Caught in the act: Forming galaxies captured in the young Universe by HST, VLT & Spitzer (Forwarded)

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From 16 to 20 April, Dr. Verma and Dr Bremer can be contacted via the NAM

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CAUGHT IN THE ACT: FORMING GALAXIES CAPTURED IN THE YOUNG UNIVERSE BY HST, VLT & SPITZER

A team of UK, French and German astronomers have discovered that the majority of the most distant galaxies so far identified are very young, undergoing their first extremely vigorous bursts of star formation. This discovery allows the astronomers to study the first important stages in the formation of the kind of galaxies we see in the Universe today. One of the scientists involved in the study, Dr Malcolm Bremer of the University of Bristol will present the team's findings in his talk on Tuesday 17 April at the Royal Astronomical Society National Astronomy Meeting in Preston. Full details of the study will soon appear as a paper in the journal Monthly Notices of the Royal Astronomical Society.

According to Dr Bremer: "Our new systematic survey shows that the majority of these distant galaxies are undergoing their first significant episodes of star formation at the epoch at which we observe them, thereby allowing us to directly observe this key moment in galaxy evolution."

The light that we see from these galaxies was emitted when the Universe was about 10 per cent of its present age (or just over a billion years old). They are forming stars at a very high rate (up to a hundred times the rate at which our own Galaxy, the Milky Way, is currently forming stars). The duration of these intense star formation events is short astronomically−speaking, comparable to the time it would take for a star to cross one of these galaxies (a few tens of millions of years). This indicates that we are seeing in these galaxies one of their first major star formation events, and are therefore watching the earliest stages of galaxy formation in the young Universe.

The team of astronomers discovered that the galaxies have a very high density of stars, the like of which is seen in only the centres of the most massive galaxies today. The stars that are forming in these young galaxies will end up in the biggest galaxies seen in the Universe today. Previous analysis of the light emitted by massive galaxies close to our own indirectly suggested that most stars in these galaxies formed just 1−2 billion years after the Big Bang. The new results give direct evidence for this, the observed galaxies are captured in the first major phases of their star formation. The lead author of the study, Dr Aprajita Verma of Oxford University noted: "It is exciting to think that by analysing the light from these very distant galaxies we can directly study the first

star formation episodes that happened so soon after the Universe began".

The data allowed the astronomers to determine further characteristics for the galaxies. In particular they were able to compare these very distant sources to star forming galaxies seen when the Universe was a billion years older. They found that the later galaxies were physically larger, more massive, more chemically enriched by heavier elements (created through nuclear fusion in the earliest stars) and had endured far longer episodes of star formation. The scientists are seeing direct evidence for the evolution of galaxies as the Universe ages. Team member Dr Matt Lehnert comments: "The differences between the two samples are exactly what is expected. As time goes on, galaxies grow from mergers of smaller systems and they can sustain longer bursts of star formation. These create multiple generations of stars that go on to enrich the galaxy with more and more elements heavier than hydrogen and helium".

Robert Kennicutt, the Plumian Professor of Astronomy and Experimental Philosophy at the University of Cambridge, commenting on this work said, "These results suggest that we are already able to observe some of the first building blocks of present−day galaxies. Furthermore, these results predict that many of the galaxies observed should have relatively primitive chemical compositions. In the coming decade it should be possible to test this prediction, by measuring the heavy element content of these galaxies with the next generation giant ground−based telescopes such as ESO's Extremely Large Telescope and with the successor to the Hubble Space Telescope, the James Webb Space Telescope".

How did the astronomers carry out this work?

In 2003 Lehnert and Bremer showed that samples of very distant galaxies could be reliably identified in a set of deep optical images by their unique colours. While the technique relied upon the galaxies containing some young stars, it could not determine how long star formation had continued in the galaxies. In the current work, the team led by Aprajita Verma observed similar objects in infrared light, enabling them to better characterise the galaxies' emission and thereby determining for how long star formation had been taking place.

The astronomers combined pre−existing data of an area of sky from several telescopes in order to identify many distant galaxies and then to determine the mix of stars within those galaxies. They used Hubble Space Telescope imaging to explore their properties in visible light, together with the ground−based ESO VLT (in Chile) and the orbiting NASA Spitzer telescope to determine their brightnesses in the infra red. Because these galaxies are so far away, their light is dramatically reddened by the expansion of the Universe that has occurred between the time the light was emitted by the galaxies and when it is received by us.

By determining the relative brightness of each galaxy in visible and infrared light, the team of astronomers were able to determine the ages of the stars within the galaxies. In common with several more limited

studies, they found that a few of the most distant galaxies have moderately old stellar populations indicating that they had been forming stars for several hundred million years. However, the comprehensive nature of this study showed that the majority of the galaxies had been forming a significant amount of stars for a far shorter period. In essence the galaxies were being seen in their first flush of youth.

What happens to the galaxies subsequently is an ongoing topic of study. It is not clear whether these objects cease forming stars on a timescale of a few tens of millions of years or whether they continue but become enshrouded in dust produced as part of the ongoing star formation process and are effectively rendered invisible to the telescopes used for these studies. Only further observations will make this clear.

NOTES FOR EDITORS

The 2007 RAS National Astronomy Meeting is hosted by the University of Central Lancashire. It is sponsored by the Royal Astronomical Society and the UK Science and Technology Facilities Council.

This year the NAM is being held together with the UK Solar Physics (UKSP) and Magnetosphere, Ionosphere and Solar−Terrestrial (MIST) spring meetings. 2007 is International Heliophysical Year.

The preprint of the paper to be published by MNRAS can be found at:
http://arxiv.org/pdf/astro−ph/0701725
"Lyman−break galaxies at z~5 −I. First significant stellar mass assembly in galaxies that are not simply z~3 LBGs at higher redshift" by Verma, A, Lehnert, M.D., Foerster−Schreiber, N., Bremer, M.N., Douglas, L.

IMAGES

These are available at:
http://www−astro.physics.ox.ac.uk/~averma/LBGpages/PressRelease/index.html

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