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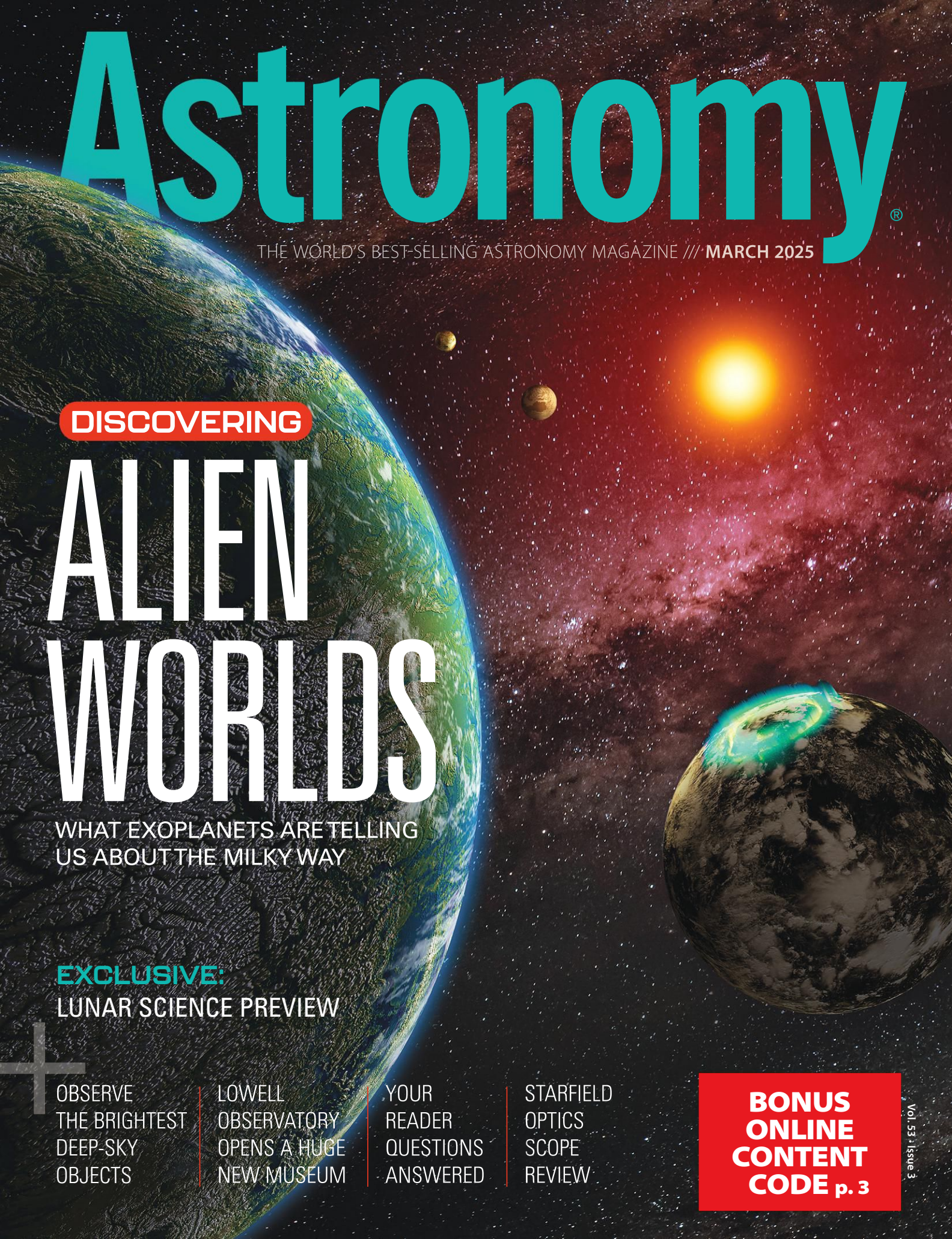

DISCOVERING

ALIEN WORLDS

WHAT EXOPLANETS ARE TELLING US ABOUT THE MILKY WAY

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HOW BIG WERE THE FIRST

JWST's Near-Infrared Camera captured this galaxy-filled field as part of the Cosmic Evolution Early Release Science Survey. Some of the most distant galaxies, which formed within 1 billion years of the Big Bang, appear brighter than they otherwise would because they contain accreting supermassive black holes. NASA, ESA, CSA, STEVE FINKELSTEIN (UT AUSTIN)

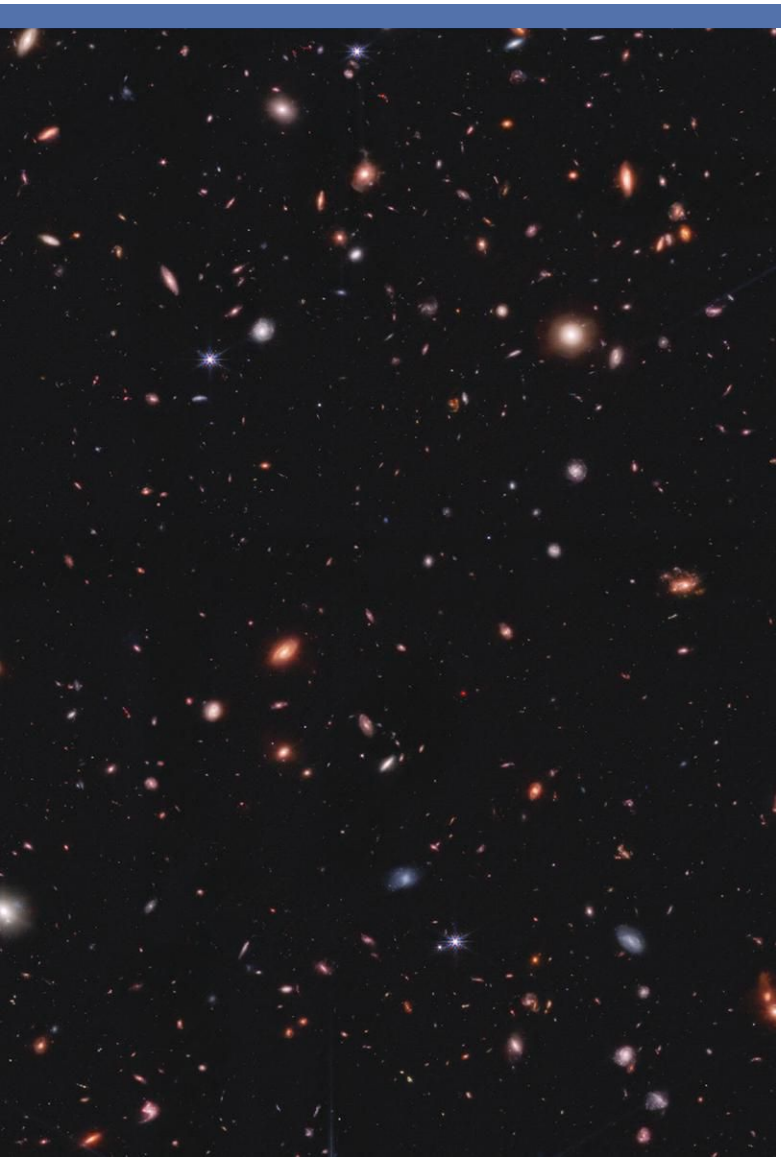
THE COSMOS MAY NOT BE BROKEN AFTER ALL. Soon after the James Webb Space Telescope (JWST) started its science mission in 2022, astronomers discovered a half-dozen galaxies near the universe's edge that appeared far more massive than anyone expected. (See "Too big, too soon" in the September 2023 issue.)

Prevailing theory held that the first galaxies were relatively small clouds of gas, stars, and dust that slowly grew into the majestic spirals and unassuming ellipticals that populate today's universe. But based on the amount of light these six galaxies emitted, researchers estimated that each weighed at least 10 billion solar masses and one seemed 10 times that size, or nearly the bulk of the Milky Way.

The observations implied that these galaxies — all existing within 1 billion years of the Big Bang — were converting nearly 100 percent of their gas into stars. Cosmologists

JWST finds that accreting black holes may explain why early galaxies appeared more massive than they truly are. BY RICHARD TALCOTT

GALAXIES?



couldn't figure out how this was possible, at least within the standard model of cosmology. But the astronomers who studied these galaxies, led by Ivo Labbé of the Swinburne University of Technology in Melbourne, Australia, stressed that their results were preliminary, and that future observations were needed to rule out other possibilities.

A FRESH LOOK

A new study brings one of those alternatives front and center. It finds that some early galaxies hold far less mass than they appeared to initially. In these objects, a significant portion of their light radiates from an accretion disk surrounding a centrally located supermassive black hole.

These black holes can boost a galaxy's output by 10 times or more. As the black hole pulls in surrounding material, an accretion disk forms. Friction within the disk heats the material to millions of degrees and produces copious amounts of light.

Katherine Chworowsky, a graduate student at the University of Texas at Austin, led a team that analyzed 118 massive galaxies — those weighing more than 10 billion solar masses — in the distant cosmos. "We are still seeing more galaxies than predicted [at these early times]," said Chworowsky in a press release, "although none of them are so massive that they 'break' the universe." The researchers reported their results in the September 2024 issue of *The Astronomical Journal*.

The accretion disks appear small and reddish on JWST images. And spectra reveal fast-moving hydrogen gas, a signature of accretion disks. When the team removed these objects from their analysis, the early galaxies that remained fell within theoretical predictions. "The bottom line is there is no crisis in terms of the standard model of cosmology," said co-author Steven Finkelstein, also of the University of Texas.

QUESTIONS REMAIN

The new results may have solved the biggest puzzle posed by the initial observations — that early galaxies appeared to be too massive — but cosmologists aren't out of the woods yet. Chworowsky's team also discovered roughly twice as many massive galaxies in their sample than the standard model predicts. She suggests that galaxies in the early universe may have been more efficient at turning gas into stars than those that exist today.

The idea isn't as strange as it may sound. Although stars in the nearby universe form at a snail's pace — the Milky Way creates only a few new stars every year — the higher densities and low abundance of elements heavier than helium at early cosmic times could well increase this rate significantly.

Contributing Editor **Richard Talcott** *wrote about JWST's observations of the super star cluster Westerlund 1 in the January issue.*