Herschel observes Andromeda's past and future stars

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Herschel in space, close up on its mirror. Credits: ESA (Image by AOES Medialab)

Recently, the infrared Herschel Space Observatory, has taken a series of beautiful high-resolution infrared images of Andromeda. It is the first time we can see M31, at these wavelengths, at such a high resolution. The quality and sensitivity of the Herschel data is so good scientists were able to study the properties of individual regions in Andromeda as small as about 400 light years.

The Andromeda galaxy, also known as M31, is our biggest neighbour. It is, in astronomical terms, very close to us, 'only' 2.2 million light years. This gives astronomers the unique opportunity to study a galaxy, which is not our Milky Way, in great detail. Recently, the infrared Herschel Space Observatory, has taken a series of beautiful high-resolution infrared images of Andromeda. "It is the first time that we can see M31, at these wavelengths, at such a high resolution", says Dr. Jacopo Fritz, who works at the Centro de Radioastronomía y Astrofísica in Morelia, Mexico. He is the principle investigator of the HELGA (the Herschel Exploitation of the Local Galaxy Andromeda) team that observed M31.

In fact, when we observe an object, the level of detail we are able to distinguish, critically depends on the wavelength at which we are observing (infrared, in this case) and on the diameter of the telescope's mirror. Until now, all infrared telescopes, had a relatively small mirror, and this was limiting the resolution of the observations. Herschel, with its 3.5-m mirror, is the largest telescope sent into space so far. It conducted its observations at a distance of 1.5 million km from the Earth. "This", adds Jacopo Fritz, "allows the telescope to be very cold, about -190 degrees Celsius, a requisite to operate at infrared wavelengths."

Together with images taken at different wavelengths -ultraviolet, visible, and near infrared- these new data allowed the members of the HELGA team to build a complete picture of the components that constitute a galaxy: stars, gas, and dust. This collection of data, covering a large portion of the electromagnetic spectrum, lets astronomers study where these different components are located and how they interact with each other. But now, using such detailed images, astronomers are also able to study why, in the majority of the galaxies we observe, we find very well-defined relations between their properties like the mass of their stars and the number of newly formed ones, or the content of gas and dust.

"The quality and sensitivity of the Herschel data is so good that we were able to study the properties of individual regions in Andromeda as small as about 400 light years", says Sébastien Viaene, PhD student at Ghent

University in Belgium. Together with the investigators in the HELGA collaboration, he analysed the light coming from 10000 of such 'small' regions. "By studying the light emitted from these regions at many wavelengths, we found something completely counter-intuitive, which we did not expect" continues Sébastien. "Astronomers believe that the dust that permeates the space between the stars in galaxies, is predominantly heated by recently born, massive stars. These are very luminous and emit lots of ultraviolet radiation, which is very efficient in heating the dust. Hence, dust emission is very often used to calculate the amount of new stars a galaxy is producing. Instead, in the bulge of M31, where the dust temperature reaches its maximum, we see that the dust is predominantly heated by the older stars."

This finding not only warns astronomers about the role of old stars, often neglected, in the interaction with the interstellar medium, but it also helps them to get more insights in what is going on inside a galaxy. How galaxies like Andromeda and the Milky Way are formed and evolve is one of the outstanding questions in astronomy. One way to gain insight in this matter is by studying the relation between the structural and physical properties of galaxies. For example, the rate at which new stars are formed is inversely proportional to the galaxy's mass of stars. Similarly, the dust content is inversely proportional to the stellar mass. "These correlations" comments Prof. Maarten Baes, member of the HELGA team at Ghent University, "are what astronomers call 'scaling relations'. Why galaxies are following these relations is an open question, but with this study we found that their origin has a local nature. That is, the individual regions of Andromeda that we have analysed, behave, with respect to these relations, as if they were small galaxies on their own."

These results were recently published in the journal *Astronomy & Astrophysics*, and the images of the study were chosen for the cover of the journal issue.

More information: "The Herschel Exploitation of Local Galaxy Andromeda (HELGA). IV. Dust scaling relations at sub-kpc resolution." Viaene S, Fritz J, Baes M, Bendo GJ, Blommaert JADL, Boquien M, Boselli A, Ciesla L, Cortese L, De Looze I, Gear WK, Gentile G, Hughes TM, Jarrett T, Karczewski OŁ, Smith MWL, Spinoglio L, Tamm A, Tempel E, Thilker D, Verstappen J. *Astronomy & Astrophysics*, Volume 567, A71
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