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Cosmic 'Dig' Reveals Vestiges of the Milky Way's Building Blocks

ScienceDaily (Nov. 25, 2009) — Peering through the thick dust clouds of our galaxy's "bulge" (the myriads of stars surrounding its centre), and revealing an amazing amount of detail, a team of astronomers has unveiled an unusual mix of stars in the stellar grouping known as Terzan 5. Never observed anywhere in the bulge before, this peculiar "cocktail" of stars suggests that Terzan 5 is in fact one of the bulge's primordial building blocks, most likely the relic of a proto-galaxy that merged with the Milky Way during its very early days.

This wide-field image, based on data from Digitized Sky Survey 2, shows the whole region around the stellar grouping Terzan 5. (Credit: Image courtesy of ESO)

"The history of the Milky Way is encoded in its oldest fragments, globular clusters and other systems of stars that have witnessed the entire evolution of our galaxy," says Francesco Ferraro from the University of Bologna, lead author of a paper appearing in the November 26 issue of the journal *Nature*. "Our study opens a new window on yet another piece of our galactic past."

Like archaeologists, who dig through the dust piling up on top of the remains of past civilisations and unearth crucial pieces of the history of mankind, astronomers have been gazing through the thick layers of interstellar dust obscuring the bulge of the Milky Way and have unveiled an extraordinary cosmic relic.

The target of the study is the star cluster Terzan 5. The new observations show that this object, unlike all but a few exceptional globular clusters, does not harbour stars which are all born at the same time -- what astronomers call a "single population" of stars. Instead, the multitude of glowing stars in Terzan 5 formed in at least two different epochs, the earliest probably some 12 billion years ago and then again 6 billion years ago.

"Only one globular cluster with such a complex history of star formation has been observed in the halo of the Milky Way: Omega Centauri," says team member Emanuele Dalessandro. "This is the first time we see this in the bulge."

The galactic bulge is the most inaccessible region of our galaxy for astronomical observations: only infrared light can penetrate the dust clouds and reveal its myriads of stars. "It is only thanks to the outstanding instruments mounted on ESO's Very Large Telescope," says co-author Barbara

Lanzoni, "that we have finally been able to 'disperse the fog' and gain a new perspective on the origin of the galactic bulge itself."

A technical jewel lies behind the scenes of this discovery, namely the Multi-conjugate Adaptive Optics Demonstrator (MAD), a cutting-edge instrument that allows the VLT to achieve superbly detailed images in the infrared. Adaptive optics is a technique through which astronomers can overcome the blurring that the Earth's turbulent atmosphere inflicts on astronomical images obtained from ground-based telescopes; MAD is a prototype of even more powerful, next-generation adaptive optics instruments [1].

Through the sharp eye of the VLT, the astronomers also found that Terzan 5 is more massive than previously thought: along with the complex composition and troubled star formation history of the system, this suggests that it might be the surviving remnant of a disrupted proto-galaxy, which merged with the Milky Way during its very early stages and thus contributed to form the galactic bulge.

"This could be the first of a series of further discoveries shedding light on the origin of bulges in galaxies, which is still hotly debated," concludes Ferraro. "Several similar systems could be hidden behind the bulge's dust: it is in these objects that the formation history of our Milky Way is written."

Note:

[1] Telescopes on the ground suffer from a blurring effect introduced by atmospheric turbulence. This turbulence causes the stars to twinkle in a way that delights poets but frustrates astronomers, since it smears out the fine details of the images. However, with adaptive optics (AO) techniques, this major drawback can be overcome so that the telescope produces images that are as sharp as theoretically possible, i.e. approaching conditions in space. Adaptive optics systems work by means of a computer-controlled deformable mirror that counteracts the image distortion introduced by atmospheric turbulence. It is based on real-time optical corrections computed at very high speed (many hundreds of times each second) from image data obtained by a wavefront sensor (a special camera) that monitors light from a reference star, Present AO systems can only correct the effect of atmospheric turbulence in a very small region of the sky -- typically 15 arcseconds or less -- the correction degrading very quickly when moving away from the reference star. Engineers have therefore developed new techniques to overcome this limitation, one of which is multi-conjugate adaptive optics. MAD uses up to three guide stars instead of one as references to remove the blur caused by atmospheric turbulence over a field of view thirty times larger than existing techniques (ESO PR 19/07).

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Journal Reference:

1. Ferraro et al. **The cluster Terzan 5 as a remnant of a primordial building block of the Galactic bulge**. *Nature*, 2009; 462 (7272): 483 DOI: 10.1038/nature08581

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