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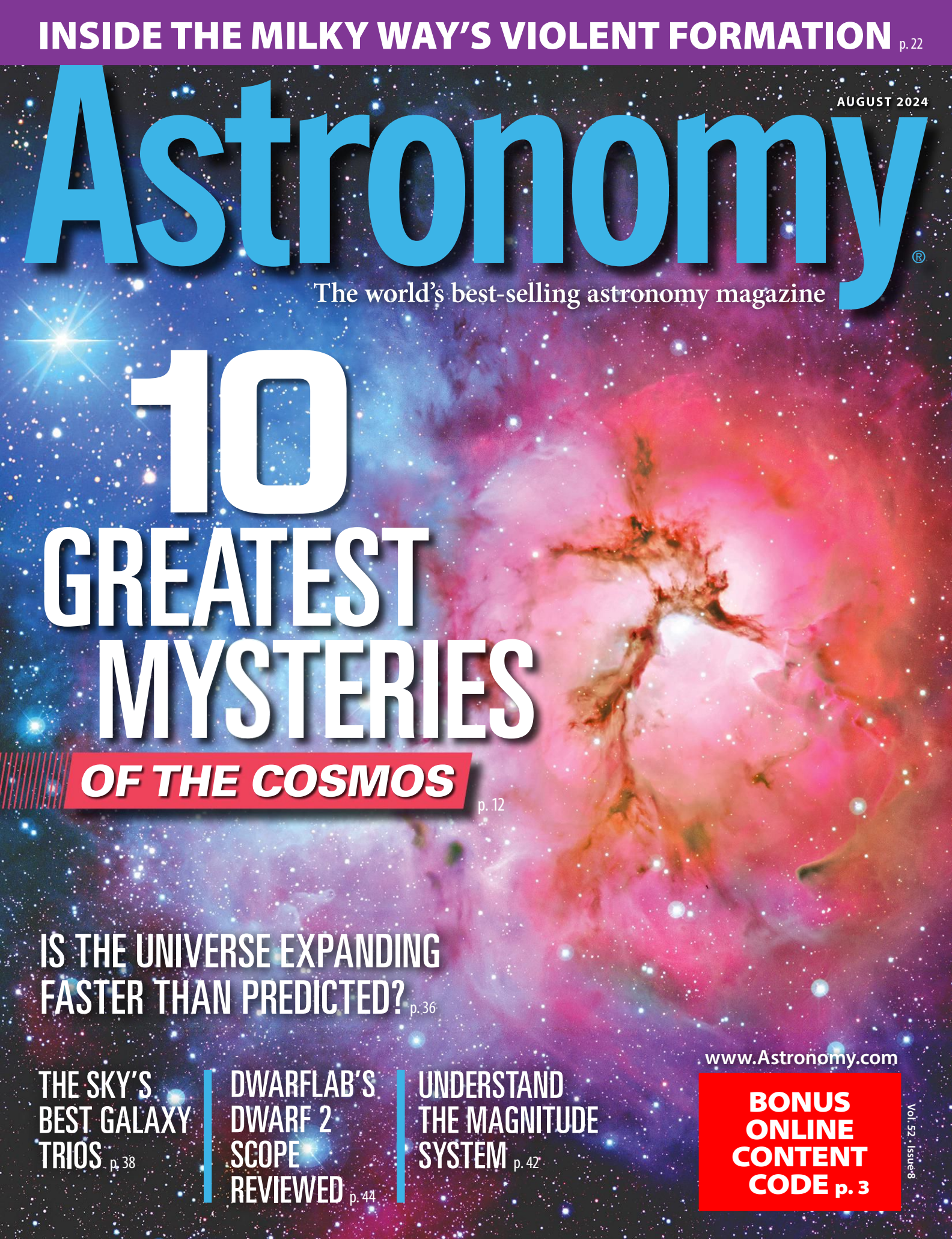

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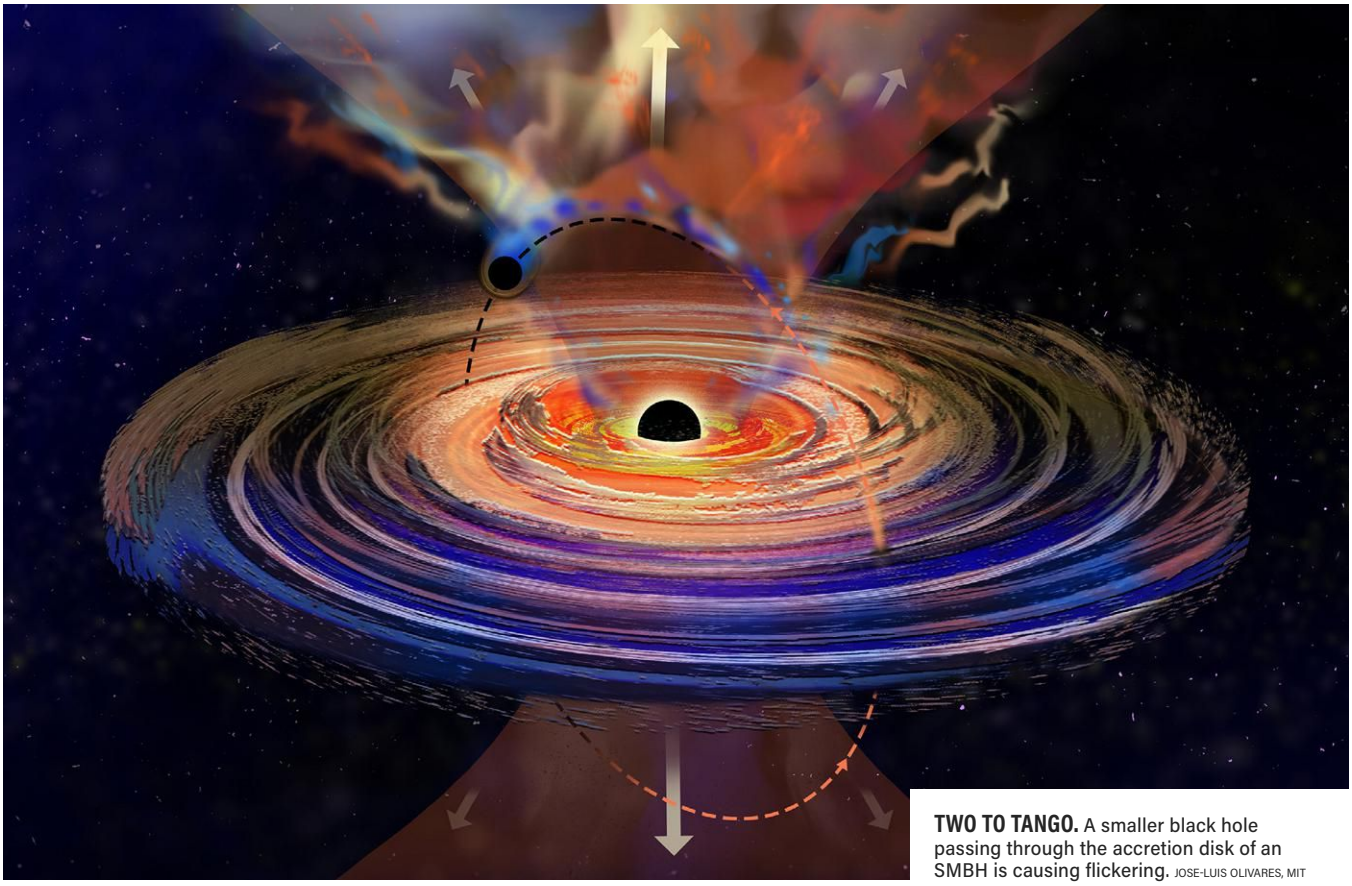
TWO BLACK HOLES FOUND DANCING IN THE NIGHT

Astronomers have never seen a pair of black holes quite like this one — but the universe may be filled with them.



TWO TO TANGO. A smaller black hole passing through the accretion disk of an SMBH is causing flickering. JOSE-LUIS OLIVARES, MIT

Just a few years ago, astronomers witnessed something strange happening in a galaxy 848 million light-years away.

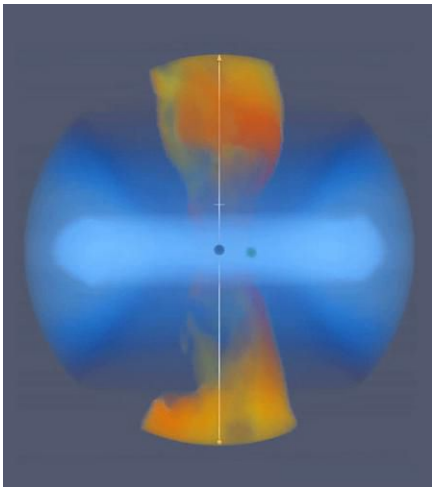
The supermassive black hole (SMBH) at the center of this galaxy was chugging along, steadily gobbling up matter. Then in December 2020, it suddenly flared up as it feasted on a wayward star and became 1,000 times brighter — only to subsequently develop an odd, steady flicker.

For four months, until the outburst eventually faded, the galaxy's center dimmed slightly every 8.3 days — a behavior never seen before in an SMBH outburst.

After some forensic investigation, astronomers think they know why: This supermassive black hole has a smaller companion black hole zipping around it that kicks up dust every time it pops through the disk of material that surrounds the SMBH. In a paper published March 27 in *Science Advances*, an MIT-led team reported on the strange sequence of events.

This binary system of black holes is the first known to contain an SMBH and an intermediate-mass black hole (IMBH). IMBHs, which range from about 100 to 100,000 solar masses, are thought to be common in the universe but have proved difficult to find — the first direct detection of an IMBH was in 2020. Researchers now hope this flickering behavior is a signature that could lead to the discovery of many more binary systems featuring IMBHs.

The find also shakes up our thinking of what the environment at the core of a galaxy looks like. Instead of a simple disk of matter surrounding the central black hole, steadily swirling across its event horizon, the centers of galaxies



SIMULATED DANCE. Every time the smaller black hole (green) punches through the accretion disk (blue) surrounding its larger companion (black), it generates a plume of material (orange-yellow), seen in this frame from a computer simulation.
PETRA SUKOVA, ASTRONOMICAL INSTITUTE OF THE CAS

could host multiple black holes of different sizes, leading to more complex behavior.

A FLASH IN THE NIGHT

The initial flare was likely caused by the SMBH tearing apart and gorging on a star that wandered too close — what astronomers call a tidal disruption event. Dubbed ASASSN-20qc, it was identified by the All-Sky Automated Survey for Supernovae (ASAS-SN), a global network of telescopes that looks for bright flashes across the sky every night. After ASASSN-20qc was first spotted in December 2020, astronomers trained a variety of space-based telescopes on the object. (Big explosions or energetic events typically shine brightest in X-rays, which can't be observed from the ground.)

At first glance, the X-ray data did not immediately appear unusual. "I was like, 'OK, cool, you know, whatever, X-ray detection,'" says Dheeraj R. Pasham, an Einstein Fellow at MIT and lead author of the paper. "But when I looked closer, what we found was, there's some interesting signal within the X-ray spectrum that appeared to be showing these regular modulations repeating every 8.3 days."

After gathering a stream of data, the team considered a number of scenarios. These included ongoing changes in how the inner accretion disk rotates, clumpy matter falling into the black hole, or light being reflected in odd ways by material in the region.

But none of these could create the kind of flickering seen in ASASSN-20qc. That's when the team realized the likeliest culprit: a second black hole.

While the main, larger black hole is millions of times the mass of the Sun, the second black hole is mere hundreds or thousands of times the mass of the Sun. As the IMBH orbited the larger black hole, it passed through the surrounding accretion disk and kicked up dust that blocked our view, causing it to dim.

Pasham says that while looking for possible culprits, the team came across a paper from a group of Czech astronomers proposing a theoretical scenario just like this, where "there is a supermassive black hole with an accretion disk and then the secondary object that is going around," Pasham says. "Every time it punches through, you should see these kind of absorption features."

After holding several meetings and performing some simulations, Pasham's team and the Czech authors discovered that the kinds of features seen in ASASSN-20qc could only be caused by an IMBH.

MORE TO COME

The team thinks that such systems are commonplace, and they have already found another dozen or so candidate events with similar features. Currently, they're working on observing these objects from the ground and with X-ray space telescopes.

Because these objects will continue to spiral closer to each other until they merge, they will also produce gravitational waves — ripples in the fabric of space-time caused by powerful events.

Mergers of large black holes produce gravitational waves that are too long for current technology to detect. But ESA's Laser Interferometer Space Antenna (LISA) mission should be able to detect these gravitational waves from space, Pasham says, providing astronomers with insight into what happens when huge black holes merge.

"For one of the systems, we predict that it could be detectable with the LISA in 2037," Pasham says. – JOHN WENZ

QUICK TAKES

SPACE BROTHERS

The U.S. and Japan have declared their "shared goal" for a Japanese national to be the first non-American to walk on the Moon on a future Artemis mission. As part of an agreement signed April 9, Japan will also develop and build a lunar rover with a pressurized closed cockpit.

HIDING IN PLAIN SIGHT

Researchers have discovered the eroded remains of a 280-mile-wide (450 km) volcano on Mars amid the canyons of Noctis Labyrinthus. A buried glacier may lie below its lava flows, making it an intriguing site for human settlements and to search for life.

SINK LIKE A STONE

Meteorites preserved on Antarctic ice fields are important sources of solar system material. But a study finds climate change is causing roughly 5,000 meteorites to sink into the ice every year; over three-quarters of all meteorites could be lost by 2100 in a high-emissions scenario.

STELLAR OUROBOROS

A study published April 11 proposes that the 2019 mysterious gamma-ray burst GRB 191019A — originally thought to be a supernova — was a star that met a black hole and became so stretched that it wrapped fully around the black hole and collided with itself.

VOYAGER CHECKS IN

On April 20, NASA successfully reestablished a readable downlink from the Voyager 1 probe after a five-month period when it was sending gibberish signals. A memory chip failed on the 46-year-old craft, requiring a software patch to store code across multiple chips instead.

TINIEST GALAXY

A trio of observatories in Hawaii has discovered what could be the Milky Way's smallest satellite galaxy yet known. The suspected dwarf galaxy UMa3/U1 consists of 60 stars with a combined mass 16 times that of the Sun; it appears to be held together mostly by dark matter. – M.Z.