News

Cosmic Waves

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Interconnected gas flows show how star-forming gas accumulates in galaxies

The molecular gas in galaxies is organised into a hierarchy of structures. It moves along filament-like orbits to centres of gas and dust where it is compressed into stars and planets. To better understand this, an international team of astronomers led by Dr Jonathan Henshaw from the Max Planck Institute for Astronomy and Dr Diederik Kruijssen from the Center for Astronomy at Heidelberg University examined gas movements on various size scales. The scientists found that the gas flows through different scales are dynamically interconnected: while star and planet formation takes place in compact cores of dense gas, this process is controlled by a cascade of matter flows that begin on galactic scales.

The molecular gas in galaxies is set in motion and structured by physical processes such as galactic rotation and supernova explosions. “In order to understand how these gas movements directly affect the formation of stars and planets, we had to measure them over an unprecedented range of spatial scales and then to connect these movements with the observed physical structures,” explains Dr Henshaw. To do this, the scientists measured gas movements in a variety of different environments across the Milky Way and in another nearby galaxy. Using their newly developed software, the team was able to analyse millions of such measurements and visualise the interstellar gas in a novel way.

The researchers found that the motions of the molecular gas appear to fluctuate in velocity, reminiscent in appearance of waves on the surface of the ocean. The scientists were surprised to discover how similar the velocity structure is in different regions. It didn't matter whether they were looking at an entire galaxy or an individual cloud within the Milky Way – the structure was more or less the same.

At the same time, the research has shown that the velocity fluctuations measured throughout giant molecular clouds do not have a characteristic wavelength. "The density and velocity structures that we see in these clouds are 'scale-free', because the turbulent gas flows generating these structures form a chaotic cascade, revealing ever smaller fluctuations as you zoom in – similar to a snowflake," explains Dr Kruijssen. This scale-free behaviour takes place between two well-defined extremes: the large scale of the entire cloud, where the matter flows begin, and the small scale of the cores, which ultimately form individual stars. "We are now realising that these extremes have well-defined characteristic sizes, but in between them chaos rules," says the Heidelberg astronomer.

Partners from 21 research institutes in eight countries were involved in the research work. The findings of the study were published in the journal "Nature Astronomy".

Publication

J. D. Henshaw, J. M. D. Kruijssen, S. N. Longmore, M. Riener et al.: Ubiquitous velocity fluctuations throughout the molecular interstellar medium. Nature Astronomy.

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Last Update: 07 Jul 2020

Back to top

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- Publications

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- Imprint
- Data Protection
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