Galactic Mergers and Acquisitions
Date Saturday, January 17 @ 16:10:39
Topic Stellar Evolution

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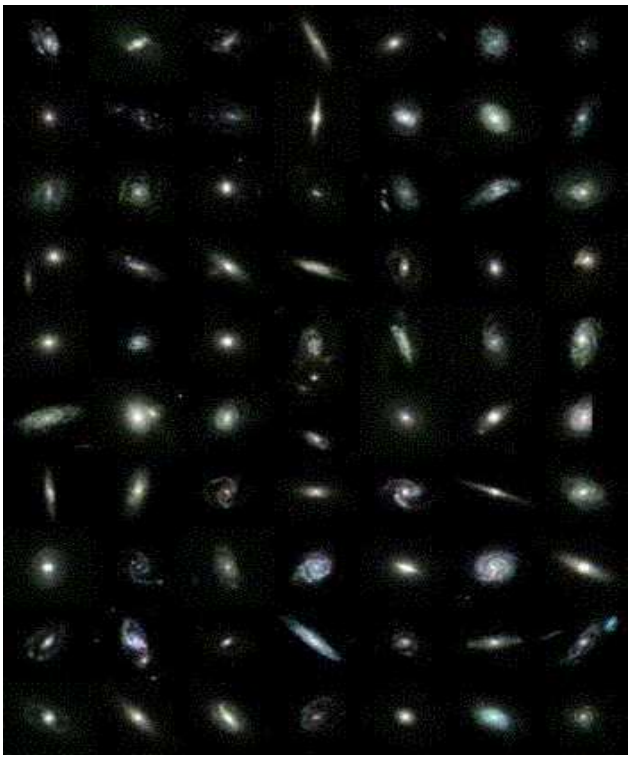
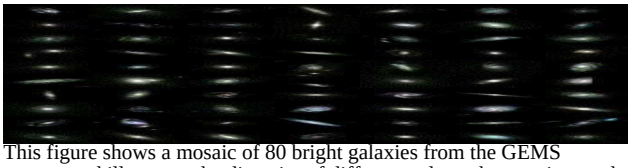
Coincident with the announced de-orbiting of the Hubble Space Telescope in 2007, a team of astronomers have created the largest color Hubble image yet, showing 80 diverse galaxies and helping visualize how large galaxies like our own Milky Way have evolved among the menagerie of different types, sizes and shapes.

Galactic Mergers and Acquisitions

based on Max Planck Society report

The largest contiguous color image taken with the Hubble Space Telescope has been unveiled by an international team of astronomers at the American Astronomical Society meeting in Atlanta, Georgia.





This figure shows a mosaic of 80 bright galaxies from the GEMS survey, and illustrates the diversity of different galaxy shapes, sizes and types: watermelon-shaped elliptical galaxies, majestic spiral galaxies, some with elongated bars in their centers, and spectacular galaxy mergers.
Credit:GEMS Collaboration

Dr. Eric F. Bell of the Max-Planck-Institute for Astronomy in Heidelberg, Germany, and Dr. Shardha Jogee of the Space Telescope Science Institute in Baltimore, Maryland presented an image in the constellation Fornax equal to the apparent size of the full moon containing more than 40,000 galaxies. The astronomers, members of a large team called the GEMS consortium and led by Dr. Hans-Walter Rix, Director of the Max-Planck-Institute for Astronomy, said the image will help them understand how large galaxies, like the Milky Way, evolved over the last nine billion years, about 2/3 the age of the universe. GEMS is an acronym for Galaxy Evolution from Morphology and Spectral energy distributions.

To construct the image, the team stitched together 78 separate exposures from Hubble's Advanced Camera for Surveys. "It's like making a big picture of a mountain range by pasting together individual pictures of each mountain we have done exactly the same thing, only with the Hubble Space Telescope", said Dr. Daniel H. McIntosh, a researcher at the University of Massachusetts in Amherst, Massachusetts.

The main advantage of GEMS is its large area. "This is the largest color image ever taken by HST", continues McIntosh. "Because galaxies clump together in space, smaller images may accidentally land on unusual patches. For example, a picture of the USA at night shows bright areas near the cities and dark areas in the mountains, forest, and farmlands. To understand the population of the United States, we would need an image covering both the rare, bright cities and the dark but sparsely-populated farmland and wilderness. Furthermore, galaxies, like people are incredibly diverse. Only by having images of a large sample of galaxies can one explore the huge diversity of galaxy types, sizes and shapes, as well as discovering important but very brief episodes in their lives."

The team chose an area in which they already knew the distances to nearly ten thousand galaxies. Because of the expansion of the Universe, more distant galaxies are moving away from us faster than nearby galaxies. Astronomers use the Doppler shift of the galaxies' light to measure this movement and compute the distance. And because the light from distant galaxies takes longer to reach Earth than that from the nearby objects, we see distant galaxies as they were in the past, giving astronomers a kind of cosmic 'time machine.' GEMS can see back accurately about 9 billion years, 4.5 billion years before the Sun and the Earth formed.

Dr. Christian Wolf of the University of Oxford and Dr. Klaus Meisenheimer of the Max-Planck-Institute for Astronomy led a team to measure the distances to ten thousand galaxies in GEMS with accuracies of a few percent. "This is the first time that astronomers have had such a large sample of galaxies with accurate distances and exquisite HST data", said Wolf. He continues, "With these distances and the exquisite images, astronomers can investigate how the sizes and structures of galaxies evolve over the last 9 billion years." For instance, one of the questions addressed by GEMS is the evolution of stellar bars majestic elongated stellar concentrations which shape galaxy evolution by driving gas towards the central regions of galaxies, often igniting spectacular bursts of star formation. Although the majority of present-day spiral galaxies host stellar bars, including our own Galaxy, little is known about when and how bars formed at earlier epochs.

One of the many goals of GEMS is to investigate how galaxy interactions impact galaxy evolution. Interacting galaxies exert strong gravitational forces and shocks on each other, induce dramatic morphological transformations, and may even merge into a final product which is vastly different from the progenitors. "With GEMS, we identify interacting and merging galaxies over the last 9 billion years by capturing their tell-tale strongly disturbed morphologies: double bright nuclei, stellar tidal tails flung out over thousands of light years, and highly asymmetric star formation", says Jogee. Interactions may also play an important role in feeding gas to huge black holes in the centers of massive galaxies, 'activating' the nucleus into releasing prodigious amounts of energy. GEMS can bring valuable insights into the nature of galaxies hosting such active nuclei. "Furthermore, our current understanding of the physics of galaxy interactions is still pretty uncertain, and good observations of how frequently galaxies merge at different times in the Universe's history would be a really important part of this puzzle," said Dr. Rachel S. Somerville, a staff astronomer at the Space Telescope Science Institute in Baltimore, Maryland. First indications are that galaxy interactions are much more common in the past than they are today. "Most massive galaxies are simply aging now, fading slowly into obscurity", said Rix.

Another focus of GEMS is to explore the leftovers of particularly violent galaxy mergers -- watermelon-shaped galaxies called elliptical galaxies. "With GEMS, we have proven for the first time that there are more elliptical galaxies today than there were in the past", explains Bell. "This is exciting first evidence for a merger origin of at least some elliptical galaxies."

Timelines

1990
- Hubble Space Telescope launches aboard Space Shuttle Discovery, as Earth Orbiting Observatory

1994
- Hubble Space Telescope finds evidence of black hole in the center of M87
- Hubble Key Project begins studying Cepheid variable stars to better define Hubble Constant, and the size of the universe

1996
- Sidney van den Bergh and Gustav Tammann debate Hubble Constant and the scale of the universe

1998
- Jim Peebles and Michael Turner debate nature of universe and whether cosmology is solved

1999
- John Cowan confirms age estimates of globular clusters and universe by dating metal-poor stars
- Wendy Freedman and Allan Sandage debate Hubble Constant and the scale of universe

2001
- Hubble Space Telescope detects an atmosphere around an extrasolar planet

2002
- Chandra X-ray Observatory finds evidence for new matter in "quark stars", matter so dense it exceeds terrestrial nuclear material with 1.2 million degree temperatures

2003
- Final mission in NASA Great Observatory series, the infrared observatory, or Spitzer Space Telescope, finds evidence for organic molecules in intergalactic regions
- Microwave measurements precisely date the Big Bang at 13.7 billion years ago, with a remarkable 1% error prediction

2004
- French COROT mission will look at 50,000 to 60,000 stars and should find a few dozen terrestrial planets and several hundred close-in gas-giant planets during a two- to three-year mission

2006
- Kepler, Extrasolar Terrestrial Planet Detection Mission, designed to look for transiting or earth-size planets that eclipse their parent stars [survey 100,000 stars]. Scientists expect to find thousands of planets, and perhaps 50 Earth-like candidates.

2007
- Likely de-orbit for Hubble Space Telescope [date announced assumes no planned shuttle visits from NASA]

2009
- Planned launch for NASA-ESA Next Generation Space Telescope, or NGST [James Webb Space Telescope], a near-infrared telescope that will succeed the Hubble Space Telescope.

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