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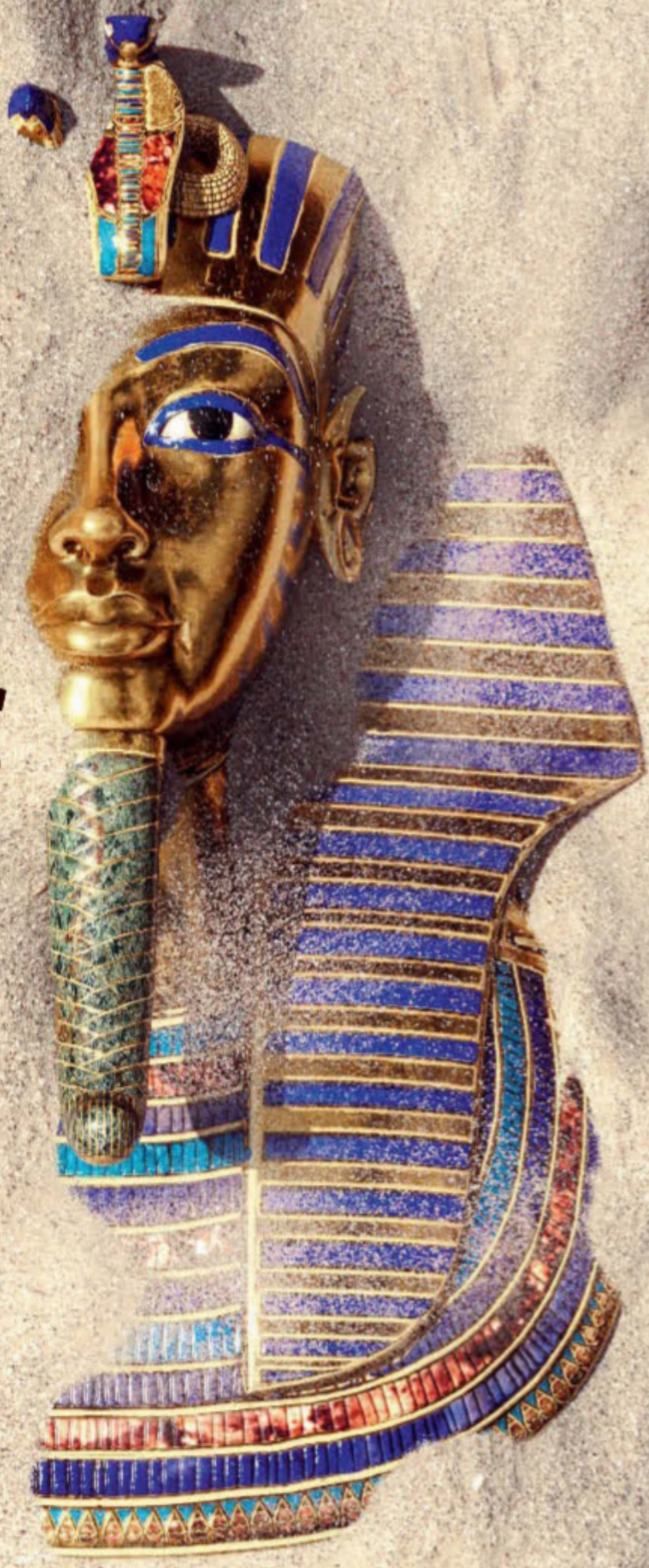

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Technology

Quantum navigation device could augment GPS

Karmela Padavic-Callaghan

A QUANTUM device that can determine its position in three dimensions is more accurate than non-quantum versions and could be used by vehicles to navigate if GPS stops working.

One way to keep track of something's position is with an accelerometer, which is a small device that is found in everything from phones to drones. These work by detecting changes in movement and therefore position.

It has been known for decades that quantum effects could be used to make accelerometers more accurate, but most built so far can only measure in one dimension. Philippe Bouyer at the French National Centre for Scientific Research and his colleagues have now built a quantum accelerometer that can measure in three.

The device works by firing three lasers – in the length, width and height directions – at rubidium atoms cooled to near absolute zero. At this temperature, quantum effects come in to play so that the laser light causes the atoms to ripple like waves, the nature of which depends on the device's movements. By analysing the ripple patterns, the device can calculate the acceleration in the laser's three directions.

The atoms can be controlled extremely precisely, which makes the device very accurate, says Bouyer. The team found that if acceleration measurements were used to calculate the device's position in space while on a shaking table, after a few hours, it would be inaccurate by around 20 metres. In the same time, a standard version would be off by 1 kilometre (arxiv.org/abs/2209.13209).

Large vehicles that absorb lots of vibrations, such as ships, could be a good match for this new technology, says John Close at the Australian National University in Canberra. ▮

Astrophysics

JWST shows ancient galaxy may be merging with another

Alex Wilkins

ONE of the oldest known galaxies might actually be two galaxies in the process of colliding, according to new observations from the James Webb Space Telescope (JWST).

In 2012, the Hubble Space Telescope spotted what seemed to be the oldest galaxy we had found, MACS0647-JD, thanks to the gravity from a cluster of galaxies called MACS0647 bending and magnifying its light, a phenomenon called gravitational lensing.

MACS0647-JD formed about 13.3 billion years ago, or just 400 million years after the big bang, although JWST has since found galaxies that are potentially older.

Now, Tiger Yu-Yang Hsiao at Johns Hopkins University in Maryland and his colleagues have captured light from MACS0647-JD using JWST's powerful infrared sensors and found that it appears to be either two galaxies that are merging or a galaxy with two distinct clumps of stars. There is also a third galaxy nearby.

13.3

Age, in billions of years, of the galaxy MACS0647-JD

Galaxies so distant from us, about 13.3 billion light years away, are usually too dim to observe. "Due to gravitational lensing from the galaxy cluster, the light will bend and magnify [MACS0647-JD] by eight times, so it's actually eight times brighter than it was," says Hsiao.

One of the clumps of stars in MACS0647-JD looks larger and bluer than the other, which indicates that it formed more recently than the redder clump. This is because the longer it takes light to travel to us, the more its colouration shifts to redder spectral hues.

Hsiao and his team don't have enough data to say for sure whether they are seeing galaxies merging, but if it is confirmed to be such an event, it would be the oldest known example of this (arxiv.org/abs/2210.14123).

Even if MACS0647-JD is just one galaxy made up of two clumps, it could provide information on how the first galaxies formed. It came into being in the reionisation era of the universe, just after the first stars began to appear.

The universe has vastly expanded since these early galaxies took shape, so they are all very far away. "Although other galaxies have been observed out to these early times, you can count them on one hand," says Simon Dye at the University of Nottingham, UK. "They are rare and therefore each one gives us valuable insight into galaxy formation in the very early universe."

However, we will need a larger sample of such objects across the sky to work out exactly when and how the first galaxies began to form, he adds.

Hsiao and his team hope to learn more about MACS0647-JD with another JWST observation in January next year.

On that occasion, it will take photos at two longer wavelengths of light and gather spectroscopic data for MACS0647-JD, which will allow better estimates of age and composition. ▮

NASA, ESA, CSA, STScI, UT, JHU

Light from MACS0647-JD is bent and magnified by a cluster of galaxies, called MACS0647, so it appears in multiple places in this image (shown in boxes)