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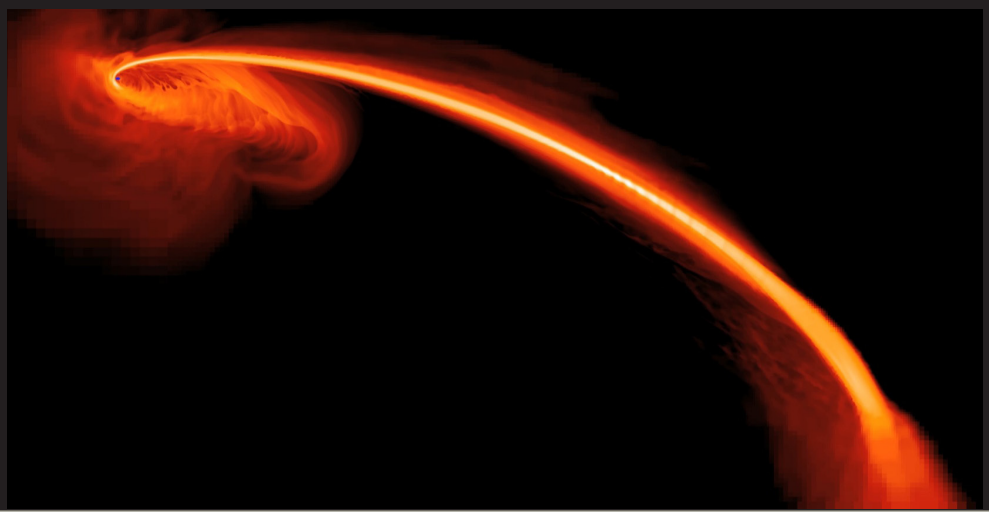
CS BITS & BYTES

HIGHLIGHTING INNOVATIVE COMPUTER SCIENCE RESEARCH

Cosmic Slurp

Researchers use computer simulations to understand and predict signs of black holes swallowing stars



ABOVE IMAGE

COMPUTER-SIMULATED IMAGE SHOWING GAS FROM A STAR THAT IS RIPPED APART BY TIDAL FORCES AS IT FALLS INTO A BLACK HOLE.

CREDIT: NASA, S. GEZARI (THE JOHNS HOPKINS UNIVERSITY), AND J. GUILLOCHON (UNIVERSITY OF CALIFORNIA, SANTA CRUZ)

"There are many situations in astrophysics where we cannot get insight into a sequence of events that played out without simulations. We cannot stand next to the black hole and look at how it accretes gas. So we use simulations to learn about these distant and extreme environments."

TAMARA BOGDANOVIC
GEORGIA TECH

Somewhere out in the Universe, an ordinary galaxy like our spins. Then all of a sudden, a flash of light explodes from the galaxy's center. A star orbiting close to a black hole at the center of the galaxy has been sucked in and torn apart by the force of gravity, heating up its gas and sending out a beacon of light to the far reaches of the Universe.

These beacons aren't visible to the naked eye, but in recent decades, with improved telescopes, scientists noticed that some galaxies that previously looked inactive would suddenly light up. Astronomers identified those as galaxies where a central black hole just "ate" a star – an event called a **tidal disruption**. Since black holes by themselves do not emit light, the best chance to discover them in distant galaxies is through tidal disruptions and when they interact with the stars and gas that are around them.

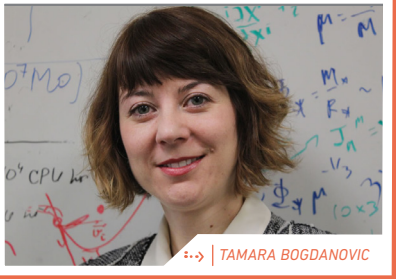
"A tidal disruption is like a black hole putting up a sign that says 'Here I am,'" according to Tamara Bogdanovic, an astronomy professor at Georgia Tech.

Scientists believe that a black hole swallowing a star should have a distinct signature to an observer, reflecting the physics of the phenomenon. By converting these physical properties first into mathematical principles, and then into a computer simulation code, Bogdanovic tries to nail down exactly what the signature of a tidal disruption would look like to someone on Earth.

Bodganovic and her collaborators recently used several of the most powerful supercomputers in the world to simulate the dynamics of a tidal disruption in greater detail than ever before. **The simulations are virtual experiments, where scientists can fast forward, rewind or repeat tidal disruptions to examine the process from many perspectives to explain what's really going on near the gravitational edges of black holes.** This in turn allows the researchers to better understand the physical processes at play.

Who does this stuff ?

Tamara Bogdanovic is an assistant professor of physics at Georgia Tech and a recipient of the prestigious Sloan Research Fellowship awarded to early-career scientists whose achievements identify them as rising stars. Dr. Bogdanovic studied astrophysics in Serbia and went on to get a Ph.D. at Penn State University. When she's not studying the observational signatures associated with supermassive black holes, she enjoys doing yoga and spending time with her family and friends.



TAMARA BOGDANOVIC

TRY THIS OUT

Here are a couple of activities:

1 How much do you know about black holes? To find out, determine whether each statement is a Fact or a Myth!

1. The volume of a black hole is huge.
2. Black holes have no mass.
3. A rotating black hole may lie at the center of our galaxy, the Milky Way.
4. Gravity bends light.
5. Our Sun will eventually become a black hole.
6. Light cannot escape from a black hole.
7. Black holes will pull in everything in the universe and eventually destroy it.
8. NASA sent a space probe into a black hole.
9. The gravity of a black hole is felt everywhere.
10. The gravity that your body creates is felt everywhere.
11. Astronomers have evidence confirming that ordinary black holes are the gateway to worm holes.

2 Discuss the following:

Computer simulations help to provide important insights for many scientific phenomena. Develop a list of criteria for when computer simulations would be used in lieu of building a physical model.

Answers to (1): Myth, Myth, Fact, Fact, Myth, Fact, Myth, Myth, Fact, Fact, Myth. For explanations to each question, visit: http://amazing-space.stsci.edu/resources/explorations/blackholes/lesson/whatisit/myths.html]

ABOVE IMAGE

ARTIST'S CONCEPTUALIZATION OF THE STELLAR ENVIRONMENT AROUND A BLACK HOLE OF ABOUT 10 BILLION SOLAR MASSES. THE VELOCITY OF STARS IN ORBIT (AND CLOSE TO) THE BLACK HOLE HELP TO DETERMINE ITS MASS.

CREDIT: GEMINI OBSERVATORY/AURA ILLUSTRATION BY LYNETTE COOK

Learn More

Now that you've tested your basic knowledge about black holes, visit the Hubble Space Telescope's interactive journey into a black hole.

> http://hubblesite.org/explore_astronomy/black_holes/modules.html

To see what a black hole and its environment might looks like, take a tour of a black hole simulation.

> http://www.newscientist.com/article/dn18498-new-black-hole-simulator-uses-real-star-data.html#.U3uTav0mxet

And, then go on a journey through a wormhole!

> http://www.newscientist.com/blogs/nstv/2012/03/what-a-trip-through-a-wormhole-would-look-like.html

Can't get enough? Then "Fall into a black hole" with this NASA board game.

> http://www.spaceplace.nasa.gov/black-hole-boardgame/en/

ABOUT

CS Bits & Bytes is a bi-weekly newsletter highlighting innovative computer science research. It is our hope that you will use CS Bits & Bytes to engage in the multi-faceted world of computer science to become not just a user, but also a creator of technology. Please visit our website at: www.nsf.gov/cise/csbytes.

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