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Cosmology

Mini black holes could spell trouble

Merging black holes may create bubbles capable of swallowing the entire universe

Leah Crane

LARGE colliding black holes could be a breeding ground for tiny black holes. If we spot signs of these cosmic lightweights, it could provide proof of the fundamental nature of our universe.

There have been hints in particle physics that our universe may not be in the lowest possible energy state – instead of a true vacuum, it may be in a state called a false or metastable vacuum. If any part of the universe were to collapse into a true vacuum, the laws of physics as we know them would collapse inside that bubble of vacuum, which would expand at the speed of light and eventually swallow up everything.

Some research has suggested that the extreme gravity near a black hole could create a foam of small bubbles of true vacuum. If those bubbles immediately fell into the black hole, though, that process could occur without destroying the universe.

Rostislav Konoplich at Manhattan College in New York and his colleagues calculated what might happen if these vacuum bubbles formed in between two

ESA

Illustration of two black holes spiralling towards each other

colliding black holes. "In the region between the colliding horizons of the black holes, you have gravitational pull from both sides balancing out, so maybe for a short time interval the bubble can exist sandwiched between the two black holes," says Konoplich.

The surface of each vacuum bubble would be expected to form a kind of film similar to a regular soap bubble. Given even a small amount of time to percolate between a pair of black holes, the bubbles could be expected to collide with one another. The researchers calculated that if multiple bubbles collided at once, the intersecting surface could become infinitely dense, forming a micro- black hole (arxiv.org/abs/2111.07178).

Because of a process called Hawking radiation, these tiny black holes would emit a random mix of particles and evaporate away extremely quickly. Konoplich and his colleagues calculated that this entire process could take place in just about 10 milliseconds before the larger black holes collided and devoured any bubbles or micro black holes in their way.

But if bubbles of true vacuum do exist, it isn't necessarily a certainty that the bubbles will safely fall into the huge black holes that enable their formation, says Ruth Gregory at King's College London. "We know that these bubbles, once they're formed, start to expand quite quickly and rapidly reach the speed of light," says Gregory. "If they're outside the horizon, it might be that they would expand instead of falling in."

This would be a disaster of apocalyptic proportions. "If one of these bubbles of true vacuum escaped, it would destroy the universe – oops," says Gregory. The fact that the universe is still

"If one of these bubbles of true vacuum escaped, it would destroy the universe – oops"

around suggests that bubbles of true vacuum are rare, if they exist at all, she says.

However, if they do exist and form micro black holes, we could detect the random radiation from their eventual evaporation. "If we can detect something like this, it would be very important because it would prove that our universe is metastable from an observational result, not just theoretical," says Konoplich. That would be a major insight into the fundamental nature of our universe, which theoretical physicists are still debating. ▮

Plant genetics

Genetic diversity of heirloom tomatoes is surprisingly low

THE colours, sizes and shapes of the tomato varieties traditionally grown in Europe vary greatly, but it turns out this diversity is only skin deep. Apart from the few genes controlling these obvious characteristics, these tomatoes are virtually identical genetically.

"It's like a desert with some oases of variety," says Jose Blanca at Valencia Polytechnic University in Spain. "The tomatoes that you find in the supermarket nowadays, they have more diversity than the traditional [European] ones."

A handful of varieties of tomato were brought to Europe from the Americas around the 16th century, and were then grown mostly by poorer farmers in Spain and Italy.

Blanca's team partially sequenced the genomes of more than 1000 tomatoes developed in Europe – and now classed as heirloom varieties – alongside another 200 or so modern varieties. The researchers found significant diversity at just 300 sites in the genomes of the heirloom varieties.

GAP PHOTOS/VIRGINIA GREY

Heirloom tomatoes come in many shapes and sizes

"There are few diverse sites, but the ones that are diverse, they are very diverse," says Blanca.

This is because the European farmers selected for mutants that had an obvious effect, he says. But because all the varieties derive from just a few plants that arrived in Europe in the 16th century, they remain very similar otherwise (bioRxiv, doi.org/g7mb).

The modern varieties were far more genetically diverse, in line with previous research. The reason for this is that modern breeders crossed plants with wild varieties to reintroduce some of the variety lost during domestication.

Having lots of genetic diversity is really important, says Blanca. It provides the raw material for creating new varieties that can cope with evolving pests and diseases, and with a changing climate. ▮

Michael Le Page