DWARF GALAXIES REVEAL SECRETS OF THE EARLY COSMOS p. 26

JULY 2024

Astronomy®

The world's best-selling astronomy magazine

SPECIAL REPORT

HOW WE CAN FIGHT LIGHT POLLUTION p. 14

THE JOYS OF WIDE-FIELD IMAGING p. 40

PLUS:

- THE STORY BEHIND LUNAR NICKNAMES p. 36
- ALL ABOUT ASTRONOMICAL ALMANACS p. 24
- CELESTRON'S SKYMASTER PRO BINOCS REVIEWED p. 46

www.Astronomy.com

$6.99

0 74470 01096 8 07

Vol. 52 • Issue 7

TINY GALAXIES PACK A HUGE WALLOP

JWST shows that dwarf galaxies played an outsized role in ending the cosmic Dark Ages. BY RICHARD TALCOTT

FEW EVENTS IN THE UNIVERSE'S HISTORY had a more profound effect than the ending of the cosmic Dark Ages. It saw the universe transform from nightlike gloom into a vibrant cornucopia of stars and galaxies. Now, astronomers using the James Webb Space Telescope (JWST) have shown that the earliest dwarf galaxies produced the radiation that triggered this revolution, revealing how the smallest things sometimes can have the biggest impacts.

THE FIRST BILLION YEARS

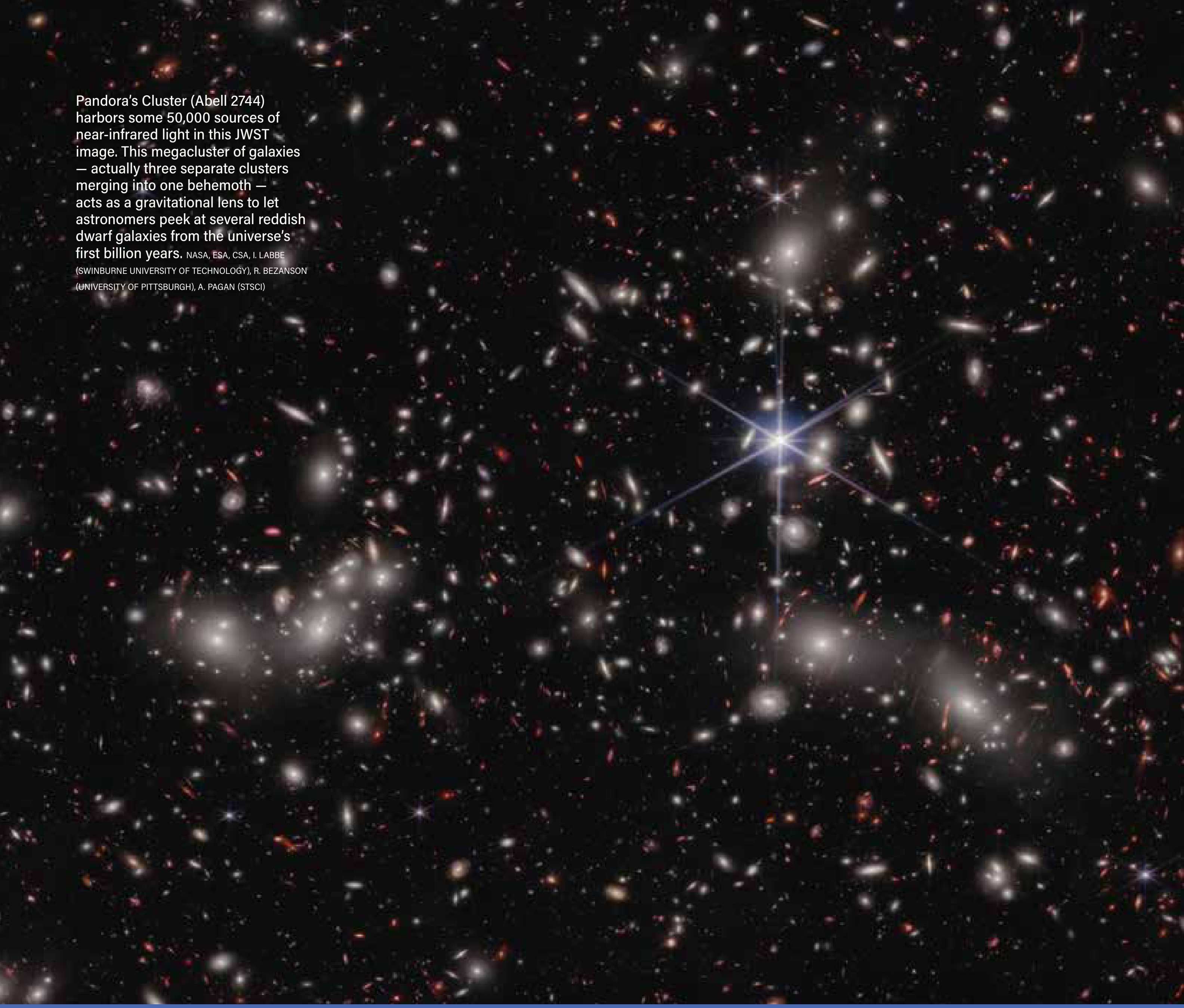
Let's start at the beginning: the Big Bang. Some 13.7 billion years ago, the universe emerged out of nothing. Within minutes, it formed a hot, dense, ionized soup of hydrogen nuclei (protons), helium nuclei, electrons, and electromagnetic radiation (photons). But the photons were essentially trapped in the expanding cosmos — they could travel only short distances before matter absorbed and then reemitted them.

That all changed 380,000 years later, once the blistering maelstrom had cooled to around 3,000 kelvins (nearly 5,000 degrees Fahrenheit). At this point, protons and electrons could capture one another and form neutral hydrogen. The photons were then free to travel unimpeded. This light still permeates the universe as the cosmic background radiation, which now glows at a frigid 2.7 K.

This major transformation also ushered in the Dark Ages. Although light could travel unhindered, the background radiation glowed at infrared wavelengths and no light-producing objects yet existed. The darkness was total.

It would take a few hundred million years before the first stars appeared. These were beasts with masses up to 300 times that of the Sun and prodigious producers of high-energy ultraviolet radiation. They and the nascent galaxies to which they belonged slowly started to reionize the universe and clear the hydrogen fog, bringing about the end of the Dark Ages. This so-called epoch of reionization peaked around 600 million

In this 2011 image, Hubble captured about half of Pandora's Cluster, but was not able to see as deeply into the early universe. NASA, ESA, AND D. COE (STSCI)/J. MERTEN (HEIDELBERG/BOLOGNA)



Pandora's Cluster (Abell 2744) harbors some 50,000 sources of near-infrared light in this JWST image. This megacluster of galaxies — actually three separate clusters merging into one behemoth — acts as a gravitational lens to let astronomers peek at several reddish dwarf galaxies from the universe's first billion years. NASA, ESA, CSA, I. LABBE (SWINBURNE UNIVERSITY OF TECHNOLOGY), R. BEZANSON (UNIVERSITY OF PITTSBURGH), A. PAGAN (STSCI)

to 800 million years after the Big Bang and ended about 1 billion years after the universe began.

TINY BUT POWERFUL

Until JWST opened its eyes, however, scientists still wondered what sources drove the bulk of this reionization. Could it be the many luminous quasars that inhabited the early universe, the first bright galaxies, or a large population of dwarf galaxies?

An international team of astronomers led by Hakim Atek of the Institut d'Astrophysique de Paris in France set about the task of finding out. As part of the UNCOVER program (an acronym for Ultradeep NIRSpec and NIRCam ObserVations before the Epoch of Reionization), the team targeted the massive Pandora's Cluster (Abell 2744) in Sculptor. Although it lies "just" 4 billion light-years from Earth, its tremendous mass acts as a gravitational lens to magnify and distort objects much farther away.

Using deep JWST images, the researchers selected eight extraordinarily faint galaxies dating from the epoch of reionization occupying a tiny field. They then took spectra of these dwarf galaxies and discovered that they produce four times more ionizing radiation than astronomers thought.

"These cosmic powerhouses collectively emit more than enough energy to get the job done," said Atek in a press release. "[The abundance of these low-mass galaxies] during this period is so substantial that their collective influence can transform the entire state of the universe."

So far, these conclusions apply only to this one field of view in Sculptor. To confirm the results, astronomers plan to observe other gravitationally lensed fields with JWST.

Contributing Editor ***Richard Talcott*** *wrote about JWST's observations of 19 nearby spiral galaxies in the June issue.*