to
52. Straying from the right course
54. Unit of weight
55. Enfold
56. Unhappy
59. Squad
61. A forceful consequence
65. Relating to hearing or the ear
67. Naked
69. Currency unit
70. Very angry
71. Prevaricator
72. Particle
73. Stratum
74. Hard tough wood
75. A strong line

Down
1. Bird of prey
2. Region
3. An indication of damage
4. A short musical passage
5. Epoch
6. Vespid
7. Catch or snare
8. Subdivision of a written work
9. Strike with an axe
10. Zeal
11. Painful
12. Fret
14. Liquidizer
20. Marquee
22. Make a mistake
25. Open river valley
27. Rile
28. Association of people with similar interests
30. Section of a journey
31. Unification
32. First appearance
33. Open vessel with a handle and spout
34. Outpouring
36. Man or boy
39. Bitumen
41. Ship's company
42. Kind of hawk
45. Pit viper
47. Metric unit of weight
50. Digit
51. Endue
53. Come into view
56. Crossjack
57. Halo
58. Camion
60. Send by post
62. Motor vehicle
63. Harvest
64. Large and scholarly book
66. Consumed
68. Male sheep

Lost Socks

Paige Turner



Acceptance to Hogwarts

Slava, Nina, Lazarina

The California Tech
Caltech 40-58
Pasadena, CA 91125

Answers to the current crossword (page 7)

-http://puzzlechoice.com