IUCAA study reveals Cannibalisation of Dwarf Galaxies by Malin 1

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A recent study by a team of scientists from the Inter-University Centre for Astronomy and Astrophysics (IUCAA) has revealed that Malin 1, the largest known low-surface-brightness galaxy, is quietly cannibalising smaller dwarf galaxies, shedding new light on its hidden growth and evolution.

Malin 1 has long puzzled astronomers since its discovery. Its central region, roughly the size of the Milky Way's stellar disk, resembles a lenticular galaxy, while its extremely faint spiral arms extend out to nearly 3,00,000 light-years. Despite appearing isolated and undisturbed, the galaxy has continued to transform internally, with no clear signs of interaction—until now.

Using observations from the Ultraviolet Imaging Telescope (UVIT) onboard AstroSat, the research team identified several young star-forming clumps in Malin 1's central region. One particularly prominent clump, known as C1, stood out due to its brightness and mass. This was unexpected, as the central region otherwise appears quenched, with little ongoing star formation.

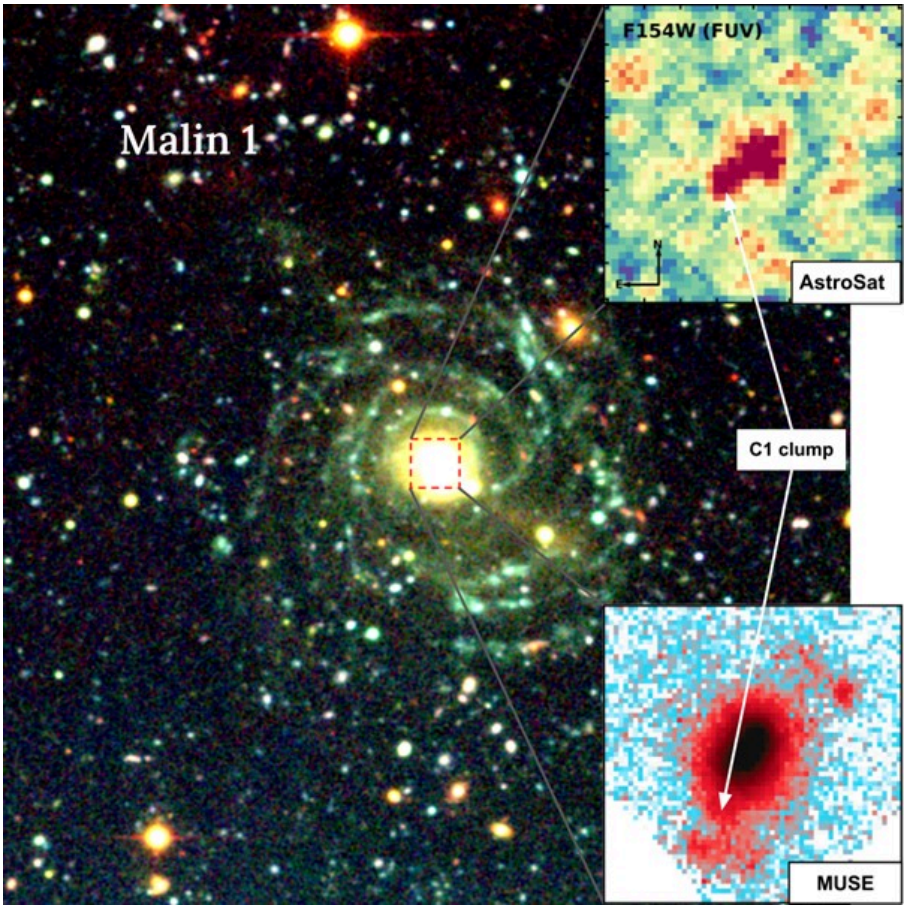

Figure 1. Left: A colour image of the giant galaxy Malin 1 made using optical data from the Canada–France–Hawaii Telescope (CFHT). The dashed box highlights the central region studied in this work. Top right: An ultraviolet image from AstroSat, showing bright patches of young stars in the same region, which are clear signs of recent star formation. Bottom right: Observations from the MUSE instrument on the Very Large Telescope reveal glowing gas associated with these young, star-forming regions.

To investigate further, the team analysed integral-field spectroscopic data from the Multi-Unit Spectroscopic Explorer (MUSE) instrument on the Very Large Telescope (VLT) in Chile. The observations revealed that the C1 clump is moving at a velocity nearly 150 km/s faster than the surrounding material and exhibits high internal turbulence. Additionally, the clump appears only in specific velocity channels, strongly indicating an external origin.

Detailed stellar population modelling of the MUSE spectra showed that beneath the C1 clump lies an old stellar population more than six billion years old, with solar-like metallicity and low alpha-element abundance. After a long quiescent phase, a burst of star formation occurred within the last 200 million years, producing extremely metal-poor, UV-bright stars that are highly alpha-enhanced—evidence of rapid enrichment by core-collapse supernovae.

Similar chemical and kinematic signatures were observed in other clumps in the central region. Together, these findings suggest that the C1 clump is the remnant of an infalling dwarf galaxy on a polar orbit. This orbit likely enabled pristine, early-universe–like gas to be delivered into Malin 1, fuelling the formation of young stars. The dwarf galaxy appears to have been torn apart into multiple fragments, all sharing comparable ages and chemical properties.

The study, published in *The Astrophysical Journal Letters* in December 2025, provides compelling evidence that Malin 1 is undergoing subtle, non-disruptive minor mergers that are reshaping its central region.

The lead author of the paper, Mr. Manish Kataria, a Ph.D. student at IUCAA under the supervision of Prof. Kanak Saha, said that understanding how giant low-surface-brightness galaxies like Malin 1 grow is crucial, as their vast, faint structures challenge existing theories of galaxy formation. He noted that combining ultraviolet imaging from AstroSat/UVIT with MUSE integral-field spectroscopy offers a powerful approach to uncovering the hidden role of minor mergers in galaxy evolution.

Prof. Kanak Saha recalled first noticing the UV clumps several years ago while examining UVIT data on Malin 1 and speculating that they might be of external origin. With the availability of MUSE data and detailed analysis, this hypothesis has now been confirmed, revealing that Malin 1 is silently cannibalising smaller dwarf galaxies—a process driving its slow but steady transformation.

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