NEWS

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How the Universe got its hydrogen pairs

Prachi Patel-Predd

Bumpy space dust explains why molecules outnumber atoms.

A computer model has made progress in solving an astronomical mystery: why is so much hydrogen in the Universe paired up into molecules instead of existing as single atoms? The secret is simple. It comes down to the fact that space dust is probably bumpy rather than smooth.

Starry skies are packed with hydrogen molecules.

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Hydrogen is the simplest and most abundant element, making up about 90% of the Universe by weight. It is estimated that half of the hydrogen in the majority of space exists in molecular form, but in the dense dust clouds in which stars form, almost all of the hydrogen is paired up. Researchers are keenly interested in these dust clouds because of their role in the formation of stars and galaxies.

It has long been assumed that hydrogen atoms sticking to these dust particles are jostled together, encouraging hydrogen atoms to pair up into H_2. But when one team of researchers tested this theory, it came up short.

In 1997, Gianfranco Vidali, a physicist at Syracuse University, New York, bombarded pieces of carbon and olivine, a crystalline silicate mineral known to exist in space dust, with hydrogen

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atoms at very low temperatures of 5 to 30 kelvin (about -268 to -243° C). His team was able to form hydrogen molecules, but the process was only efficient within narrow temperature ranges: 6 to 8 kelvin for olivine and 9 to 14 kelvin for carbon. At higher temperatures, most of the hydrogen remained in atomic form[1].

Warm work

But in dense interstellar clouds, molecular hydrogen forms in temperatures up to 50 kelvin. "You need the reaction to be 100% efficient over that temperature range to explain how there's a nearly total conversion of atomic to molecular hydrogen in these denser regions," says Eric Herbst, an astrophysicist at Ohio State University in Columbus.

So Herbst and his colleagues used a computer simulation of space dust to help explain the difference. In their models, they found that simply making the dust bumpier allowed hydrogen to pair up efficiently, even at 50 kelvin. They presented their results on 23 June at the 60th International Symposium on Molecular Spectroscopy at Ohio State University.

Vidali says these simulations have prompted him to recreate his experiment with a bumpy dust model, which he is starting to do now. But until he verifies the results in his laboratory, he remains cautious. "Rougher surfaces could increase the efficiency," he says, "but it's too early to say by how much."

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References

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