Herschel reveals details of distant galaxies and quasars

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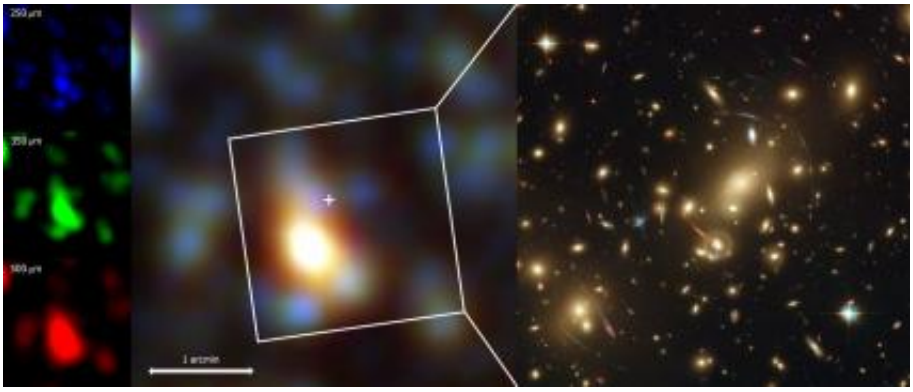

Figure A: Shows the region of sky around the massive galaxy cluster Abell 2218, as seen by Herschel and Hubble. On the left, the images at the three SPIRE wavelength bands are shown, while the centre image is a false-colour composite. The centre of the galaxy cluster is shown as a white cross-hair, while the large yellow blob just below it is a much more distant galaxy. The light from this distant galaxy is being bent and magnified by the immense mass of the Abell 2218 cluster, allowing astronomers to see it in more detail than would otherwise be possible without this chance alignment. It is seen as it was around 2.6 billion years after the Big Bang, providing a glimpse into the Universe's history. The other structures in the image are largely due to much closer, fainter galaxies which are observed by optical observatories such as the Hubble Space Telescope, as shown on the right. The public release of the Herschel data is allowing astronomers to better determine the formation and evolution of galaxies from soon after the Big Bang right up to today. Credit: ESA/SPIRE and HerMES Consortia (left); ESA/NASA/STScI (right)

(PhysOrg.com) -- Amazing new data captured by ESA's (European Space Agency) Herschel Space Observatory - carrying the largest mirror ever launched into space - have just been publicly released, allowing the World's astronomers to share in the Herschel SPIRE instrument's observations of distant galaxies. From its vantage point nearly 1.5 million km from Earth (1 million miles), the Herschel spacecraft has given astronomers new insights into the different types of galaxy in the distant Universe and will allow them to explore part of the Universe as it was some eleven billion years ago or just 3 billion years after the Big Bang.

Dr David Parker, Director of Space Science and Exploration for the UK Space Agency, said, "We're very proud to be supporting this groundbreaking mission. Herschel is a key part of the UK Space Agency's programme to explore the ancient Universe and understand how galaxies, stars and planets form. Herschel can see back in time because the light left the stars making up the distant galaxies billions of years before our planet Earth was formed and has been travelling through space ever since, only now to be captured by the spacecraft's sensitive eyes."

The new data is part of the Herschel Multi-tiered Extragalactic Survey (HerMES), led by Professor Seb Oliver at the University of Sussex and Dr Jamie Bock at the NASA Jet Propulsion Laboratory and California Institute of Technology.

The HerMES project is providing a view of the distant Universe at wavelengths which can only be observed from space. Because the SPIRE camera on board Herschel "sees" images in three sub-millimetre wavelength bands, or colours, which have hardly been used in astronomy until now, it shows a different aspect of galaxies, and is able to view cool objects previously invisible to astronomers. The appearance of an object in these three colours provides information on its temperature, distance

and luminosity.

Some of the data being released focus on a massive cluster of galaxies called Abell 2218. At a distance of over 2 billion light years from Earth, the huge mass of the cluster warps the surrounding space, bending and magnifying light from background galaxies in a manner similar to light being magnified by a normal glass lens. Abell 2218 is famous for being one of the best known examples of this “gravitational lensing”. The effect, first predicted by Einstein in the early 20th century, means that the background galaxies are magnified, allowing a much clearer view of objects as they were over 11 billion years ago - less than 3 billion years after the Big Bang. Without the gravitational lensing these galaxies would be much fainter, and confused by the presence of the foreground galaxies, but this chance alignment provides the opportunity to explore a tiny part of the early Universe in much more detail. The Herschel observations of these distant galaxies tell astronomers how fast they were forming stars at these early times, and help to build up a picture of how galaxies have evolved over the course of billions of years.

Figure A (above) shows the Abell 2218 cluster as seen by the SPIRE instrument on Herschel, in relation to an iconic image from the Hubble Space Telescope. The three wavelength bands are first shown as individual red, green and blue images, and then combined into a colour image. The centre of the cluster is marked as a white cross-hair, and the bright yellow object just below is the lensed galaxy. Most of the other galaxies shown are much bluer, and are in the foreground cluster. The properties of the cluster are also of great interest to other astronomers, such as those using the Hubble Space Telescope. Observing at many wavelengths not only helps work out the precise effect of the lensing, but also shows the nature and behaviour of galaxies within large clusters.

Using these new data, other telescopes can be used to search for galaxies at a range of distances, shedding light on the way they have formed and

evolved from soon after the Big Bang right up to the present day. Dr. Michael Zemcov of California Institute of Technology says "Images like this show that SPIRE has opened up the possibility of observing at sub-mm wavelengths in a way which was just not possible before; this kind of clarity is unprecedented at these wavelengths. Now that these data are available to the entire astronomical community, we will really be able to test our understanding of objects like galaxy clusters and, more profoundly, the formation of structure in the Universe".

Dr. Evanthia Hatziminaoglou, at the European Southern Observatory, has been using the HerMES data to study the connection between galaxies and the super-massive black holes that lie at their centre. These super-massive black holes grow by accreting gas, with some radiating vast quantities of power as quasars or “Active Galactic Nuclei” (AGN). Looking at these objects with Herschel, Dr Hatziminaoglou discovered that their sub-millimetre emission comes almost entirely from star formation and their properties, in these wavelengths, are indistinguishable from those of non-active galaxies. The results of her research, which will be published next month, confirm independently that super-massive black holes grow in size along with the galaxies in which they reside. Dr Hatziminaoglou said "it is surprising to see that these two highly energetic astrophysical phenomena co-exist in such harmony”.

The HerMES team hope that by releasing catalogues of their galaxies to the whole astronomical community, telescopes around the world will be trained on these kinds of exotic distant beasts to help our understanding of how galaxies and AGN have evolved over the lifetime of the Universe. Professor Ian Smail, an astronomer at Durham University, is not a member of the HerMES team, but uses surveys of galaxies at different wavelengths to study their formation and evolution. Discussing the release of the HerMES catalogues, Prof. Smail said "These first sub-millimetre views of young galaxies in the distant Universe clearly show

that huge numbers of new stars are being formed, but cloaked by dust and so missed by optical observatories such as the Hubble Space Telescope. It is already clear that we live in a changing Universe and, thanks to Herschel and SPIRE, few things are changing faster than our perception of it."

Professor Seb Oliver from Sussex University said “we have made these images and lists of galaxies available to all astronomers sooner than we were obliged to because Herschel is a fantastic mission but has a limited lifetime, and it is vital that it is used for the best science. We hope that other astronomers will want to use Herschel and many other telescopes to study the galaxies we have discovered”.

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