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

In healthy bone, a delicate balance exists between the cells that build bone mass and the cells that break down old bone in a continual remodeling cycle. This process is partially controlled by stem cells in bone marrow, called osteoprogenitors, that develop into osteoblasts or osteocytes, which regulate and maintain the skeleton. To better understand diseases like osteoporosis, which occurs when loss of bone mass leads to a high risk of fractures, it is crucial to study the behavior of stem cells in bone marrow. However, stem cell population is rare and not distributed uniformly throughout the bone.

In a “quantum” liquid crystal, electrons exhibit properties like the molecules in classical liquid crystals. That is, the electrons move around freely yet have a preferred direction of flow. The first ever quantum liquid crystal was discovered in 1999 by Caltech’s Jim Eisenstein, the Frank J. Roshek Professor of Physics and Applied Physics. Eisenstein’s quantum liquid crystal was two-dimensional, meaning that it was confined to a single plane. The host material—an artificially grown gallium-arsenide-based metal. Such 2-D quantum liquid crystals have since been found in several more materials including high-temperature superconductors. These are materials that conduct electricity with zero resistance at around –150 degrees Celsius, which is warmer than liquid nitrogen.

Researchers discover first three-dimensional quantum liquid crystal

Now Harter, Hsieh, and their colleagues at Oak Ridge National Laboratory and the University of Tennessee have discovered the first 3-D quantum liquid crystal. Compared to a 2-D quantum liquid crystal, the 3-D version is even more bizarre. Here, the electrons not only make a distinction between the x, y, and z-axes, but they also have different magnetic properties depending on whether they flow forward or backward on a given axis.

Continued on page 3

Photos Courtesy of the Hsieh Lab/Caltech
Upcoming Events
Poster Making for March for Science
Thursday | April 20th | 6:00 - 8:00 PM | Avery House Courtyard/Dining Hall
Join teachers preparing signs for the LA and Pasadena science marches while exploring the talents of two Caltech magicians Rmx/Rmx will do strolling magic during the sign-making and will have a stage performance to round out the night! Refreshments and Sign-Making Materials Provided.

Caltech Y Spring Friends Dinner with Dr. Charles Elachi
“The Golden Age of Exploration”
Thursday | April 20th | 6:00 PM | The Athenaeum | $85 pp
Please join us for our upcoming Friends Dinner with our guest speaker Dr. Charles Elachi who will be speaking on the topic, “The Golden Age of Exploration”

JPL missions have visited every planet in our solar system. Over the last fifteen years, three rovers have explored Mars in coordination with a number of orbiters. Samples have been brought back from a comet tail and the solar wind. Saturn and its satellites have been studied extensively with Cassini. Planets around neighboring stars were discovered. Many new insights into our planet’s environment have been acquired.

Dr. Elachi will describe, from first-hand experience, the excitement and impact of these discoveries and the challenges and risks for the next 15 years. Limited spots available, please call the Caltech Y office on 626 395 6163 to secure your seat!

March for Science
Saturday | April 22nd | Pasadena and LA
Join Caltech students in demonstrating support for science and science funding in the US. Groups of students will be attending both the Pasadena March for Science and the LA March for Science. Also look out for March for Science t-shirts and a banner that you can sign outside of Chandler during lunch.

The Pasadena March will start at Beckman Lawn at 8:00 am and walk to Memorial Park. Visit www.facebook.com/MarchForSciencePasadena for more details.

Students wanting to attend the LA March need to meet on campus at the parking lot north of the Beckman Auditorium and receive a free shuttle to the Gold Line, more details at https://www.facebook.com/events/566097387896900/. For general information on the LA March see http://marchforthenext.com/.

Your world awaits… will you act?
The Caltech Y Advocating Change Together (ACT) Award
Applications are due by Friday, April 21st no later than noon
Applications can be found at caltechy.orgprograms/services/commservice/ACT/index.php for applications and more information
Optional Info Dinner – Tues. April 11th 6 - 6:30 PM - Hosted by Tom Mannion.

Caltech Y Column
ONLINE CLASSICS
11th - 6 pm - Hosted By Tom Mannion.

Services/Commservice/ACT/index.php
21st no later than noon
Change Together (ACT) Award
see http://marchforsciencela.com/

General information on the LA March can be found at www.caltech.edu/events/366097583784693/. For more details at https://www.facebook.com/events/566097387896900/

Local, national, or global travel - as well as one day, multi-day, and even multi-week experiences - are all eligible. The Caltech Y ACT Award, made possible with generous support of the Caltech Employees Federal Credit Union, offers students an opportunity to pursue an issue through service or advocacy.

Stop by the Caltech Y or contact us to learn more about this exciting opportunity! Contact Greg Fletcher gregf@caltech.edu or Liz Jackman ljackman@caltech.edu for more information.

The Studenski Memorial Award
Proposals are due Friday, April 21st no later than noon
Visit www.caltech.edu/programs/services/areas/Studenski/index.php for proposal guidelines

Optional Info Dinner – Tues. April 11th 6 - 6:30 PM - Hosted by Tom Mannion.
RSVPs by April 7th to http://tinyurl.com/Y-Awards

Are you wondering about the next step in your life? Have you reached a crossroad where you would benefit from an opportunity to explore? Would a trip, an opportunity to volunteer with an organization, or a chance to try a new skill or interest this summer help you gain clarity? If you answered yes to any of these questions, then the Studenski Award might be for you.

The Studenski Memorial Award is a grant of up to $6000 established in the memory of Paul Studenski, a Caltech student who was killed in an automobile accident while traveling across the United States in 1974. It is awarded to a Caltech undergraduate who, having reached a crossroads in life, would benefit from a period away from the academic community to obtain a better understanding of self and to explore possible directions for the future.

Studenski proposals (1 to 2 pages maximum) are due Friday, April 21st no later than 12:00 noon to caltechY@caltech.edu for more information.

Caltech Y Photo Contest
Deadline May 10th
The Caltech Y Photo Contest is on again! If you’ve participated in a Caltech Y program and are a current student, submit your photos for a chance to win. We’re giving a $100 prize to the winner of each of the five photo contest categories. The 5 categories come from the Caltech Y pillars of:

Adventure
Service
Civic Engagement
Leadership

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Service
Civic Engagement
Leadership

Public Lecture • Free Admission • Free Parking
Caltech’s Beckman Auditorium
www.events.caltech.edu | 626.395.4652

The voyages of Christopher Columbus have inspired heated debate over the true nature of his Indies enterprise. Wey-Gomez will explore some of the facts and fiction surrounding Columbus’s geographical surveys.

Nicolas Wey-Gomez, Professor of History
Caltech Division of Humanities and Social Sciences

Photos should demonstrate the pillar in action. Photos of people are preferred, but exceptional scenic pictures will also be accepted. A waiver is required to be uploaded with the photo. After the deadline, we will select the finalists, upload them to our Facebook page, and our fans vote for their favorites to determine the winners. Winners will be announced on June 1st.

Deadline to Submit Photos:
Wednesday, May 10, 2017

Hathaway Sycamores
Every Wednesday | 6:00 - 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 an hour of travel time and 1.5 hours of tutoring. Transportation is included.

For more info and to RSVP email Sherwood Richers at sherriers@tapir.caltech.edu. Eligible for Federal Work Study.

Pasadena LEARNS
Every Wednesday | 3:00 - 5:00 PM | Pasadena
Students an opportunity to pursue an educational experience, including local, national, or global travel - as well as one day, multi-day, and even multi-week experiences - are all eligible. The Caltech Y ACT Award, made possible

Beyond the Y
Mentoring For Life
Every Monday | 3:30 PM | Wilson Middle School Pasadena
Stressed out by college life? Step outside the Caltech bubble and mentor tweens who’ve never even thought about college. Things you could do: Build a baking soda and vinegar volcano, read a book aloud, play sports or board games, teach the alphabet of another language, do a craft. Having a mentor makes an at-risk student 55% more likely to attend college, 78% more likely to volunteer regularly, and 130% more likely to hold a leadership position. Interested? If you have 180 seconds, you can watch this video and be inspired. If you have an hour a week, you can mentor someone and be their inspiration. If you feel unqualified, don’t worry. Ultimately, mentoring is about being a consistent, dependable friend—or a surrogate parent or psychiatrist. To get started, contact noddle@caltech.edu.

Caltech Earth Week 2017 Events
April 15-22, various locations
Join the Caltech community for a week of events April 15-22 to celebrate Earth Day! There will be theater performances, opportunities to engage with local environmental organizations, and lunchtime speaker seminars on a variety of topics ranging from environmental justice to urban forestry.
Visit www.earthday.caltech.edu for the full schedule of events!
New crystals may play role in computing

Continued from page 1

“Running an electrical current through these materials transforms them from nonmagnets into magnets, which is highly unusual,” says Hsieh. “What’s more, in every direction that you can flow current, the magnetic strength and magnetic orientation changes. Physicists call the electrons ‘break the symmetry’ of the lattice.”

Harter hit upon the discovery serendipitously. He was originally interested in studying the atomic structure of a metal compound based on the element rhenium. In particular, he was trying to characterize the structure of the crystal’s atomic lattice using a technique called optical second-harmonic rotational anisotropy. In these experiments, laser light is fired at a material, and light with twice the frequency is reflected back out. The pattern of emitted light contains information about the symmetry of the crystal. The patterns measured from the rhenium-based metal were very strange—and could not be explained by the known atomic structure of the compound. “At first, we didn’t know what was going on,” Harter says. The researchers then learned about the concept of 3-D quantum liquid crystals, developed by Liang Fu, a physics professor at MIT. “It explained the patterns perfectly. Everything suddenly made sense,” Harter says.

The researchers say that 3-D quantum liquid crystals could play a role in a field called spintronics, in which the direction that electrons spin may be exploited to create new technologies and materials. The discovery could also help with some of the challenges of building a quantum computer, which seeks to take advantage of the quantum nature of particles to make even faster calculations, such as those needed to decrypt codes. One of the difficulties in building such a computer is that quantum properties are extremely fragile and can easily be destroyed through interactions with their surrounding environment. A technique called topological quantum computing—developed by Caltech’s Alexei Kitaev, the Ronald and Maxine Linde Professor of Theoretical Physics and Mathematics—can solve this problem with the help of a special kind of superconductor dubbed a topological superconductor. “In the same way that 2-D quantum liquid crystals have been proposed to be a precursor to high-temperature superconductors, 3-D quantum liquid crystals could be the precursors to the topological superconductors we’ve been looking for,” says Hsieh.

“Rather than rely on serendipity to find topological superconductors, we may now have a route to rationally creating them using 3-D quantum liquid crystals” says Harter. “That is next on our agenda.”

The Science study, titled “A parity-breaking electronic nematic phase transition in the spin-orbit coupled metal Cd$_2$Re$_2$O$_7$,” was funded by the U.S. Department of Energy, the U.S. Army Research Office’s Defense University Research Instrumentation Program, the Alfred P. Sloan Foundation, the National Science Foundation, and the Gordon and Betty Moore Foundation.

• 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.

A 1-hour workshop offered 2 times this term:
Section 1: Friday, April 28th, 12:00 - 1:00
Section 2: Wednesday, May 17th, 4:00 - 5:00

Location: 229 Sherman Fairchild Library
More information: counseling.caltech.edu
Midterm Progress Grades: The Elusive Indicator

Timothy Liu  
ARC Chair

Many professors are unaware that students want midterm progress grades; students can be proactive and ask for them.

A recent study done by the Academics and Research Committee (ARC) found that the average student sees midterm progress grades in only 45% of the courses they are taking. Midterm progress grades are useful tools that give students feedback on how they’re doing in a class. They are also critical for students who are considering dropping a course. Given how useful midterm progress grades are, students can take it to simply ask their professors to post midterm grades or a grade distribution.

During Week 9 of fall term, the ARC sent a survey to the undergraduate population to gather information on midterm progress grades. A summary of the survey results can be viewed at arc.caltech.edu under the “Survey Data” link. The ARC asked students how many academic classes on grades they were taking, and of these how many classes posted midterm progress grades, either through REGIS or some other electronic service. Freshmen on pass fail were excluded from the survey. Out of 262 responses, the ARC found that students on average see midterm progress grades in 45% of the courses they are enrolled in. The survey also sought to find if students are getting their graded work returned. Students reported getting all of their work through week 6 returned in 75% of their classes. In many classes, the problem isn’t that students don’t get their graded work back, instead, students often have a poor understanding of how they are doing compared to their peers.

In March of 2017, several ARC members presented these findings to the Council on Undergraduate Education (cue.caltech.edu). The CUE is composed of faculty members from several divisions, and includes three undergraduates (Timothy Liu, Gabby Tender, and Jay Palekar). When the members of the CUE were asked why professors don’t post midterm grades, the most common answer was that faculty don’t realize they are useful to students. There is a well understood expectation that faculty should post midterm grade deficiencies for students who are on track to receive a C- or lower. However, faculty members are not actively instructed or encouraged to post midterm grades for all students. Professor Joe Shepherd noted that many faculty have the impression that only deficiencies need to be posted.

For some classes, it may be difficult to provide an accurate midterm letter grade. Professor Gil Refael pointed out that many of his classes have only sets and a final, and a midterm grade would be based only on sets. Since set scores tend to skew towards perfection, a midterm grade could have little correlation with a final letter grade. In other cases, it may be difficult to come up with a midterm letter grade for small classes or project-based classes. However broad feedback measures other than a letter grade can be just as helpful. Some professors post a histogram with the distribution of class performance, while other classes publish the mean, first quartile, and third quartile scores.

Midterm progress grades are useful tools for students. Even in classes that promptly return graded work, students want to know how they are performing compared with their peers. Students who want midterm progress grades or score distributions should get into the habit of asking their professors to post them. For professors, a midterm grade or a histogram of scores is a straightforward way to help students gauge their class performance.

Figure 1: Distribution of the fraction of classes a student is enrolled in that distribute midterm progress grades.

Figure 2: Distribution of the fraction of classes a student is enrolled in that returned all work through week 6 by week 9 of Fall term 2016.

 Figures Courtesy of Timothy Liu

Vice Provost’s 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. We look forward to hearing from you!

Student Office Hours for Spring Term 2017:

4/27/17 Thursday 9:00-10:00 a.m.
5/2/17 Tuesday 11:00 a.m.-12:00 p.m.
5/9/17 Tuesday 11:00 a.m.-12:00 p.m.
5/17/17 Wednesday 11:00 a.m.-12:00 p.m.
5/24/17 Wednesday 11:00 a.m.-12:00 p.m.
5/31/17 Wednesday 11:00 a.m.-12:00 p.m.
6/8/17 Thursday 11:00 a.m.-12:00 p.m.
Krop tosses gem against Saint Katherine

GOCALTECH.COM

Actual Sports Content Editor

PASADENA (Apr. 28, 2017) – Caltech baseball needed a standout performance from starting pitcher Jonah Krop and that’s exactly what they got when the Beavers hosted Saint Katherine College in the first of a three-game weekend series on Friday afternoon.

Behind the strong-armed Krop, the Beavers defeated the Firebirds, 3-1, for their eighth victory of the season. Krop fired five scoreless innings to start the game and maneuvered around the adversity he faced in the sixth inning and beyond, almost emotionless on the mound. He certainly had his stuff working, as the Firebirds could only muster three hits on the sophomore. Krop also limited the walks, allowing just three free passes over nine innings while striking out five. After taking his lumps as a freshman, Krop took a big step forward in 2017 as the Beavers’ top pitching option. He turned in a similar performance in the Beavers’ historic victory over Pomona-Pitzer Colleges back on Mar. 31.

Caltech staked its pitcher to an early lead in the second inning when the returning Chris McCarron knocked in junior Garrett Levine on a shot through the right side.

Not to be outdone by Krop’s big game, McCarron took responsibility for all three of the Beavers’ runs and put his team ahead in the eighth inning. With the bases loaded, McCarron floated a single over the head of the Firebirds’ shortstop to score senior Kai Kirk and sophomore Mark Burleson, both of whom provided Caltech with a spark at the top of the order. McCarron had been battling a hand injury for the better part of the last month but received clearance to slot in as the designated hitter for the Beavers’ final games in the first of her team’s two weekend games.

Occidental attacked quickly and led by four by the time Percin took advantage of an exclusion. The Beavers exhibited some of their most defensive moments of the game in the second quarter when they held the Tigers to just four goals in the second half. Head Coach Jon Bendetke’s Beavers finished their season 3-17 overall and received positive contributions up and down their young squad. They will look to build upon their 2017 next spring when they’ll look for the first SCIAC win in program history.

Women’s water polo closes out season in SCIAC Tournament

GOCALTECH.COM

Actual Sports Content Editor

LA VERNE, Calif. (Apr. 21, 2017) – Caltech women’s water polo finished up its season in the SCIAC Championships hosted by the University of La Verne over the weekend, first against Occidental College on Friday before taking on the University of Redlands on Saturday. Sophomore Brittny Percin finished her season on a seven-game scoring streak and with 55 total goals over 18 games, topping her freshman total (53) while finishing one goal off of Ashley Grant ’07’s program record.

Friday: Caltech 4, Occidental 18

Percin extended her scoring streak to six games in the first of her team’s two weekend games. Occidental attacked quickly and led by four by the time Percin took advantage of an exclusion. The Beavers exhibited some of their most defensive moments of the game in the second quarter when they held the Tigers to just four goals in the second half. Head Coach Jon Bendetke’s Beavers finished their season 3-17 overall and received positive contributions up and down their young squad. They will look to build upon their 2017 next spring when they’ll look for the first SCIAC win in program history.

Baseball wraps season, Katherine honors seniors Doubleheader

GOCALTECH.COM

Actual Sports Content Editor

PASADENA (Apr. 29, 2017) – Caltech Baseball brought a successful 2017 season to an end on Saturday with an afternoon doubleheader against St. Katherine College. While the Beavers could not quite recreate the success from Friday’s opening game in the series, one Beaver is now in sole possession of a key single-season record.

Sophomore Mark Burleson wrapped 2017 as Caltech’s record holder for hits in a single season, breaking the joint record formerly held by Brian Panserin ’12 and Greg Fricke ’00 with 40 hits over 38 games. Not to be outdone, fellow sophomore Connor Moffatt had a career year in his own right. Moffatt’s .40 hits tied the previous record held by Panserini and Fricke and his 10 doubles tied a single-season record occupied by four former Beavers and one of his teammates – Burleson, who doubled 10 times in his freshman season. Both players should be building blocks for Head Coach Matthew Levine on a shot through the right side.

McCarren, who led the team with a robust .368 batting average, also went a perfect 1-for-1 in steal attempts. Speaking of steals, the seniors, looking to make one final impression in the orange and white were also active on the basepaths. Senior Kai Kirk, who started in left field swiped two bags while fellow senior Harrison Jacobs stole second in the first inning.

Seniors Kai Kirk, Tim Menninger, Harrison Jacobs, John Galden, Schaeffer Reed, J.D. Feist and Matthew Edwards were honored for their contributions to the program in a pre-game ceremony.

The Beavers defense only gave up two goals in the third period before Percin added to her scoring total on a pass from junior Devi Gunapathi. Freshman goalie Sarah Kreider made three saves for the Beavers.

Saturday: Caltech 4, Redlands 14

The second day of the tournament went slightly better for the Beavers against Redlands. The first minutes of the game were close as Johnston knocked the game at one with five minutes remaining in the first quarter. Seconds later, the Bulldogs fired off four more goals to put the Beavers at a five-goal deficit to end the period. Percin scored twice more and freshman Mackenzie Wooten scored her second goal of the season on a pass from Percin, whose final goal came on a buzzer-beater in the final frame. The Beavers’ defense tightened late, holding the Bulldogs to just four goals in the second half.

Head Coach Jon Bendetke’s Beavers finished their season 3-17 overall and received positive contributions up and down their young squad. They will look to build upon their 2017 next spring when they’ll look for the first SCIAC win in program history.
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 small room just off the lounge in Winnett. All students are welcome, from total beginners to more experienced meditators.

Mailing list and MP3 archive: counseling.caltech.edu/students/meditation
ASCIT Minutes
Meetings are every week in SAC 13

ASCIT Board of Directors Meeting
Minutes for 28 April 2017. Taken by Alice Zhai.
Officers Present: Andrew Montequin, Tim Liu, Sakthi Vetrivel, Kalyn Chang, Alice Zhai
Guests: Sara Adams, Sarah Crucilla, Vincent Park
Call to Order: 12:18pm

President’s Report (Andrew):
- Meeting with Rachael and Joe Shepherd about Bechtel town hall meeting Monday, May 1

Officer’s Reports:
V.P. of Academic Affairs (ARC Chair: Tim):
- ASCIT teaching award nominations will be up until next week
- Writing a survey about academic advising and how students use it to see whether people find it helpful
- Met with math department about rearranging the curriculum
- Course capture is happening - people will start recording lectures
- Appointing student reps on student faculty board committees
V.P. of Non-Academic Affairs (IHC Chair: Rachael):
- Absent
Director of Operations (Sakthi):
- Got proofs for 15-16 yearbooks - actual copies will be distributed soon
- Looking into getting an ASCIT laptop
Treasurer (Kalyn):
- Multihouse funding pairs for this term are Fleming/Lloyd, Page/Avery, Blacker/Ricketts, and Dabney/Ruddock - none of the funds have been used yet
- Filing ASCIT’s tax return
- Vincent Park pitched for funding for Chester wine tasting

Social Director (Robin):
- ASCIT Movie Night is on Friday, May 3

Secretary (Alice):
- Nothing to report

If anyone has any questions or concerns about a section of the minutes please email the appropriate officer. We are happy to answer any questions.
Meeting Adjourned: 12:49pm

Crossword

Across

Down

Announcements
THE CALIFORNIA TECH
MAY 1, 2017

A 3-workshop series offered twice this term. Pre-screening is required - call the counseling center’s front desk at (626) 395-8331 for more information.

- Learn how stress affects you, and make a personalized stress response profile.
- Learn tools for being with stressful and difficult emotional experiences when you can’t easily change them.
- Get a clearer sense of your moment-to-moment experiences.
- Learn how to separate from unhelpful patterns of thinking.
- Get a clearer sense of what’s important to you, and how you can make choices in line with that.

Section 1: Wednesdays 4:00 - 5:00, April 19, April 26, and May 3rd
Section 2: Mondays 4:00 - 5:00, May 8, May 15, and May 22nd
Location: 229 Sherman Fairchild Library
Answers to current crossword (pg 7)

- http://puzzlechoice.com

The California Tech

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