Vast cosmic voids merge like soap bubbles

The gaps between the Universe’s filaments of dark matter and galaxies are far from static.

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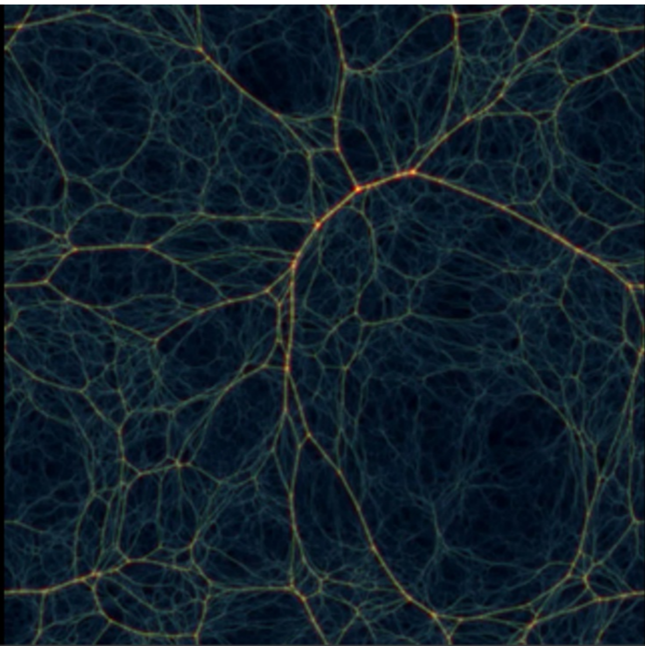


Simulations of cosmic voids

This 2012 simulation of voids merging as cosmic structure evolves is now borne out by data from the Sloan Digital Sky Survey.

Credit: J. Hidding, R. van de Weygaert, Univ. Groningen / http://arxiv.org/abs/1205.1669 (2012).

Vast regions of near-empty space in the Universe are growing and shrinking, much as bubbles merge and separate in soapsuds, astronomers have discovered.

The cosmic voids, some as large as 50 megaparsecs (163 million light years), are the holes in the spidery network of dark matter and galaxies that forms the backbone of the Universe — the cosmic web. But most astronomers had thought that the near-empty globules were, on average, static with respect to the Universe as a whole. Because they have little gravity with which to tug on one another, they would simply be dragged along as the cosmos expands.

In fact, the smaller voids are generally getting squeezed together, while the bigger ones are typically receding and getting larger, according to Diego Lambas, an astronomer at the National University of Cordoba in Argentina, and his colleagues. “We were extremely surprised to find such large, coherent motions,” he says.

Soapy webs

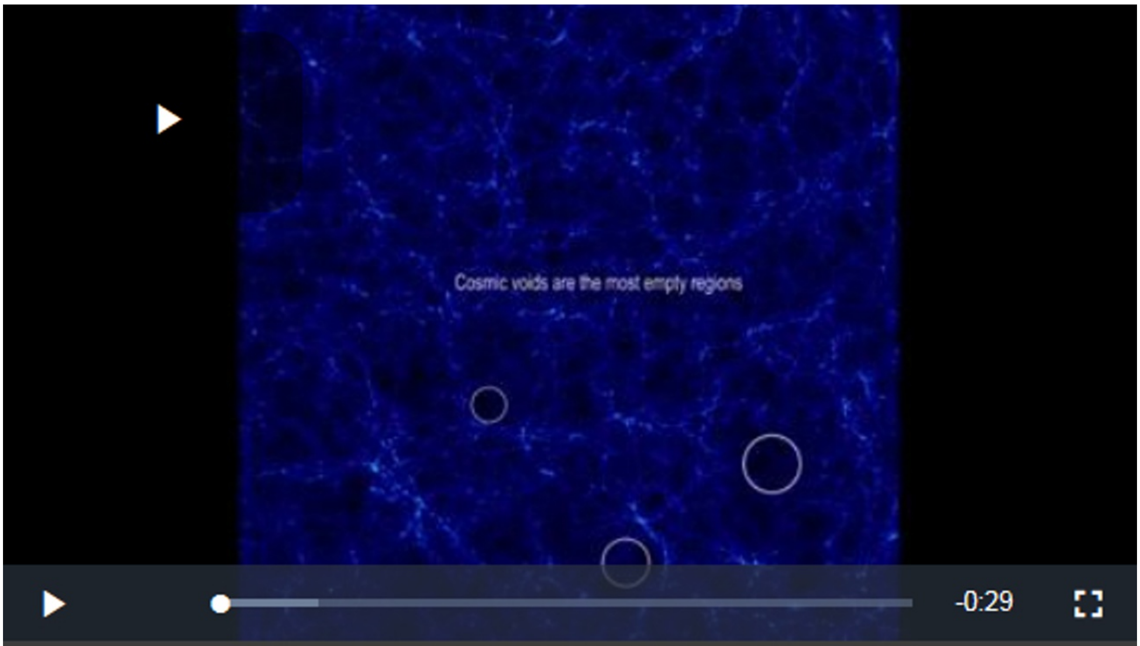
Lambas and his colleagues compared a simulation of the cosmic web with 245 cosmic voids that they identified from data compiled by the Sloan Digital Sky Survey, a large ground-based survey of the heavens. The team found that the voids move at 300–400 kilometres per second above and beyond their motion associated with the Universe’s expansion.

They posted their findings on the arXiv preprint server[1] on 2 October; the work will be published in an upcoming issue of the *Monthly Notices of the Royal Astronomical Society Letters*.

As well as establishing that voids move, the study also identifies the cause of the motion, says astronomer Mark Neyrinck of Johns

Hopkins University in Baltimore, Maryland.

The smaller voids that are approaching each other do so because they are embedded in parts of the web that have a higher than average density, he notes. Gravity would cause such regions to eventually coalesce and shrink. Larger voids tend to lie within patches of the web that have lower density, and are being pulled apart by the gravity of adjacent patches.



The sparkling Universe

Credit: Diego G. Lambas/Victoria Rubinstein, Observatorio Astronomico Press Office

Straight from the sky

Another astronomer who has studied voids, Rien van de Weygaert of the University of Groningen in the Netherlands, says that he has seen such motion only in simulations[2]. “It is fantastic that Lambas and his team have managed to find the same effect in the observational reality of the Sloan Digital Sky Survey,” he says.

Future sky surveys that measure the speeds of a much larger group of voids more precisely could be used to test models of the evolution of cosmic structure, Lambas says. Large-scale structures in the Universe grow not only by merging galaxies, gas and dark matter, but also by the merging of voids, he explains.

Although astronomers have traditionally used filaments of galaxies and dark matter to study the Universe’s evolution, cosmic voids offer a key advantage, says van de Weygaert. Because they contain so little matter, their physics is relatively simple and dominated by dark energy — the mysterious entity that is revving up the rate at which the Universe is expanding. Whether dark energy supplies a constant cosmic push or varies with time could be encoded in properties such as the velocity of the voids.

The new work, says van de Weygaert, provides further evidence that “voids are highly interesting objects that contain important information on global cosmology as well as the galaxy-formation process”.

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References

1. Lambas, D. G. *et al*. *Preprint at* http://arxiv.org/abs/1510.00712 (2015).
2. Sheth, R. K. & Van De Weygaert, R. *Mon. Not. R. Astron. Soc.* **350**, 517–538 (2004).