



Tech scientists make black hole discovery

MARCUS WOO
Caltech Science Writer

When a massive star exhausts its fuel, it collapses under its own gravity and produces a black hole, an object so dense that not even light can escape its gravitational grip.

According to a new analysis by an astrophysicist at Caltech, just before the black hole forms, the dying star may generate a distinct burst of light that will allow astronomers to witness the birth of a new black hole for the first time.

Tony Piro, a postdoctoral scholar at Caltech, describes this signature light burst in a paper published in the May 1 issue of the *Astrophysical Journal Letters*. While some dying stars that result in black holes explode as gamma-ray bursts, which are among the most energetic phenomena in the universe, those cases are rare, requiring exotic circumstances, Piro explains.

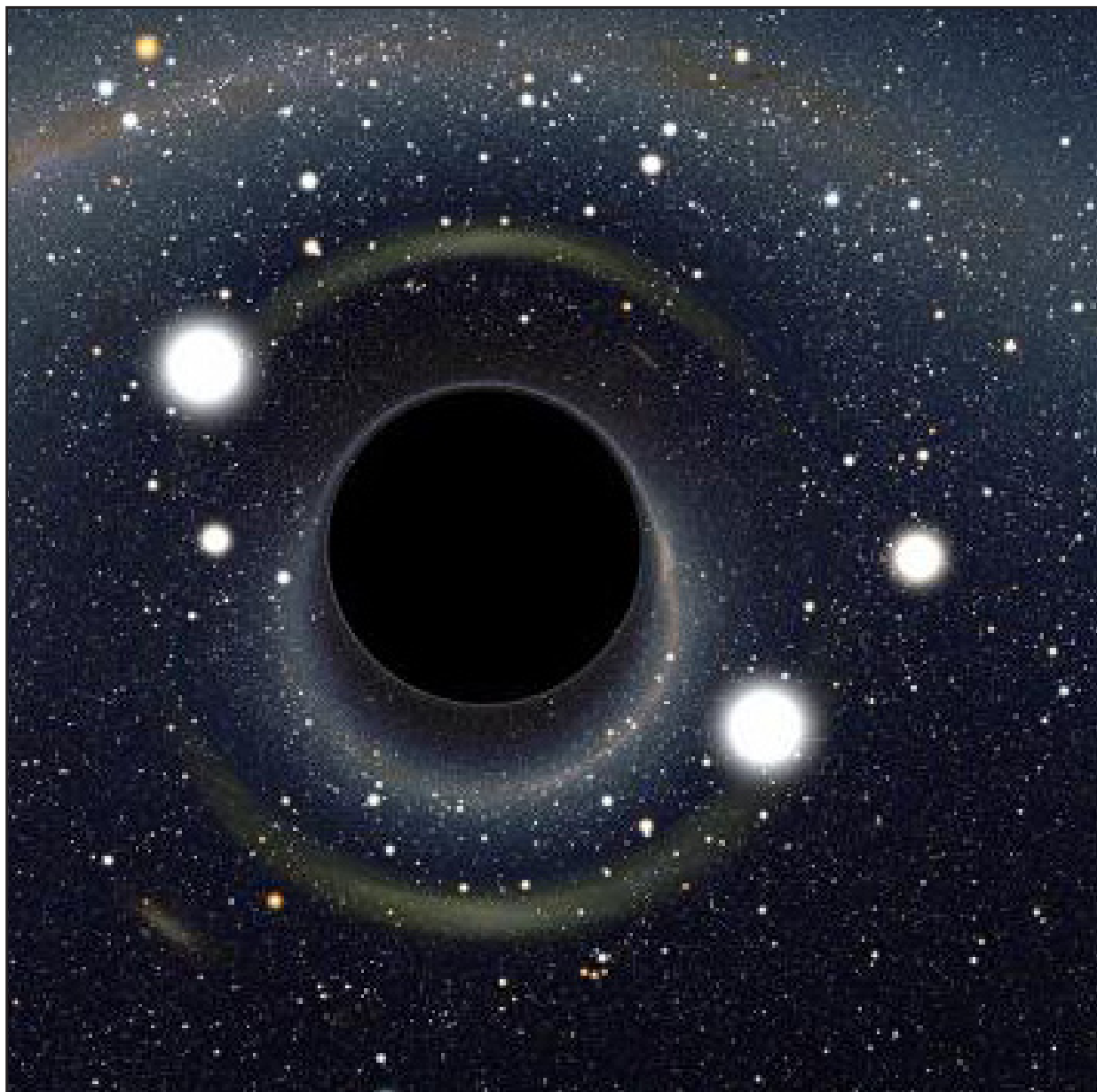
"We don't think most run-of-the-mill black holes are created that way."

In most cases, according to one hypothesis, a dying star produces a black hole without a bang or a flash: the star would seemingly vanish from the sky—an event dubbed an unnova.

"You don't see a burst," he says. "You see a disappearance."

But, Piro hypothesizes, that may not be the case.

"Maybe they're not as boring as we thought," he says.



A computer-generated image of the light distortions created by a black hole.

- Alain Riazuelo, IAP/UPMC/CNRS

a tenth of the sun's mass (since energy and mass are equivalent, per $E = mc^2$).

According to a little-known paper written in 1980 by Dmitry Nadezhin of the Alikhanov Institute for Theoretical and Experimental Physics in Russia, this rapid loss of mass means that the gravitational strength of the dying star's core would abruptly drop. When that happens, the outer gaseous layers—mainly hydrogen—still surrounding the core would rush outward, generating a shock wave that would hurtle through the outer layers at about 1,000 kilometers per second (more than 2 million miles per hour).

Using computer simulations, two astronomers at UC Santa Cruz, Elizabeth Lovegrove and Stan Woosley, recently found that when the shock wave strikes the outer surface of the gaseous layers, it would heat the gas at the surface, producing a glow that would shine for about a year—a potentially promising signal of a black-hole birth. Although about a million times brighter than the sun, this glow would be relatively dim compared to other stars. "It would be hard to see, even in galaxies that are relatively close to us," says Piro.

But now Piro says he has found a more promising signal.

Continued on Page 3

According to well-established theory, when a massive star dies, its core collapses under its own weight. As it collapses, the protons and electrons that make up the core merge and produce neutrons. For a

few seconds—before it ultimately collapses into a black hole—the core becomes an extremely dense object called a neutron star, which is as dense as the sun would be if squeezed into a sphere with a radius of about 10 kilometers (roughly 6 miles).

This collapsing process also creates neutrinos, which are particles that zip through almost all matter at nearly the speed of light.

As the neutrinos stream out from the core, they carry away a lot of energy—representing about

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Helping readers burst out of the Caltech bubble

Need to know

< **100** words about the world this week - topics sorted from good to bad

by *The Tech Eds*

Solar plane takes flight	20 hours in the air, the Solar Impulse flew only on solar power	[BBC]
Economy adds jobs	165,000 jobs, more than were predicted, were created in April	[CNN]
War fort found in Georgia	234 -year-old Carr's Fort from Revolutionary War was uncovered	[ABC]
New Dutch king crowned	46 -year-old Dutch King Willem-Alexander is Europe's youngest king	[TIME]
Wildfires burn in CA	28,000 -acre fire in Ventura County is burning since Thursday	[CNN]
SARS-like Virus emerges	7 cases of a SARS-related virus were reported in Saudi Arabia	[TIME]
Deadliest month in Iraq	712 people killed in April, Iraq's deadliest month since June 2009	[TIME]

Food with Mannion!

Do you like eating food?

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The Tech will be beginning a new column to chronicle the foodie experiences of new writers every other week... The Catch: They'll be going head-to-head with Tom Mannion who will be reviewing the same restaurant. If you have ever thought you were more of a gourmand than our resident master chef, now's your chance to prove it!

Email us for a spot on the list at tech@caltech.edu

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ASCIT Minutes

Minutes for April 29th, 2013. Taken by Allika Walvekar

Officers present: Diego Caporale, Zach Rivkin, Pushpa Neppala, Malvika Verma, Mario Zubia, Connie Hseuh, Michelle Tang, Puikie Cheng, Monica Enlow, Connor Coley, Allika Walvekar

Guests: Samantha Marie Piskiewicz, Leslie Timms, Alexander Mouschovias, Catherine Xie, Josie Kishi, Catherine Jamshidi, Connor Rosen

Funding Requests: ASCIT granted the all male acappella group, The Ketones, \$300 to buy sheet music. ASCIT also funded Caltech Y's request of \$500 for the annual Health Fair.

Call to Order: 10:06pm

President's Report (Diego / Zach):

This year's leadership conference was not well attended. This is most likely due to several class trips scheduled the same day and the current tensions between the students and admins. In the future, Caltech should avoid planning the leadership conference when so many people (Esp. freshman and sophomores) are away. ASCIT and IHC will work to make sure this does not happen again. That aside, the sessions that were offered seemed to be useful to a wide range of leadership roles. This type of diversity should be carried over to next year's Leadership Conference when we have more students.

ASCIT secretary signups will be posted on Tuesday morning. Any and all interested should sign up.

The town hall meeting for opinions on the Presidential Search is coming up on May 8th at 12pm.

The charter for the Honor Code Committee will be sent out by email by Tuesday with information about how people will be able to sign up.

Officer's Reports:

V.P. of Academic Affairs (ARC Chair: Pushpa):

The ARC is currently going through the nominations for ASCIT Teaching awards which will be held on Thursday May 23rd. They are in the process of contacting TAs and professors.

Pushpa emailed Ray for the final report on the Honor Code Survey, and hopes to hear back from him shortly.

Pushpa is still working on communicating with Betsy Mitchell and Cassandra regarding undergraduate satisfaction with PE classes.

The next SFL will be held on May 14th

V.P. of Non-Academic Affairs (IHC Chair: Connor):

The IHC has been working on the terms regarding Ricketts's participation in Rotation. Once that policy is finalized, Connor will send an announcement through the presidents or ug-spam.

Committee chair sign ups have gone down for the first round of appointments. The next round of appointments will be faculty student representatives, which will go up in a few weeks.

Director of Operations (Mario):

If you are a club that would like to be represented at future Club Fairs, then please submit the paperwork found at clubs.caltech.edu, so that you can be included.

Blacker collected their lights. Mario is working on securing the microphone stand.

Treasurer (Puikie):

Puikie reimbursed checks to BoD members.

She would like to remind everyone that the Take A Professor to Lunch program is still active. Feel free to email her with questions and requests.

Social Director (Michelle):

Upcoming Events: Rathskellar (Week 6), Ruddock Frosh Party (Week 6), BFP (Week 8), Europarty (Week 9 - June 1st)

ASCIT Movie Night will probably be moved to a later date in the term so that students can choose between Iron Man 3 and Star Trek. The current tentative date is May 25th.

Secretary (Allika):

Allika posted the new Calendar for May.

She made a collage on ASCIT Formal for the donors and Mt. Wilson superintendent to show our gratitude.

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: 11:15

New kind of cosmic flash may reveal black hole birth

Continued from Page 1

In his new study, he examines in more detail what might happen at the moment when the shock wave hits the star's surface, and he calculates that the impact itself would make a flash 10 to 100 times brighter than the glow predicted by Lovegrove and Woosley.

"That flash is going to be very bright, and it gives us the best chance for actually observing that this event occurred," Piro explains. "This is what you really want to look for."

Such a flash would be dim compared to exploding stars called supernovae, for example, but it would be luminous enough to be

we're going to start getting worried if we don't find these things." But for now, he says, his expectations are perfectly sound.

With Piro's analysis in hand, astronomers should be able to design and fine-tune additional surveys to maximize their chances of witnessing a black-hole birth in the near future. In 2015, the next generation of PTF, called the Zwicky Transient Facility (ZTF), is slated to begin; it will be even more sensitive, improving by several times the chances of finding those flashes. "Caltech is therefore



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“ Within the next decade, the Large Synoptic Survey Telescope (LSST) will begin a massive survey of the entire night sky.

detectable in nearby galaxies, he says.

The flash, which would shine for 3 to 10 days before fading, would be very bright in optical wavelengths—and at its very brightest in ultraviolet wavelengths.

Piro estimates that astronomers should be able to see one of these events per year on average. Surveys that watch the skies for flashes of light like supernovae—surveys such as the Palomar Transient Factory (PTF), led by Caltech—are well suited to discover these unique events, he says. The intermediate Palomar Transient Factory (iPTF), which improves on the PTF and just began surveying in February, may be able to find a couple of these events per year. Neither survey has observed any black-hole flashes as of yet, says Piro, but that does not rule out their existence. "Eventually

really well-positioned to look for transient events like this," Piro says.

Within the next decade, the Large Synoptic Survey Telescope (LSST) will begin a massive survey of the entire night sky. "If LSST isn't regularly seeing these kinds of events, then that's going to tell us that maybe there's something wrong with this picture, or that black-hole formation is much rarer than we thought," he says.

The *Astrophysical Journal Letters* paper is titled "Taking the 'un' out of unnovae." This research was supported by the National Science Foundation, NASA, and the Sherman Fairchild Foundation.

Join the conversation!

The new Caltech opinion journal, *The Hamiltonian*, is looking for writers to contribute articles on topics in science, technology, politics, economics, philosophy, history, social issues, foreign policy, and local events.*

Undergraduates, graduate students, faculty, and staff are all invited to participate. We are looking for writers committed to defending and exploring their views in accordance with the rigorous intellectual standards that make Caltech so unique.

For more information, contact us by e-mail at hamiltonian@caltech.edu

*Serial commas appreciated, but not required.

The Irreverent Review: *Makers: The New Industrial Revolution* by Chris Anderson

MICEALA SHOCKLEE
Contributing Writer

Technology. DIY. Cool shit.
That is what the Maker is all about.

the excitement of a sugar-hyped child at Disneyland to the plastic creatures birthed through the mechanical vaginas of 3-D printers and the growing population of new Frankensteins (more commonly

itself proof of the powerful products the human brain is capable of generating. Though it is clear from the beginning that Chris Anderson has strong opinions about the way that industry does and should work, his book is so refreshingly resonant with Techer life, generally socially relevant, and written in prose so relishable it could be a hot dog condiment, *Makers: The New Industrial Revolution* earns itself five out of five stars.

“

Anderson proposes his own prototype for the global Maker market to come, pointing with all the excitement of a sugar-hyped child at Disneyland to the plastic creatures birthed through the mechanical vaginas of 3-D printers and the growing population of new Frankensteins.

”

It is also what DIY Drones CEO Chris Anderson's aptly named book, *Makers: The New Industrial Revolution* is all about. Part history and part projection, Anderson's book sleuths its way through the story of how the "Web generation" met the real world.

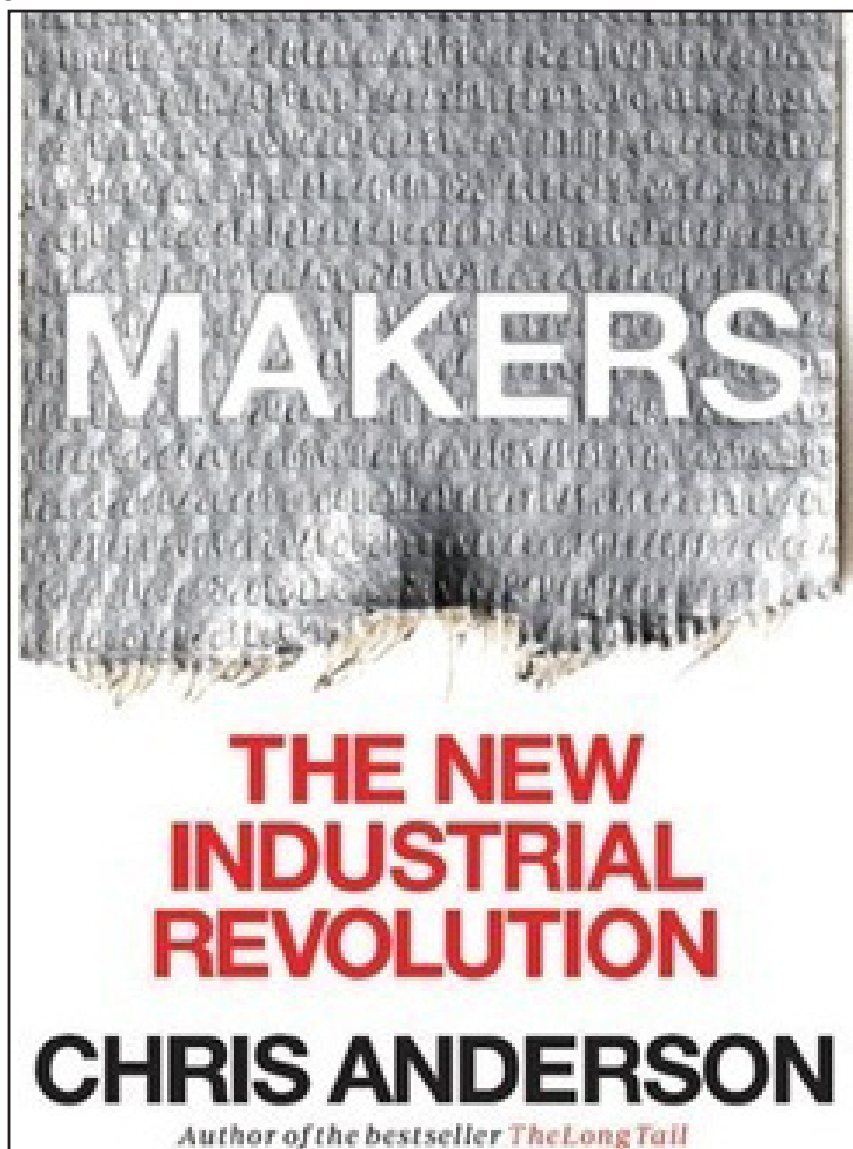
Anderson proposes his own prototype for the global Maker market to come, pointing with all

known as biohackers, or members of the DIYbio movement).

Complete with an appendix on how to use CNC machines and the other shiny toys—excuse me, tools—typically found, complete with shrine and slaves, in the makerspaces that are breeding their way across the nation with the speed of bunnies on crack, Chris Anderson's latest book is in

Interested in the Maker life? Get involved in the Los Angeles scene through lamakerspace.com.

Published something? Inquire about being featured in the Irreverent Review! Contact Miceala Shocklee at mshocklee@caltech.edu



- courtesy of Miceala Shocklee



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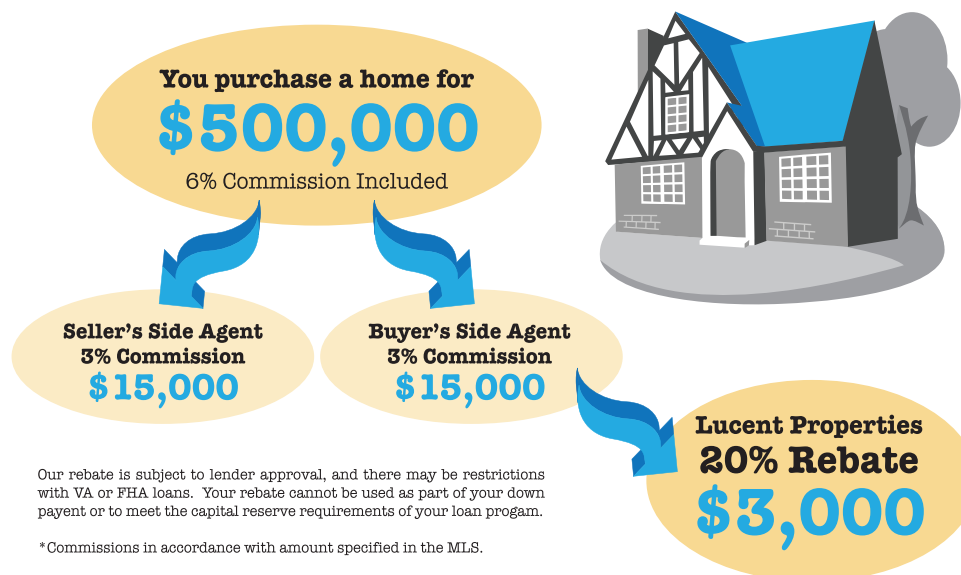
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Cameron Carpenter delivers stunning performance at the LA Philharmonic

CASEY HANDMER
Contributing Writer

Last year I wrote with extreme enthusiasm about the LA Phil debut of American organist Cameron Carpenter. So it was with substantial excitement that I anticipated his recital the following year.

As is his custom, Cameron did not publicise the evening's program in advance. Instead he gave a preshow talk until three minutes before the start, despite having pulled an all-nighter. The question and answer session revealed a deep musical insight and carefully considered positions, elaborating briefly on the innovations of Hope-Jones in the 1920s, the errors of Virgil Fox, and the extent to which Marc-Andre Hamelin is the perfect embodiment of Toscanini's unachieved ideal, the delivery of the text.

He also spoke at length about the debut of the digital organ in early 2014, a decade long project of his to provide for the organ what has long been considered normal for all other instruments - a standardized yet infinitely customizable interface and tonal palette.

Cameron began with the *Prelude* from the Back Cello Suite No. 1 in G major, building on the theme with inversions and interpolations of his own. He followed this immediately with the *Bach Fantasia and Fugue* in G minor (BWV 542, not 578).

The fugue in particular drove relentlessly, interweaving its many voices with equal consistency despite a much wider variation in registration than might traditionally be employed.

Following this Cameron played for us his organ transcription of Isaac Albeniz' *Evocación* from his Iberia suite. I saw this as a possible nod to Hamelin's extraordinary recording of the suite in 2005, although the piece certainly plays well on the organ. In some ways the organ swaps limitations in tone for limitations in touch, but in no way loses its poetic ability.

Cameron then asked us to join him for a pseudo-intellectual moment as he explained what he meant by the organ being an irony-free instrument. As a result, the performer must give back what the machine itself lacks, in particular, "... sensuality, which the organ can give us in spades, in direct defiance of all that is sacred and holy."

From this he segued to a discussion of Marcel Dupre, one of the most significant composers and organists of the 20th century. "Behind his bourgeois high-collared facade lurked a schizophrenic fashion show of musical personalities." To illustrate this he performed Dupre's *Variations on Noel*, in which the basic medieval carol melody is sliced, diced, and examined from every angle.



- cbsnews.com

He rounded out the first half with his transcription of Richard Rogers' score for George Balachine's ballet *Slaughter on 10th Avenue*, featured in the 1936 Broadway musical comedy *On Your Toes*.

Featuring a superb collage of evocative period music, the piece is defined by the presence of a soft, simple melody at its core underscoring the central tragedy of the work.

The second half began with a transcription of the highly recognizable *Scherzo* from Tchaikovsky's 6th symphony, a piece perfectly suited to performance on the organ. Cameron followed this with a discussion of the music and life of Charles Ives, a composer who lived and worked in near-total isolation.

As a result, his music is still original today. In Cameron's words "... still totally avant garde. It's not even in the garde..."

He introduced the next piece as the 3rd movement from the *Concord Sonata*, a piece that's nearly 100 years old. The sonata's movements are entitled Emerson, Hawthorne, The Alcotts, and Thoreau, after the principle Transcendentalists that formed the center of the movement into which the piece was composed.

Following this generous introduction, he duly dispatched the very musically interesting piece, complete with the "most sycophantically stereotypic church organ sound [Cameron] can muster" for the snippet of *Here Comes The Bride*.

Next up Cameron sought to honour the spirit of Brooklyn

(about which his previous performances on that stage this week had been) by performing an improvisation on a theme generated by translating the letters b, r, o, o, etc onto the keyboard. But first he was careful to define improvisation as "the performance of a work of music which has not yet been notated and rehearsed and will not be heard again, which is not the same as making it up as you go along."

He also told us he'd draw on George Gershwin and Lou Reed as he progressed. He took a break to announce that the third movement would have a poetic rather than a

musical theme, and recited Walt Whitman poem 68:

Sometimes with one I love,
I fill myself with rage, for fear I
effuse unreturn'd love;

But now I think there is
no unreturn'd love - the pay is
certain, one way or another;

(I loved a certain person
ardently, and my love was not
return'd;

Yet out of that, I have written
these songs.)

After such a musical treat the audience demanded no fewer than a dozen curtain calls, and received two encores, including a transcription of Chopin's *Minute Waltz*, showcasing Cameron's extreme ability to play with his feet. During the first encore, an error with preset registrations had the organ go silent for a stanza.

Without skipping a beat he continued to play, giving a rare insight into the clicks and clacks of the organ console, and providing a (hopefully intentional) drop between cascades of rich sound.

Overall, the audience and I attended with varied but high expectations. None were left disappointed.

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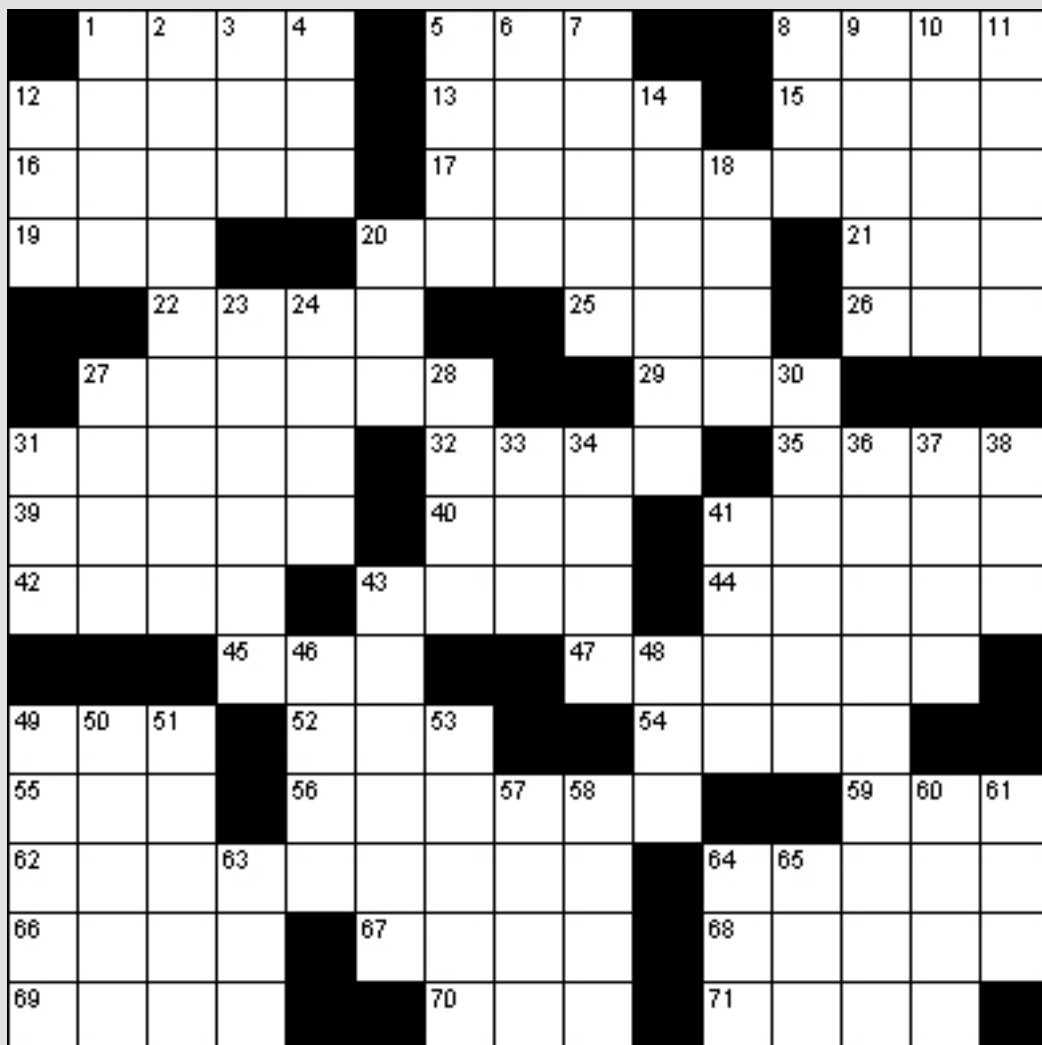
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Today's Puzzle: Crossword

(It's correct, Andy, I promise)



[<http://www.puzzlechoice.com/>]

Across

1. Mountain top
5. In favor of
8. Combustible material
12. Two
13. Optical device
15. Small island
16. Colorado ski resort
17. Unharmed
19. First note of a major scale
20. Aaft
21. Thin-shelled object
22. Method of transport
25. Sum up
26. Cereal grass
27. Felines are fond of this herb
29. Prevarication
31. State capital, ___ Rouge
32. Gemstone
35. Box
39. Portents
40. Fall behind
41. Musical notation
42. Part of a church
43. Song for one
44. Whittled
45. Part of a minute, in short
47. Stringed instrument
49. Lout
52. Biblical boat

54. Part of a plant
55. Everything
56. Country on the Pacific, Arctic and Atlantic
59. Australian flightless bird
62. Roald Amundsen got there first
64. South American mountain chain
66. Within
67. Additional
68. Pretext
69. Visionary
70. Sever
71. Engrave

Down

1. Cuban currency
2. Asian river
3. Expert
4. Knowledge or understanding
5. Arithmetic operation
6. Let for money
7. Beginning
8. Healthy
9. Guide
10. Lament
11. Shelf
12. Father
14. Rolled up document
18. Not in favor
20. Triple world heavyweight champion, Muhammad ___
23. Make amends for
24. Lodges
27. Live in a tent
28. Sport played on horseback
30. All assets and liabilities
31. Constrictor
33. Friend
34. Excited
36. Emergency services professional
37. Affirm
38. Arm of the Indian Ocean, ___ Sea
41. Meat skewer
43. Abrasion
46. Every one
48. Country, initially
49. Fertile part of a desert
50. Unaccompanied
51. Musical instrument
53. Small hill
57. In addition
58. Far down
60. Net
61. Employ
63. High rocky hill
64. Grow older
65. Hard-shelled seed

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Five athletes compete at Occidental Invitational



Yet again, Paige Logan shows off her dance moves after breaking her own school record in shot put. We're not actually sure what this one is called, but we're sure it's gonna catch on.

- gocaltech.com

GOCALTECH.COM The Real Sports Editor

Five Caltech track and field athletes participated in one of the largest track and field events in the southern California region on Saturday afternoon.

The Occidental Invitational featured well over 1,000 participants from nearly 75 different organizations. Highlighting the meet for Caltech was Paige Logan's

effort in the shot put. For the fourth time this season she re-set her own school record.

Her top throw on the afternoon of 41' 9 3/4" was nearly two-feet farther than her previous school mark.

Stephanie Reynolds ran the 1500 meter race in 4:54.54 which was the third fastest time among competitors from NCAA Division III schools. Also competing in a distance race was Juliette Becker.

The junior ran the 3000 meter steeplechase in 12:15.48.

Sarah Wright competed in the 100 meter hurdle race in 16.27. The senior has one meet left in her Beaver career when she participated in the CMS multi-duals next weekend.

Eric Martin toed the line in the 800 meter race and his time of 1:57.81 was the fifth best mark among NCAA Division III schools.

Scoreboard

April 30: Baseball vs Chapman
L, 15-1

May 3: Women's Tennis vs Whittier
L, 5-4

vs CMS
L, 5-0

May 3: Men's Tennis vs Whittier
L, 8-1

vs CMS
L, 5-0

Beavers close solid year at SCIAC Championships

GOCALTECH.COM The Real Sports Editor

The Caltech women's tennis season came to a close at the 2013 SCIAC Championships hosted by the La Verne.

The event brought to a close one of the more successful seasons in recent memory for the Beavers.

Caltech started the championships against top seeded, and the nation's No. 2 team, ClaremontMuddScripps.

The Athenas won the match 6-0. The defending champions dropped just three games during doubles play then clinched the match with straight sets wins at the No. 4-No. 6 singles positions.

Playing in the consolation semifinals the Beavers nearly upset Whittier but the Poets prevailed 5-4.

In what proved to be a pivotal difference in the match, the fifth seed Poets took two of the three doubles matches.

Caltech's top team of Rebekah Kitto and Monica Li won 8-3 as the team's headed into singles play.

The Beavers cruised in the top three matches as Kitto, Li and Stephanie Kwan all won in straight sets.

The trio combined to drop just 12 of a possible 30 games.

However, the singles matches at the No. 4-No.6 matches went



Senior Stephanie Kwan, seconds before she caught the ball, dropped it at her feet, said "Game" to her opponent, and walked off the court dripping in swag.

- gocaltech.com

Whittier's way as they pulled out the team win.

Caltech didn't leave the championships without a win as the exacted a measure of revenge against Cal Lutheran.

After falling to Regals earlier in the year 5-4, the Beavers won

their final match of the season 6-3 against the seventh seed.

The Beavers started well as they won two of the three doubles matches.

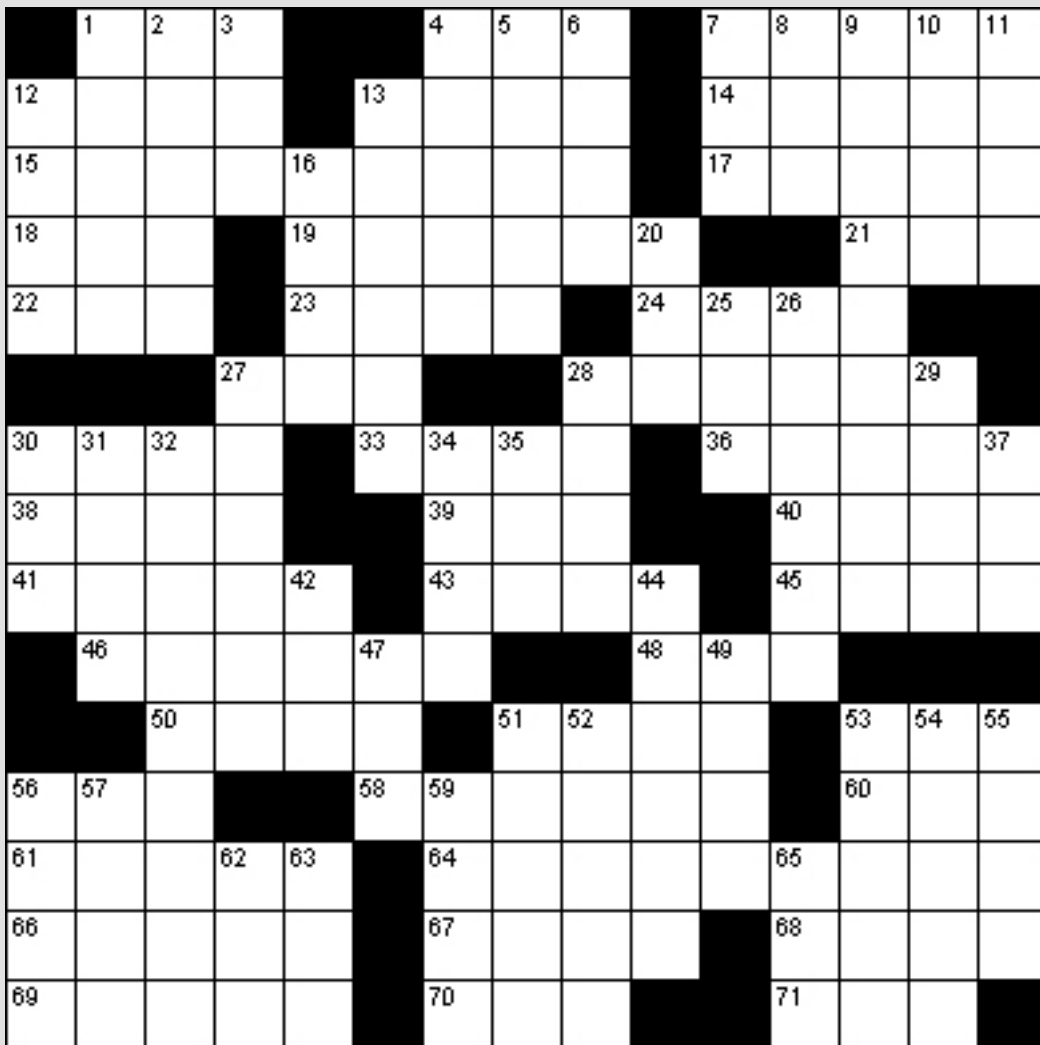
Kitto and Li prevailed in the top spot while Kwan and Jessica Yu teamed up for a victory at the

No. 2 spot. Caltech continued that winning trend into singles play. Kitto cruised in her match at the No. 1 spot 6-0, 6-3 while Li pulled out a 7-6, 7-5 win at the No. 2 position.

Jessica Yeung and Zeke Millikan each recorded straight sets wins

at the No. 5 and No. 6 spots respectively to seal the win in the seventh place match. The Beavers prevailed in seven matches during the year; three of which came during SCIAC play. Both win totals are the most for a Caltech squad since the 2000 season.

We goofed on last week's puzzle, but hopefully this makes up for it!



[<http://www.puzzlechoice.com/>]

Across

- 1. Lower part of a skull
- 4. Small viper
- 7. Globe
- 12. Couch
- 13. Poker stake
- 14. Farewell remark
- 15. Canoe stabilizer
- 17. French artist 1834-1917, Edgar ____
- 18. Beer
- 19. English composer 1862-1934, Frederick ____
- 21. Frequently
- 22. For each
- 23. Form of security
- 24. Bucket
- 27. Affirmative
- 28. Composer famous for his Water Music
- 30. Salvage
- 33. West African country
- 36. Giant
- 38. Biblical brother
- 39. Spoil
- 40. Film director, ____ Preminger
- 41. Stringed instrument
- 43. Is obliged to pay
- 45. A mix of boys and girls, in short
- 46. Bohemian composer, Antonin Leopold ____
- 48. Attempt

- 50. Water jug
- 51. Ripped
- 53. Gremlin
- 56. Skill
- 58. Polish composer Frederic ____
- 60. Observe
- 61. Bind
- 64. Worldwide
- 66. Drama set to music
- 67. A telephone connection
- 68. Female relative
- 69. Sometimes given for thoughts
- 70. Expert
- 71. Obtain

Down

- 1. Unit of electrical energy
- 2. Later
- 3. Armed conflict
- 4. Can be acute or obtuse
- 5. Beer mug
- 6. Lima is the capital
- 7. Batch
- 8. Type of Poem
- 9. Opera by Giuseppe Verdi
- 10. Part of a tree or book
- 11. Fine particles
- 12. As seen on TV

- 13. Type of discrimination
- 16. Not working
- 20. Health resort near a spring
- 25. Insect
- 26. Foolish conduct
- 27. Color
- 28. Charter
- 29. Tardy
- 30. Pouch
- 31. Lying in
- 32. Type of fabric
- 34. Berserk
- 35. Body of rules
- 37. Indicate assent
- 42. Metal-bearing mineral
- 44. Attempt with effort
- 47. Part of a circle
- 49. First name of philosopher, Descartes
- 51. Bracer
- 52. Speak up
- 53. Publish
- 54. Intended
- 55. Fur
- 56. At the peak
- 57. Mature
- 59. Polynesian dance
- 62. Large vase
- 63. Salary
- 65. Type of music, usually for piano

For more photos, videos, and archives of previous issues, check out the Tech website!

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