Saturday Citations: The first Goldilocks black hole; Toxoplasma gondii metabolism; pumping at the speed of muscle

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The globular cluster Omega Centauri — with as many as ten million stars — is seen in all its splendor in this image captured with the WFI camera from ESO's La Silla Observatory. Credit: ESO, CC BY 4.0

This week: Physicists conducted a biological study, engineers built a waste-recycling suit for astronauts (and worm riders), and astronomers identified the first known intermediate-mass black hole, and it's right here in our own galactic back yard.

Pumping water

Observing that human muscle tissue is about 70% water, physicists at the University of Michigan created [a theoretical model](#) of water's role in muscle contraction and report that the speed of a fluid through a [muscle fiber](#) determines [muscle contraction](#) speed. But they also found an odd type of elasticity, which, in accordance with the "Snakes on a Plane" principle, they call odd elasticity. This allows the muscle to generate energy via three-dimensional deformations, as observed by the perpendicular bulging of muscles when they're contracted lengthwise, often while posing in the mirror and referencing the price of admission to the gun show.

U-M physicist Suraj Shankar says, "Our results suggest that even such basic questions as how quickly muscle can contract or how many ways muscle can generate power have new and unexpected answers when one takes a more integrated and holistic view of muscle as a complex and hierarchically organized material rather than just a bag of molecules. Muscle is more than the sum of its parts."

Spacewalk without rhythm

Ideally, astronauts should enjoy spacewalks as observers of the unveiled majesty of the universe without the undignified and diminishing requirement to wear adult diapers. The unhygienic reality of life in space is that human biological requirements supersede our evolution into transdimensional, floating star children and astronauts totally wear

diapers. Another disadvantage is that EVA urination bypasses the recycling system aboard the International Space Station and represents waste in an environment with few resources.

Researchers at Cornell University, inspired by the waste-recycling stillsuits worn by the Fremen people in the films "Dune Part One" and "Dune Two: The Squeakquel," have developed an undersuit that could solve both problems for future astronauts. It incorporates a vacuum-based external catheter that directs pee to a combined forward-reverse osmosis unit and provides a continuous supply of potable water. This is a simplified description of a much more technical piece of kit, which you can read about [here](#).

Parasite Eve

Toxoplasma gondii is a parasite that causes a potentially behavior-altering, incurable condition called toxoplasmosis. It reproduces in felids and ultimately seeks to infect rodents to make them more amenable to approaching cats. There is no vaccine for toxoplasmosis, partially because the biological mechanisms of infection are little studied, so a team at the University of Wisconsin–Madison [conducted an optical imaging study](#) to better understand it. They used a noninvasive technology called optical metabolic imaging in order to monitor [metabolic activity](#) within cells in real time.

They report that over the course of infection, host cells became more oxidized and NAD(P)H lifetime increased—this extra energy powers the parasite during replication. They also found a dynamic in T gondii's interaction with the host cell surface, to which they applied the vaguely revolting name "kiss and spit."

Scientist Gina Gallego-Lopez says, "One cell may be infected while the cells around it are not; it looks like the parasite 'kisses' those cells and

then injects some proteins—kiss and spit," she says. "To our surprise, we were able to see similar changes as the full infection. So it looks like a simple 'kiss' from the parasite is enough to induce changes in the host cell."

New black hole just dropped

Omega Centauri is a globular cluster located in the Milky Way galaxy, 17,090 light-years from the sun and visible from the southern sky. A gravitationally bound bundle of 10 million stars, it's the most massive globular cluster in our galaxy. Scientists believe it's the surviving core of another galaxy that was captured by the Milky Way and stripped of its outer star populations. For years, astronomers have speculated that if it is, in fact, the nucleus of a galaxy, Omega Centauri could contain a central black hole.

Now, researchers at the Max Planck Institute for Astronomy have confirmed this suspicion with a [detailed study](link) of stellar trajectories within the cluster. The researchers compiled a massive catalog of the motions of stars within Omega Centauri, calculating the velocities of 1.4 million stars from 500 Hubble images. They ultimately focused attention on seven fast-moving stars in the central region, which exhibited speeds and movements that could only be explained by an unseen gravitational body.

Here's the cool part: This black hole represents a missing link between stellar-mass [black holes](link) and [supermassive black holes](link)—an intermediate-mass black hole, which has been predicted but never before observed. The reason that it's so much smaller than the black holes normally found in the cores of galaxies is because Omega Centauri itself is frozen in time—with its stable population of core stars and lacking an outer population of stars, the black hole can't feed and increase its mass.

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