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Cosmology

We may finally solve the mystery of how fast the universe is expanding

Leah Crane

ONE of the most frustrating questions in modern cosmology may be getting closer to an answer. The different methods we use to measure the rate of expansion of the universe have been in disagreement for years, but a relatively new measurement technique seems to be a way to resolve the dispute.

The universe is constantly expanding, and the rate at which that expansion accelerates is described by a number called the Hubble constant. There are two main ways that we determine this number: by examining the cosmic microwave background (CMB), which is a relic of the first light to shine through the universe, and by observing nearby objects to see how fast they are moving away from us. The results of those two methods have always clashed.

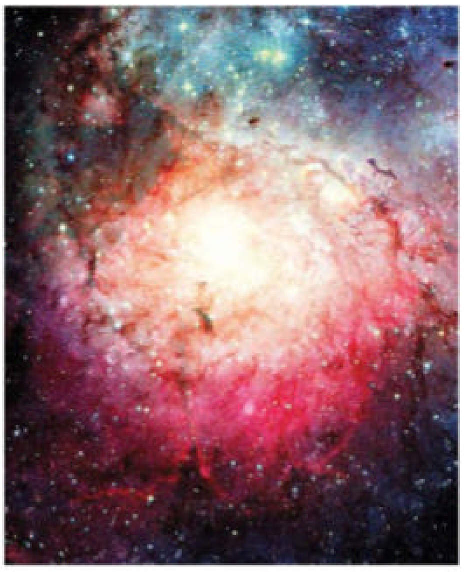
Now, Wendy Freedman at the University of Chicago has pioneered a new way of measuring nearby objects that may resolve the clash. To make local measurements of the Hubble constant, we use objects with known brightnesses to measure distances in what is called the distance ladder.

The most common way to do this is to use variable stars called Cepheids to find the distances to galaxies with supernovae in them, and then use supernovae to probe further out. However, Freedman used a different type of star, called tip of the red giant branch (TRGB) because of its place on charts of stellar evolution, to replace Cepheids – and the results determined from these stars match the CMB measurements.

While Cepheids are generally formed in dusty stellar nurseries, which may obscure measurements, TRGB stars can be found in the same relatively dust-free areas as the supernovae that form the next rung of the distance ladder. Freedman found that as observations probed increasingly distant objects, the Cepheids and the TRGB measurements diverged from one another. At these distances, Cepheids are obscured by dust and crowded among other stars, and it becomes more difficult to determine how their chemical make-up, or metallicity, affects the observations (arxiv.org/abs/2106.15656).

"It's not simply that the effects of dust are worse: the effects of crowding are worse, the effects of metallicity are worse, and they're all entangled. So if you get one correction wrong, you get them all wrong," says Freedman. "With TRGB stars, it's simple – there's no dust, nothing to disentangle." These stars aren't variable like Cepheids, so they are simpler and far better understood.

Supernovae help astronomers calculate cosmic distances



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The fact that replacing Cepheids on the distance ladder eliminates the tension between CMB measurements and local observations may mean there are just errors in our understanding of Cepheids. If the tension had remained, it might have meant there was some larger confusion about cosmology and the physics of the early universe that produced the CMB.

"It allows for the possibility that there is no tension, and it's just a matter of imperfect measurements," says Dan Scolnic at Duke University in North Carolina. "Some might say that incorrect measurements is the least exciting outcome of the Hubble tension, but on the other hand, it would show that our cosmological model can explain the entire expansion history of the universe."

More observations are required before we can say for sure that the tension over the Hubble constant has been ironed out, but these results provide a ray of hope that it is resolvable, says Freedman. ▮

Palaeontology

Trilobite survived a fight with giant sea scorpion

ABOUT 453 million years ago, a trilobite might have escaped the claws of a hungry giant sea scorpion, a fossil suggests.

Trilobites flourished in the oceans from around 522 million to 252 million years ago before going extinct. These hard-bodied arthropods resembled woodlice and ranged between about 1 millimetre and 70 centimetres in length.

Oldřich Fatka at Charles University in the Czech Republic and his colleagues studied an unusual eye trauma in the fossilised head of a common trilobite species called *Dalmanitina socialis* and believe it survived a predator's attack.

Casts of the fossil's surfaces enabled the researchers to see that part of the eye was missing. They think either all or part of the eye was gouged away but moultings of the animal's exoskeleton helped the wound heal and allowed a smaller eye to grow back. Other signs of injury and healing included scratches, a crescent-shaped scar and misshapen cheeks.

The most likely explanation, the researchers think, is that the trilobite was attacked by a predator. In theory, that predator might have been a larger trilobite, a cephalopod or a giant eurypterid "sea scorpion" – all were living in the region at the same time as the small trilobite (*International Journal of Paleopathology*, doi.org/gnzz).

However, the team eliminated the first two candidates because their method of inflicting damage didn't tally with the injuries. That left just one contender. Giant sea scorpions were the largest arthropods known to have ever lived, with some species reaching 2.5 metres long. They had arm-like appendages with toothed claws for grabbing prey.

"The trilobite survived to regenerate the damaged eye and surrounding cheeks"

"A failed predatory attack with the trilobite surviving to regenerate the damaged eye and surrounding cheeks really is the most likely cause," says Greg Edgecombe at the Natural History Museum in London. "It must have been this guy's lucky day." ▮

James Urquhart