MAX PLANCK SOCIETY

Press Release

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Mining for Cosmic Treasures with GEMS

Largest Hubble color image tells the history of the Universe

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. 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."

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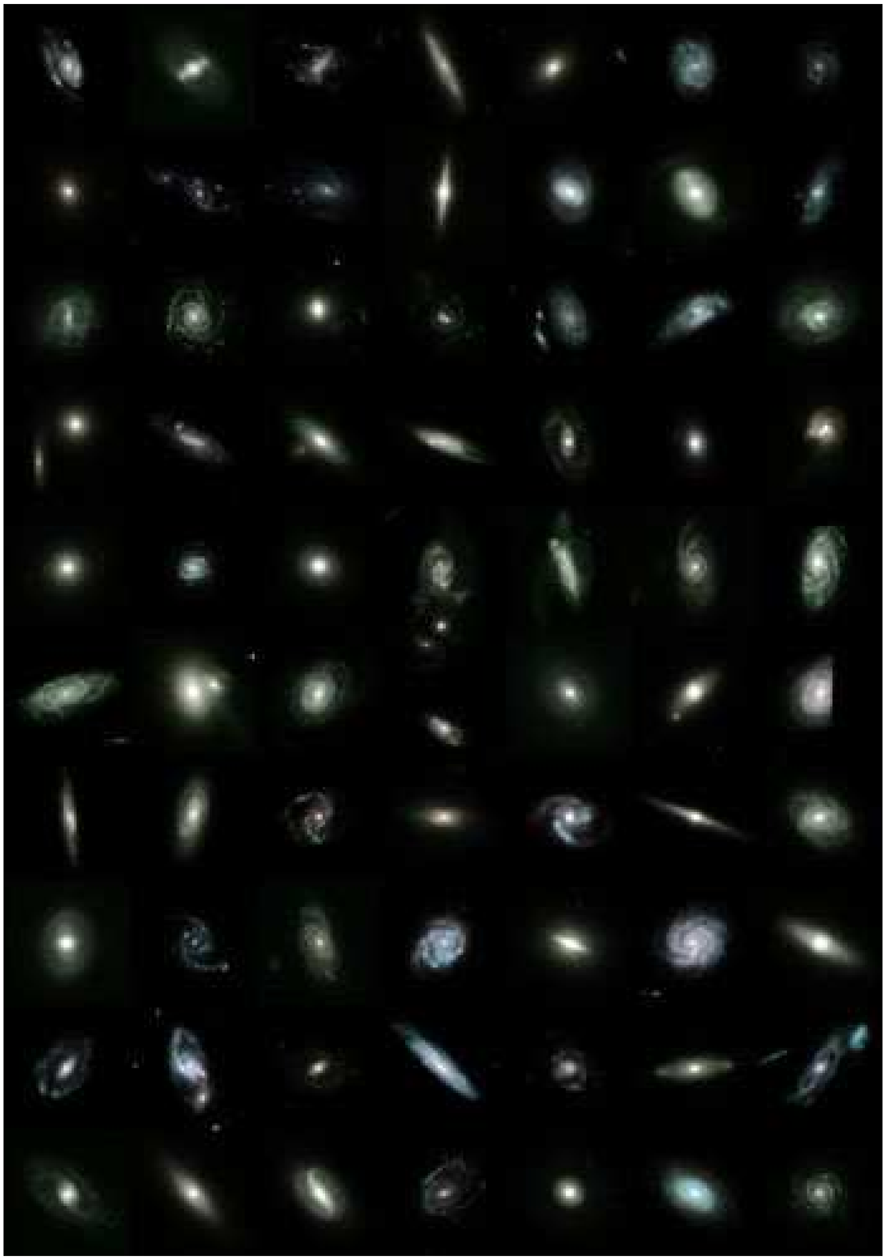

Fig. 1: *This figure shows a mosaic of 80 bright galaxies from the GEMS survey, and illustrates the diversity of different galaxy shapes, sizes and types: watermelon-shaped elliptical galaxies, majestic spiral galaxies, some with elongated bars in their centers, and spectacular galaxy mergers.*

Image: the GEMS collaboration

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.

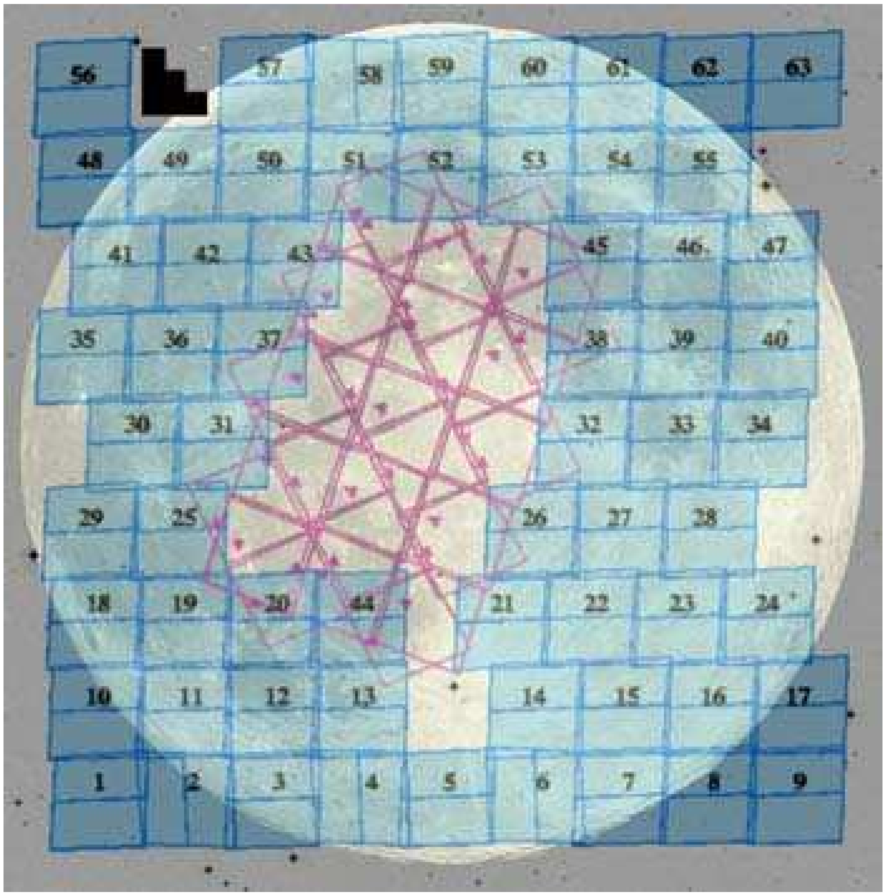

Fig. 2: *This figure shows the layout of the Hubble Space Telescope (HST) Advanced Camera for Surveys fields which are stitched together to form the largest color mosaic ever taken by HST. The numbered tiles are the GEMS tiles, the inner tiles are from the Great Observatories Origins Deep Survey, and are used to complete the full moon-sized color image. The field is in the constellation of Fornax in the Southern Hemisphere, and the full moon is overlaid for comparison.*

Image: the GEMS collaboration

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.

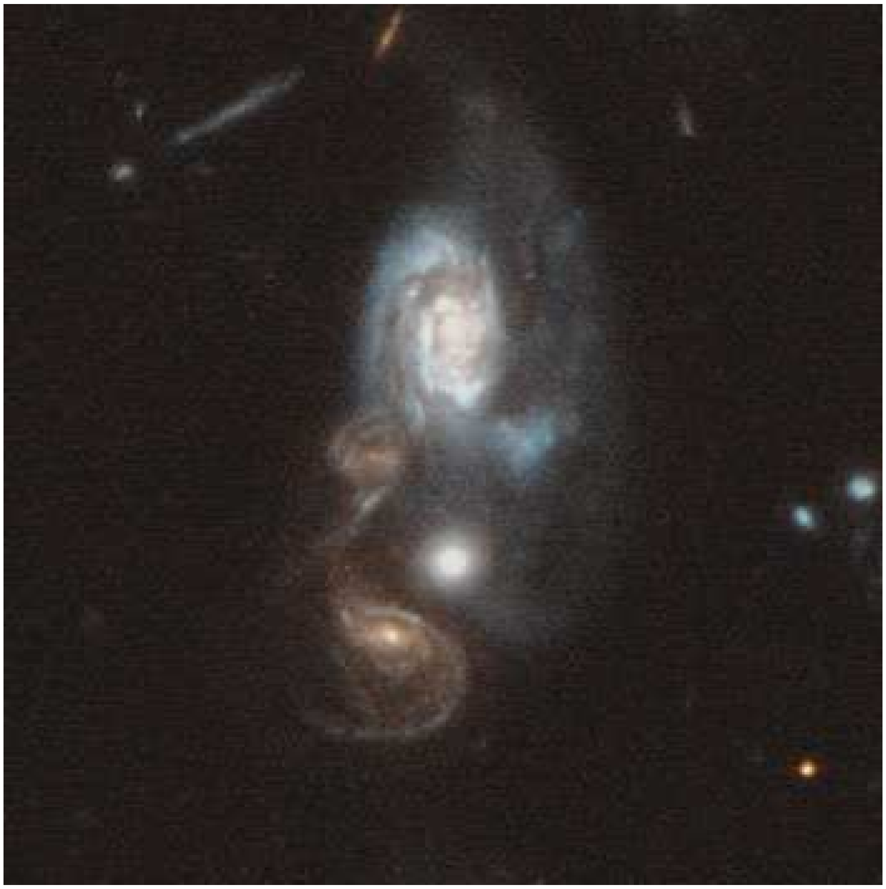

Fig. 3: *This figure shows a particularly spectacular double galaxy interaction in the GEMS field. In the foreground are two interacting spiral galaxies; while in the distant background there is another pair of interacting spiral galaxies.*

Image: the GEMS collaboration

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."

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[1] Electronic versions of the figures

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