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Dwarf Galaxy Questions Current Galaxy Formation Models

ScienceDaily (Feb. 27, 2012) — Researcher from the Centro de Astrofísica da Universidade do Porto (Center for Astrophysics of the University of Porto) observed the dwarf galaxy I Zw 18, and found that much of what is known about galaxy formation and evolution might need substantial revision.

I Zw 18 region. (Credit: Image courtesy of Centro de Astrofísica da Universidade do Porto)

CAUP Astronomer Polychronis Papaderos, along with his colleague Göran Östlin (Oskar Klein Center, U. Stokholm), used the Hubble Space Telescope (HST) to get extremely accurate observations of the I Zw 18 galaxy. Their research led to the conclusion that this enigmatic blue compact dwarf might force astronomers to review current galaxy formation models.

I Zw 18 is one of the most studied dwarf galaxies, because among those that have strong star forming activity, it's one of the poorest in heavy elements. Besides, it's proximity to Earth, combined with a total exposure time of nearly 3 days, gave the researchers data with unprecedented resolution and sensitivity.

Analysis of these data revealed an extended gas halo surrounding this galaxy, 16 times larger than the star component of the galaxy, and without any stars. This halo is the result of huge amounts of energy generated by the starburst this galaxy is going through. This energy heats and disturbs I Zw 18's cold gas, which ends up emitting an amount of light comparable to what's being emitted by the stellar component. This emission is designated nebular emission.

Papaderos, a greek astronomer working in Portugal, comments that: "This is ground-breaking work because it provides the first observational proof that, in the early Universe, young galaxies that underwent starbursts must have been surrounded by a huge halo of nebular emission. This extended nebular halo results from the cumulative energetic output from thousands of massive stars exploding as supernovae, shortly after their formation."

So far, in distant galaxies where it's not possible to reach resolutions high enough in order to distinguish between nebular and star emission, it was assumed that the gas occupied the same region as the stars and stars were responsible for emitting most of the light.

This study showed that galaxies undergoing starbursts, similar to I Zw 18, might not obey this rule. This result might lead to substantial corrections in a lot of the work being developed in cosmology and extragalactic astronomy. An example is the estimate of star mass in a galaxy, which is calculated from the galaxies total luminosity. But, as these results shows, up to 50% of that luminosity might originate in nebular, and not star, emission.

Another result from this research shows that, according to Papaderos, "the distribution of nebular emission might be misinterpreted as a stellar disk. These galaxies, still in early stages of formation, might thus be wrongly classified as fully formed galaxies" (such as spirals or ellipticals), a classification mistake that might have happened in many past studies to determine galaxy evolution in the early Universe.

These results are also of importance for our understanding of galaxy formation, because the team concluded that I Zw 18 is extremely young, with most stars younger than 1 billion years. So this galaxy is currently undergoing the dominant phase of its formation, much like the ones formed shortly after the Big Bang.

Story Source:

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Journal Reference:

1. P. Papaderos, G. Östlin. **I Zw 18 as morphological paradigm for rapidly assembling high-zgalaxies**. *Astronomy & Astrophysics*, 2012; 537: A126 DOI: 10.1051/0004-6361/201117551