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The turbulent birth of stellar super clusters in merging galaxies

This is the first analysis of scientific data acquired by the very new Atacama Large Millimeter Array (ALMA). **Combining data with that from the** Very Large Telescope (VLT) **of the European Southern Observatory, French teams from the** Institut d'astrophysique spatiale (IAS-CNRS/ Université Paris-Sud) a**nd from the** Laboratoire d'étude du rayonnement et de la matière en astrophysique (LERMA- Observatoire de Paris/CNRS/Ecole normale supérieure/Université Pierre et Marie Curie/Université Cergy-Pontoise)**, were able to track, for the first time, the earliest stages of star formation in the Antenna group of galaxies.**[1]. **Published in the February 9th issue of the European journal** Astronomy and Astrophysics Letters, **this innovative approach has revealed the origin of stellar super clusters in merging galaxies**

Galaxy mergers produce spectacular bursts of star formation. These can be so bright that astronomers can detect them very far in the past, even from the earliest moments of the Universe. These celestial firworks are associated with the birth of huge stellar clusters, in which millions of stars are enclosed in a volume hardly larger than several tens of light years. A comparable volume around the Sun contains just a few stars.

About twenty years ago, using the Hubble space telescope, astronomers had found these super clusters in the galaxies of the Anntenna group, but the physical processes responsible for their formation are still poorly understood. Now, by combining the first data acuired by ALMA with data obtained earlier with the VLT, the scientists are in a position to elucidate, for the first time, how the merging of galaxies can lead to the formation of stellar super clusters. This type of observation is well within the research objectives of ALMA.

This work forms the basis of Cinthya Herrera's thesis; she is preparing a doctorate at the Institut d'Astrophysique Spatiale (IAS) . She has a research scholarship within the framework of an agreement between the CNRS and the Chilean CONICYT.

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[1]The inaugural image obtained by ALMA was in fact of the galaxies in the Antenna group (cf. ALMA opens a new window on the Universe).

Rather than looking at stellar clusters which are already formed, her idea is to study the energy lost by the gas in which the clusters are born. The point is that stars are born in regions where the gas is very dense and cold. Now, the process of galaxy merging induces considerable turbulence in the gas, which must therefore lose this energy in order to condense, cool and collapse to form clusters of new stars.

Theoretical analysis shows that this energy loss is considerable. It can be traced today thanks to the combined observations of these two telescopes. As the gas settles down and loses its turbulent energy radiatively, it becomes visible in the infra-red, and so is observable by the VLT. The observations made by ALMA have highlighted the extremely turbulent nature of the gas in these gigantic clouds where stellar clusters are born. The turbulence is due to the gravitational energy released by the interaction of these two galaxies.

Observations have shown that in just one of these clouds, a considerable fraction of the turbulent energy contained in gas concentrations is radiated. The amount of gas in this region is enough to make a super cluster. And where ALMA sees just one cloud surrounded by others, the VLT sees the most luminous object of the entire interaction region comprising the Antenna group. Theoretical analysis has shown that in just a few million years - the blink of an eye-lid on the scale of the Universe - this gas will have lost its turbulent energy and a new cluster will have been born. This first result heralds future discoveries which astronomers like Cinthya Herrera will be making with ALMA, which will soon be fully operational.

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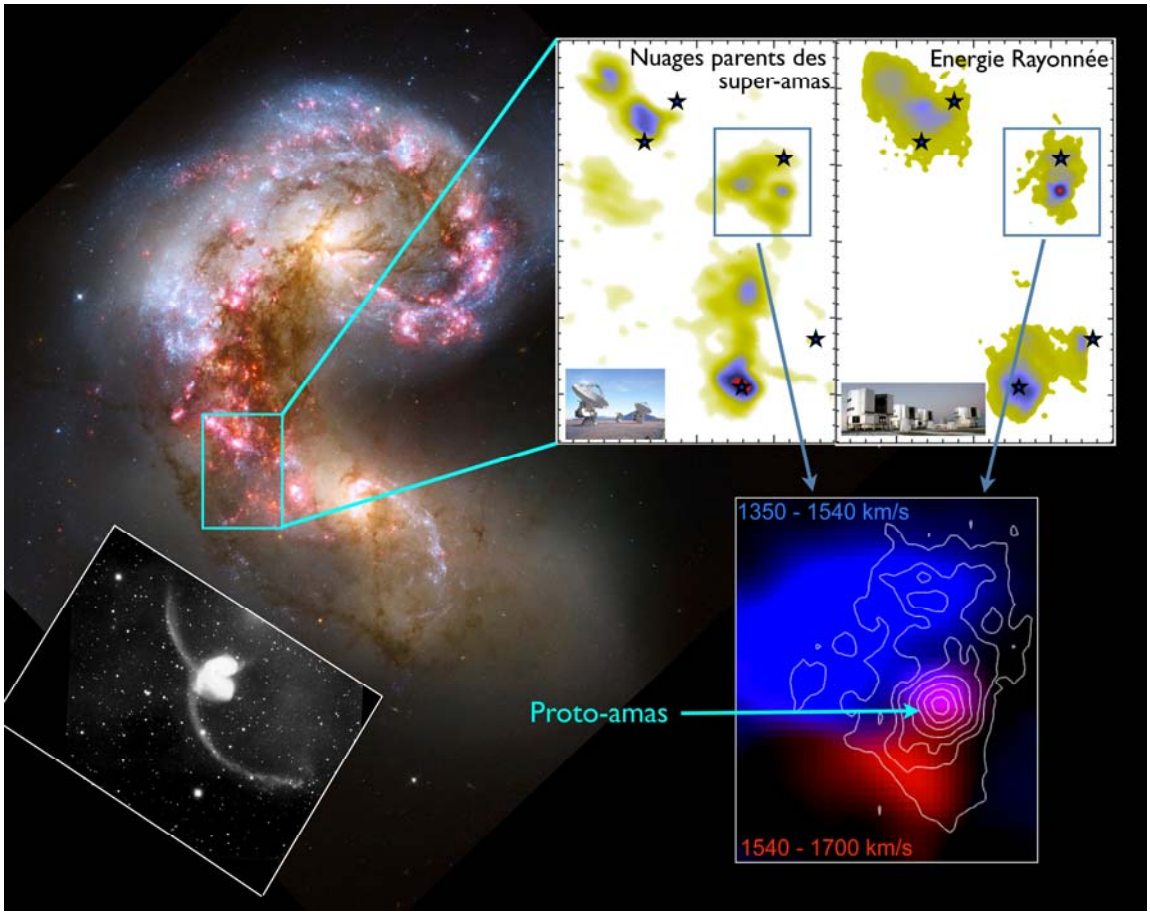

Photo-montage showing the discovery of a stellar proto-cluster in the Antenna group of galaxies.
Lower left: wide field image in the visible showing the two interacting galaxies, as they were discovered in the last century.
Upper left: zoom on the central region, where the two galaxies have penetrated each other; Hubble space telescope(NASA).
Right column: images furnished by Cinthya Herrera, showing the ALMA and VLT observations. The leftmost ALMA image, shows the clouds containing the youngest and most massive stellar clusters (labelled by stars). The rightmost image, from the VLT, shows the energy radiated by the clouds. The compact bright source in this image (marked by a red dot) marks the place where two masses of gas with very different speeds (as indicated by the red and blue colours in the lower right image) are colliding. Observation shows that energy is dissipated most strongly in this region, and that the conditions are ripe for the birth of a new cluster in a few million years.

Bibliography

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