

Astronomers find galaxy at record distance

The joint forces of NASA's Hubble and Spitzer space telescopes have identified a source that is likely to be the most distant galaxy known to date. If confirmed, this discovery will be a new milestone on the path towards the detection of the earliest galaxies emerging from the dark ages.

In astronomy, looking far is looking in the past and thus the most distant galaxies are seen as they were when the universe was only about 1000 million years old. This is roughly the time when the universe became re-ionized by the collective light of early galaxies and marks the end of the "dark ages". This period was dark not only because stars and galaxies were just starting to form but also because the universe was pervaded by cold clouds of gas that were effective in absorbing radiation at wavelengths below the photoionization threshold of hydrogen at 91.2 nm. This leads to a break in the spectrum of the most distant galaxies, which appears shifted from the ultraviolet to the infrared because of the cosmological redshift. For an object at a redshift of $z = 7$, this "Lyman break" would be shifted by a factor of $1 + z$, from 91.2 nm to 730 nm. A source at such a high redshift should thus be detectable in the infrared, while remaining unseen in the visible range. This is the signature for identifying the most distant galaxies.

Strangely, the best places to search these extreme sources are not necessarily the most empty regions of the night sky (*CERN Courier* November 2006 p10), but can also be the bright areas covered by huge clusters



This Hubble image shows the galaxy cluster Abell 1689, used as a cosmic lens to magnify the light of the most distant galaxies. (Courtesy NASA/ESA/JHU (L Bradley, H Ford)/UCSC (R Bouwens, G Illingworth).)

of galaxies. The global cluster mass deforms space-time and provides a natural lens that magnifies the light received from galaxies located far beyond the cluster. Furthermore, a detailed mapping of this gravitational lensing effect shows the places where the magnification of remote galaxies would be maximum and thus tells astronomers where to search. Using this technique, a team of astronomers announced the discovery of a source at a redshift of 10 (*CERN Courier* May 2004 p13), but this detection turned out to be spurious.

A highly reliable candidate for a galaxy at

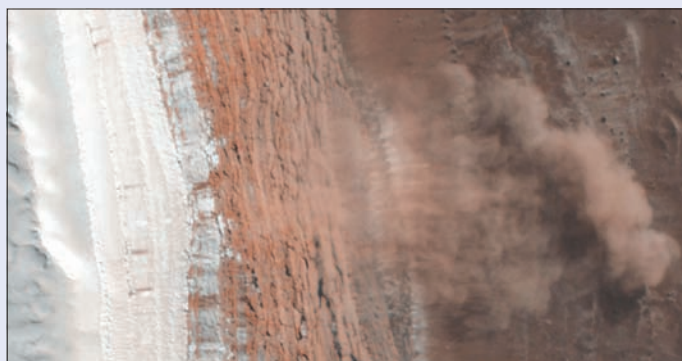
a redshift of more than seven has now been detected through the galaxy cluster Abell 1689 in a deep exposure with the Hubble Space Telescope. The relatively nearby cluster (redshift $z = 0.18$) magnifies the light of the remote galaxy by almost a factor ten. This source, found by Larry Bradley from the Johns Hopkins University in Baltimore and colleagues, is much brighter than other high-redshift candidates and therefore the detection of the Lyman break is more significant. The source was unseen with the Hubble Advanced Camera for Surveys at wavelengths shorter than 850 nm, but is detected with high significance (8σ) at $1.1 \mu\text{m}$ by the Near Infrared Camera and Multi-Object Spectrograph, while becoming dimmer towards longer wavelengths. The authors claim only a star-forming galaxy at a redshift of 7.6 ± 0.4 can reasonably fit these properties.

Subsequent observations with the infrared Spitzer Space Telescope confirm the presence of the source and constrain better the nature of the object. The observations suggest a galaxy with a mass of about 3000 million times that of the sun in the form of stars younger than about 300 million years. This is consistent with the expectations for such early galaxies, but final confirmation of the discovery will require a redshift determination with near-infrared spectroscopy.

Further reading:

L D Bradley *et al.* 2008 *ApJ* in press
<http://arxiv.org/abs/0802.2506>.

Picture of the month



This amazing view of Mars has captured an avalanche, or debris fall, in action. It was taken on 19 February by the High Resolution Imaging Science Experiment camera on NASA's Mars Reconnaissance Orbiter. It shows the edge of the dome of layered deposits on Mars' north pole.

The top part of the scarp, to the left of the image, is covered with bright (white) carbon dioxide frost. The avalanche is made of an ice-dust mixture that detached from the upper cliff and cascaded to the gentler slopes 700 m below. The dust clouds are about 180 m across and their shadows are projected on the cliff by the sunlight coming from the upper right. (Courtesy NASA/JPL-Caltech/University of Arizona.)