ASTROPHOTOGRAPHY: Holiday Gift Guide
PAGE 55

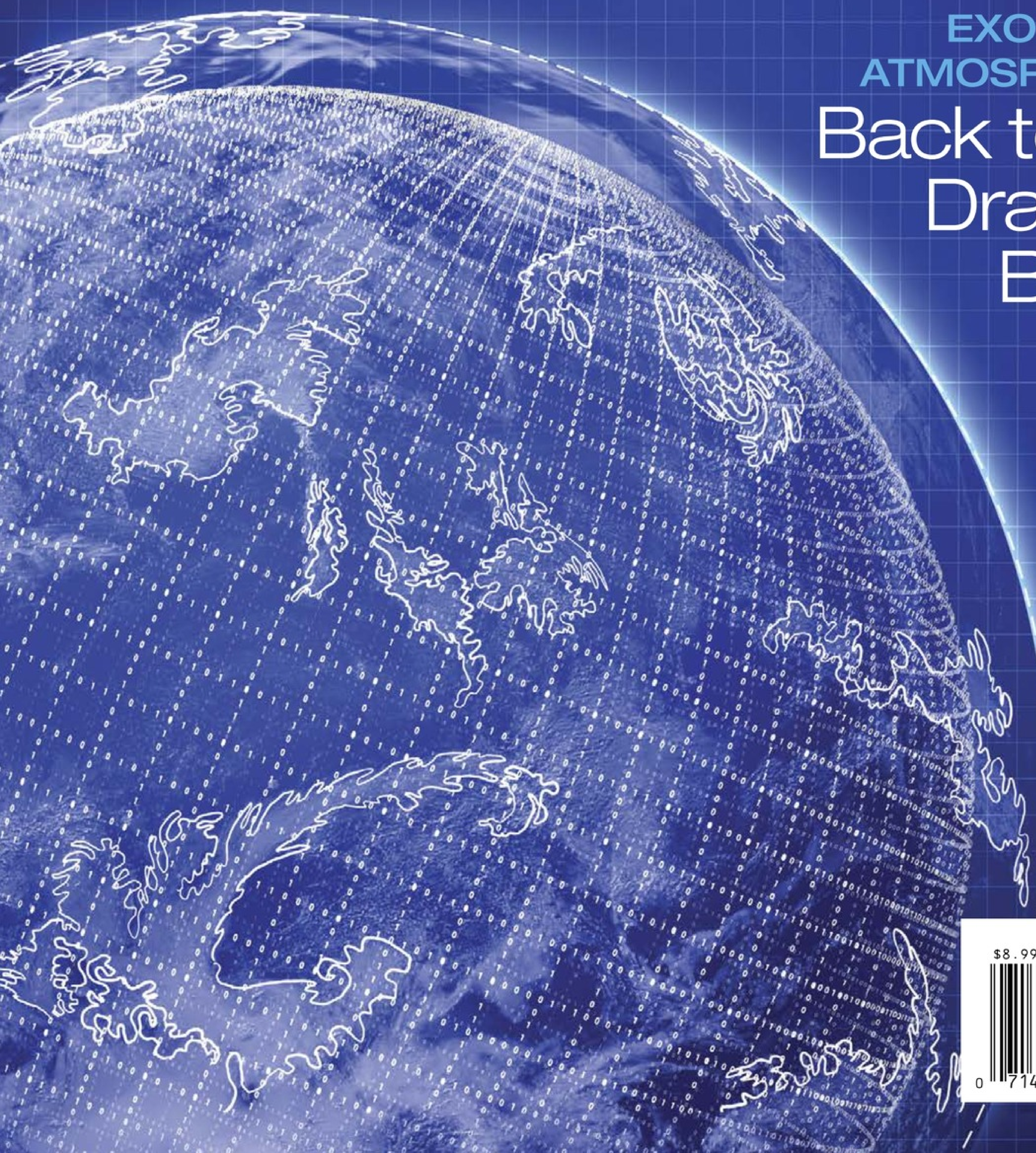
OBSERVING: Galaxy-Hop Around the Pole
PAGE 26

PLANET PHOTOMETRY: What Color Tells Us
PAGE 62

SKY & TELESCOPE

THE ESSENTIAL GUIDE TO ASTRONOMY

DECEMBER 2024



EXOPLANET ATMOSPHERES: Back to the Drawing Board

Page 34

skyandtelescope.org

$8.99US $9.99CAN

This nearby spiral galaxy (NGC 3972) was one of those observed by both the Hubble and James Webb telescopes to measure the Hubble constant.

COSMOLOGY

Hubble Tension Loosens

FOR ALMOST A DECADE, astronomers have struggled with a nagging mismatch between different ways of determining the *Hubble constant* — a measure of the current expansion rate of the universe. This mismatch, known as the *Hubble tension*, has led to claims that new physics might be needed to solve the issue (*S&T:* June 2019, p. 22). Now, new data may have resolved that tension.

The traditional way of determining the Hubble constant has been to gauge galaxies' distances using *standard candles*, for which both apparent brightness and true luminosity are known. The distance to these standard candles can then be compared to their galaxies' redshifts. Over the past decade, a team led by Adam Riess (Johns Hopkins University) has used this method to arrive at a Hubble constant of about 73 kilometers per second per megaparsec.

However, astronomers can also calculate the current expansion rate by analyzing properties of the *cosmic microwave background* (CMB), which yields a Hubble constant of just 67.4 km/s/Mpc.

Now, in a recent preprint (that is, a paper that hasn't yet undergone peer review), a team led by Wendy Freedman (University of Chicago) presents new JWST data on 11 galaxies. Like Riess and colleagues, Freedman's team used Cepheids, but they also looked at two other standard candles that involve not individual stars but whole populations of them. One is a class of old, low-mass stars, which undergo a sudden flash of helium fusion in their cores upon reaching the end of their red-giant evolutionary phase; these stars make up the so-called *tip of the red giant branch* (TRGB). Another is a type of carbon-rich pulsating stars, known as *JAGB stars* (short for J-region asymptotic giant branch).

Combining all three methods, the team finds a Hubble constant between 68.4 and 71.5 km/s/Mpc — a value higher than but consistent with theoretical predictions based on the CMB.

Freedman says the latter two methods are more accurate than using Cepheids, though she admits that there is no single perfect method. To analyze Cepheids, astronomers need to account for their temperatures and compositions as well as intervening dust. Moreover, since these supergiant stars are relatively young, they are found in galaxies' inner disks and densely populated spiral arms. So a star might appear brighter than it is because its light has blended with the light of neighboring stars.

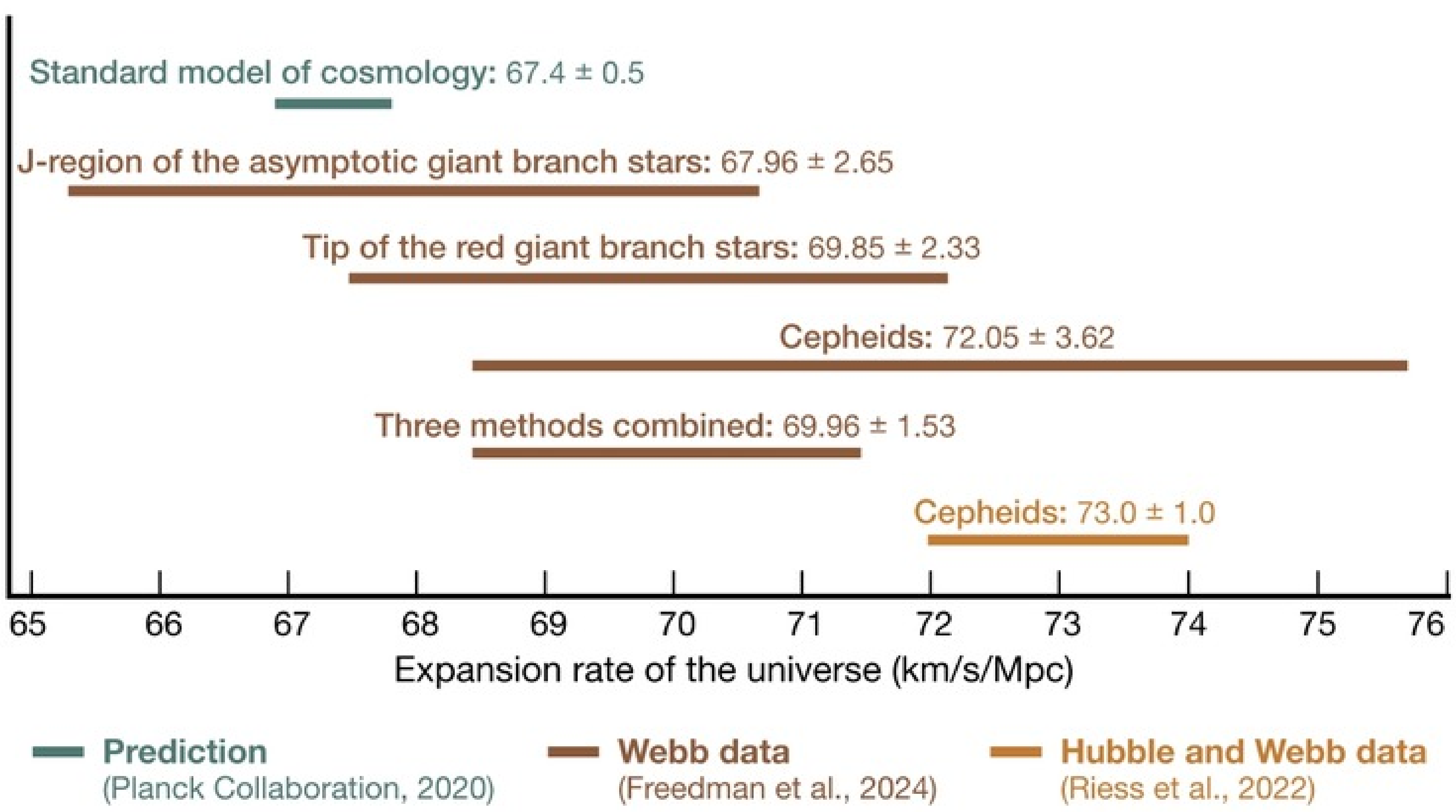
In contrast, red giant and JAGB stars, although intrinsically fainter than Cepheids, are found in galaxies' outer disks and halos. Using these stars yields values of the Hubble constant in "superb accord" with each other and consistent with CMB measurements, says Freedman, while the Cepheid method arrives at a somewhat higher value for the Hubble constant.

In a recent study, Riess's team used JWST data to show that crowding effects do not play a decisive role (*S&T:* July 2024, p. 11). Nevertheless, Freedman thinks that the divergent results for Cepheids might result from the stars' many associated complexities.

Cosmologist Richard Ellis (University College London) agrees, saying he's impressed by Freedman's TRGB work: "I really find [her] case convincing." Meanwhile, Riess has posted a rebuttal.

There's more work to be done, Freedman acknowledges: "So far, we've only scratched the surface. By observing more distant galaxies with JWST, we'll get to the bottom of it."

■ GOVERT SCHILLING



▲ Various methods and teams have measured different values for the Hubble constant.

NEARBY GALAXY: YUVAL HARPAZ, DATA VIA JWST; GRAPH: BEATRIZ INGLESSIS / S&T; SOURCE: FREEDMAN ET AL. / ARXIV: 2408.06153