Academia Sinica Press Release
Monstrous Dusty Galaxies May be more Common in the Early Universe than Originally Thought

Dusty galaxies existed at very early times in the history of the Universe; however, because these galaxies are heavily obscured in dust and do not emit much visible light, they have been difficult to study. Recently, an international team of astronomers used a state-of-the-art submillimeter array, which detects far-infrared radiation, to study these galaxies. They found that previous identifications of these galaxies were likely incomplete and failed to show further hidden galaxies. The project was initiated and led by Dr. Wei-Hao Wang, a Research Fellow of the Academia Sinica Institute of Astronomy and Astrophysics (ASIAA). The results were published in the international journal *The Astrophysical Journal Letters* on December 16, 2010.

Dusty galaxies are monstrous in energy output, and were several thousand times more luminous than our Milky Way. These galaxies are so far away from the Earth that we see them as they appeared just two to six billion years after the Big Bang. (The estimated age of the Universe is about 14 billion years.) Dusty galaxies existed in the most violent life stages of cosmic objects, either producing young stars at extreme rates, or harboring super massive black holes at their centers. All the large galaxies of today's Universe went through such stages.

The team of astronomers used the upgraded Submillimeter Array (SMA), eight 6-meter diameter radio telescopes arranged as an interferometer, to look for distant dusty galaxies. The number of dusty galaxies they found exceeded their original expectations. "Based on past observations, we expected to find two dusty objects. However, we found five," Dr. Wang said. Such a revelation led Dr. Wang and his colleagues to propose that the number of such galaxies may be more than astronomers have previously thought.

Dr. Lennox Cowie from the University of Hawaii and a co-author of the article said "our first view of these distant dusty galaxies came about a decade ago with a submillimeter camera on the James Clerk Maxwell telescope on Mauna Kea but that only gave us very blurry images. Now with these new sharper images from the SMA it seems that many of the objects we saw are actually blends of several smaller individual galaxies. This changes the interpretation quite a bit... there are more objects but they are individually smaller."

The SMA is located at the Mauna Kea Observatory in Hawaii. It contains eight radio antennas to be used together as a radio interferometer. It has the highest resolution among all submillimeter telescopes and can provide the sharpest images. It is able to detect thermal radiation from heated dust. It was recently upgraded to double its observation bandwidth and further enhance its sensitivity. The SMA is a joint project between the Smithsonian Astrophysical Observatory and the ASIAA. Academia Sinica is also a partner of the Atacama Large Millimeter/Submillimeter Array project, an even more powerful 50-elementradio interferometer currently under construction in the Atacama Desert in northern Chile.

The full article entitled "SMA Observations of GOODS 850-11 and GOODS 850-

13 —First Examples of Multiple Submillimeter Sources Resolved by an Interferometer" is available at The Astrophysical Journal Letters website at: http://iopscience.iop.org/2041-8205/726/2/L18. The full list of authors is: Wei-Hao Wang, Lennox L. Cowie, Amy J. Barger, and Jonathan P. Williams.

Caption: An artist's illustration of a dusty galaxy. Such a galaxy is several thousand times more luminous than the Milky Way. The tremendous energy output is either powered by numerous young stars, or by a super massive black hole at its center. Most of its light is absorbed by thick layers of dust. The dust absorbs light and becomes warmer, and then re-radiates the heat in the far-infrared and submillimeter range. Such monster galaxies are rare in today's Universe, but were once very common in the early Universe. This picture is an art work based on a Hubble Space Telescope image (credit: NASA, STScI).

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