entire planet, across both night and day, in each 55-hour cycle. It will produce the first global map of the Martian weather, over days and seasons, says Al Amiri. The team hopes that the data will reveal how atmospheric processes cause Mars to lose hydrogen and oxygen into space – a process that is thought to have contributed to the once-lush planet becoming barren. "This allows us to have a more holistic understanding of the planet and how it lost its atmosphere, and also the dynamics of the atmosphere as a whole," says Al Amiri.

The small Gulf state's route to becoming an emerging space power has been short and unusually fast. The mission began just six years ago, alongside the creation of a national space agency, when the UAE had only recently begun to design and build Earth-observation satellites. Hope was designed as a catalyst for science more broadly in the region, and to promote research careers in a region whose oil wealth is on the wane.

Without experience of its own in interplanetary missions, the UAE Space Agency hired US collaborators – mainly from the University of Colorado Boulder – to guide it through the process and build up science and engineering capacity within the UAE.

"This marks a historic moment for the United Arab Emirates and the entire Arab world, and I could not be more honoured to be a part of this incredible day," says Brett Landin, an engineer at the University of Colorado Boulder, who leads the mission's spacecraft team. "As much as I'd like for our team to be able to celebrate and take a well-deserved break, the difficult work of operating the spacecraft has now just begun." Construction took place mostly in the United States, but with the involvement of 75 Emirati scientists and engineers from the MBRSC who were dedicated full-time to the mission. Operations for Hope will be run out of mission control.

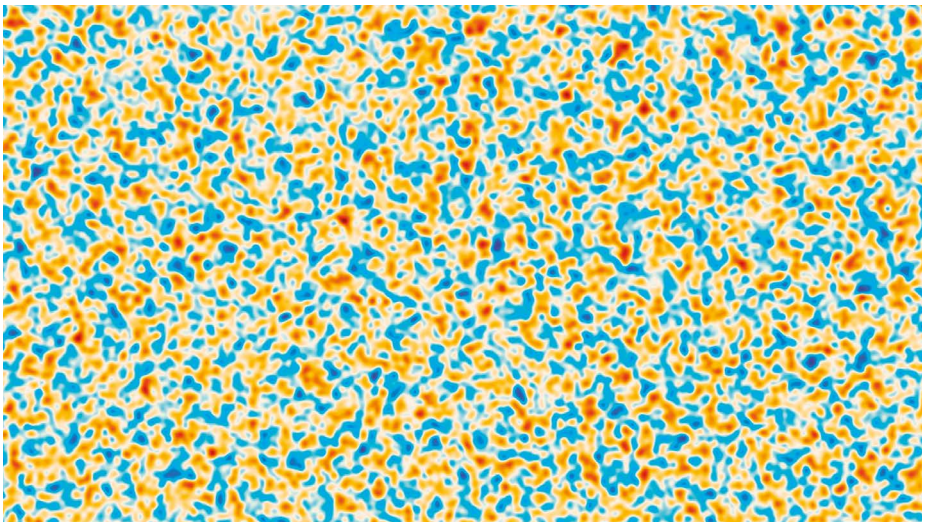
Value for money

According to the UAE's minister of cabinet affairs, Mohammad bin Abdullah Al Gergawi, the mission's cost came in at a relatively cheap US$200 million. This includes spacecraft development, launch and ground operation, a spokesperson confirmed to *Nature*. This is more expensive than India's Mangalyaan mission, which cost around US$75 million, but is cheaper than fully fledged NASA missions, such as the US$720-million Mars Reconnaissance Orbiter. The UAE Space Agency had declined to release the cost until now.

Although the mission was on time and within budget, COVID-19 presented a final challenge. International travel restrictions, including a mandatory 14-day quarantine period for all those entering Japan, meant that the mission had to be shipped earlier than planned, at the expense of some last-minute tests. Groups of engineers, travelling two weeks apart, had to tag-team to make sure the craft was always in expert hands while they adhered to quarantine rules. The accelerated schedule meant the second team was still able to make it to the launch site in time for preparations.

Back at mission control, celebrations continued into the early hours. "There is an accumulation of many emotions," says Fatma Lootah, a member of the mission's science team at the MBRSC. "We are excited and we are ready, and, by we, I mean the entire nation," she says, adding that pictures of the probe cover the country's billboards and screens.

The mission's success is not only about launching successfully, or even getting to Mars, but about the ripple effects on the UAE's education and economy, says Al Amiri. "The impact we have is something I'm looking forward to seeing over the next few years."



ACT COLLABORATION

A portion of the new map of the Universe's cosmic microwave background radiation.

MYSTERY OF UNIVERSE'S EXPANSION DEEPENS WITH FRESH DATA

A long-awaited map of the Big Bang's afterglow fails to settle debate over how fast the Universe is expanding.

By Davide Castelvecchi

A new map of the early Universe has reinforced a long-running conundrum in astronomy over how fast the cosmos is expanding. The data – collected using a telescope in Chile's Atacama Desert – back up previous estimates of the Universe's age, geometry and evolution. But the findings clash with measurements of how fast galaxies are flying apart from each other, and predict that the Universe should be expanding at a significantly slower pace than is currently observed.

The Atacama Cosmology Telescope (ACT) mapped the cosmic microwave background (CMB), the radiation 'afterglow' of the Big Bang. The findings, based on data collected from 2013 to 2016, were released on 15 July (S. K. Choi *et al.* Preprint at https://arxiv.org/abs/2007.07289 (2020); S. Naess *et al.* Preprint at https://arxiv.org/abs/2007.07290 (2020)).

CMB radiation comes from all directions of space, but it is not perfectly uniform: its variations across the sky reveal that regions of the early Universe differed slightly in temperature. Over the past two decades, cosmologists have used those minute variations – together with an established theory called the standard model – to calculate key features of the Universe's structure and evolution, including its age and the density of matter. Cosmologists also use the variations to predict the rate at which the Universe is currently expanding, a measure known as the Hubble constant.

The European Space Agency's Planck telescope mapped the entire CMB sky from 2009 to 2013 with unprecedented precision, and its observations are considered the gold standard of CMB cosmology. The ACT data

now vindicate Planck's findings and produce a very similar value for the Hubble constant.

But neither result matches direct measurements of the Hubble constant — a discrepancy that has become known as the Hubble-constant tension. Astronomers who use the brightness of particular stars and supernova explosions, collectively called standard candles, to calculate the expansion rate find that galaxies rush away from each other roughly 10% faster than CMB maps predict.

Many researchers had hoped that, as techniques became more accurate, the gap would shrink. Instead, narrowing error bars for each type of study have only made the inconsistency more significant.

The ACT is the first ground-based CMB experiment that could have challenged Planck's results, says Erminia Calabrese, a cosmologist at Cardiff University, UK, who led the analysis of the data. The telescope's design and location, just inside the tropics, enables it to map more of the CMB sky than can other ground-based or balloon-borne telescopes, which have typically been limited to smaller regions.

Mapping the sky on a large scale is crucial for calculating the key parameters of cosmic expansion, Calabrese says. Another strength of the ACT was that an upgrade in 2013 allowed it to make precise measurements of the polarization of the CMB radiation, says principal investigator Suzanne Staggs at Princeton University in New Jersey. Polarization data reveal the effect of galaxies in the foreground on how the CMB travels, and help to make the cosmological measurements more precise.

"For the first time, we have two data sets measured independently and with enough precision to make a comparison," Calabrese says. Having also been a member of the Planck team, she says it was a relief to find that the two experiments' Hubble-constant predictions agreed to within 0.3%.

This agreement between ACT and Planck is "a truly major milestone", says Paul Steinhardt, a theoretical physicist at Princeton University. "I am very impressed by the quality of the new data and their analysis," he adds.

Adam Riess, an astronomer at Johns Hopkins University in Baltimore, Maryland, who has led much of the cutting-edge work on standard candles, says that the ACT data's agreement with Planck is "reassuring" and "a testament to the quality of the experimenters' work and carefulness".

But the tension over the Hubble constant remains. Techniques developed by several teams could help to resolve it. Steinhardt thinks that the measurements will eventually converge as experimentalists perfect their methods.

But Riess says that perhaps it is cosmology's standard model that is wrong instead. "My gut feeling is that there's something interesting going on."

EDUARDO SOTERAS/AFP/GETTY

Ethiopia's Grand Renaissance Dam is two-thirds built.

ROW OVER GIANT NILE DAM COULD ESCALATE, EXPERTS WARN

Ethiopia wants to start filling the dam's reservoir this summer. Egypt calls the project an 'existential threat'.

By Antoaneta Roussi

Researchers are warning that Egypt, Ethiopia and Sudan need to move faster to resolve a long-running dispute over the building of Africa's largest hydroelectric dam.

Seasonal rains are starting to fill the reservoir of the Grand Ethiopian Renaissance Dam, set to become Africa's largest hydroelectric power plant, on the Blue Nile river. Two-thirds of the dam has been built.

Egypt's government, which has opposed the project since it began in 2011, calls the dam an 'existential threat'. It is concerned that the dam will reduce the nation's water supplies, which come almost entirely from the Nile, particularly during times of drought.

Ethiopia, by contrast, calls the dam an 'existential necessity'. Its citizens — whose taxes mostly paid for the dam's nearly US$5-billion price tag — are anticipating electric power, a boost for industry and new jobs. The World Bank estimates that nearly half the country's population lacks access to electricity.

According to hydrologists and political scientists, already-strained relations between Ethiopia, Egypt and Sudan could worsen if a deal isn't quickly reached.

South Africa's President Cyril Ramaphosa has been hosting talks on behalf of the African Union, and the three nations have resolved some key issues, including the volume of water and time needed to complete the fill. But the latest talks ended without agreement on 13 July.

There is still an impasse over what would happen in the event of a drought, as well as some other technical and legal issues. Ethiopia is keen for reservoir filling to begin properly during its rainy season of July and August. From Ethiopia's perspective, if it misses the summer window, it would have to wait another year to start filling.

In a normal-to-wet year, Ethiopia, Egypt and Sudan have effectively agreed that, after an initial 2 years of filling, the dam's reservoir would reach 18 billion cubic metres (b.c.m.). After that, Ethiopia would retain around 10 b.c.m. each year to operate electric power from the dam if conditions are normal to wet, researchers familiar with the talks have told *Nature*.

In the case of a drought year, the filling period would extend to seven years. However, the three sides have yet to agree on what to do in this case — one of the sticking points in the current negotiations.

According to Kevin Wheeler at the Environmental Change Institute at the University of