Il Colle di Galileo

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Deep X-ray and IR study of the distant X-ray cluster XDCP J0044.0-2033 «Gioiello» at z=1.6

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Abstract. A recent, deep exposure using NASA's Chandra X-ray Observatory showed strong diffuse X-ray emission from the high redshift cluster XDCP0044, discovered in 2011 in the framework of the XMM Distant Cluster Project. This is the deepest X-ray observation yet made on a cluster beyond a distance of about 8 billion light years. At the same time, Infrared observations from ESA's Herschel Space Observatory showed intense star formation in the center of XDCP0044, providing for the first time a snapshot of the epoch when the stars of the most massive cluster members are still forming. The two works originating from these data are led by the authors of this short contribution.

Keywords. X-ray, Galaxy Clusters, Redshift, ESA, star formation

The long Chandra observation, equivalent to over four days' time, allowed us to gather sufficient X-ray data which, when combined with scientific models, can provide an accurate weight of the cluster. We found that XDCP0044 is a virialized cluster at redshift z=1.6 with a mass of about 400 trillion times the mass of the Sun. Furthermore, its Intra Cluster Medium has global properties similar to that of local clusters. This is the first time that a virialized halo has been clearly identified at a distance of 9.6 billion light years away. This is an important step in understanding how galaxy clusters, the largest structures in the Universe held together by gravity, have evolved over time.

Another important piece of information comes from the Infrared observation from ESA's Herschel Space Observatory that allows us to detect cold dust in galaxies - an important signature of ongoing star-formation activity. We found that the cluster center has a star-formation rate of almost two thousand solar masses per year. The detection of such an unprecedented level of star formation in the cluster center, typically a harsh environment with many galaxies packed together that hampers star formation, makes this discovery a breakthrough for clusters of this mass and distance. Finding active star birth in the core of XDCPJ0044.0-2033 is an important step towards establishing at what period in cosmic history the star-formation preference changed from the high-density environments in cluster cores, to the low-density settings at the periphery of clusters, such as the star formation we see in our local Universe.

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The cluster is officially known as XDCP J0044.0-2033. Our team, however, have nicknamed it «Gioiello», which is Italian for «jewel». We chose this name because an image of the cluster contains many sparkling colors from the hot, X-ray emitting gas and various star-forming galaxies within the cluster. But perhaps the real reason is that we met to discuss the Chandra data for the first time at Villa il Gioiello, a 15th century villa on the hills of Arcetri, which was the last residence of Galileo Galilei.

Bibliography

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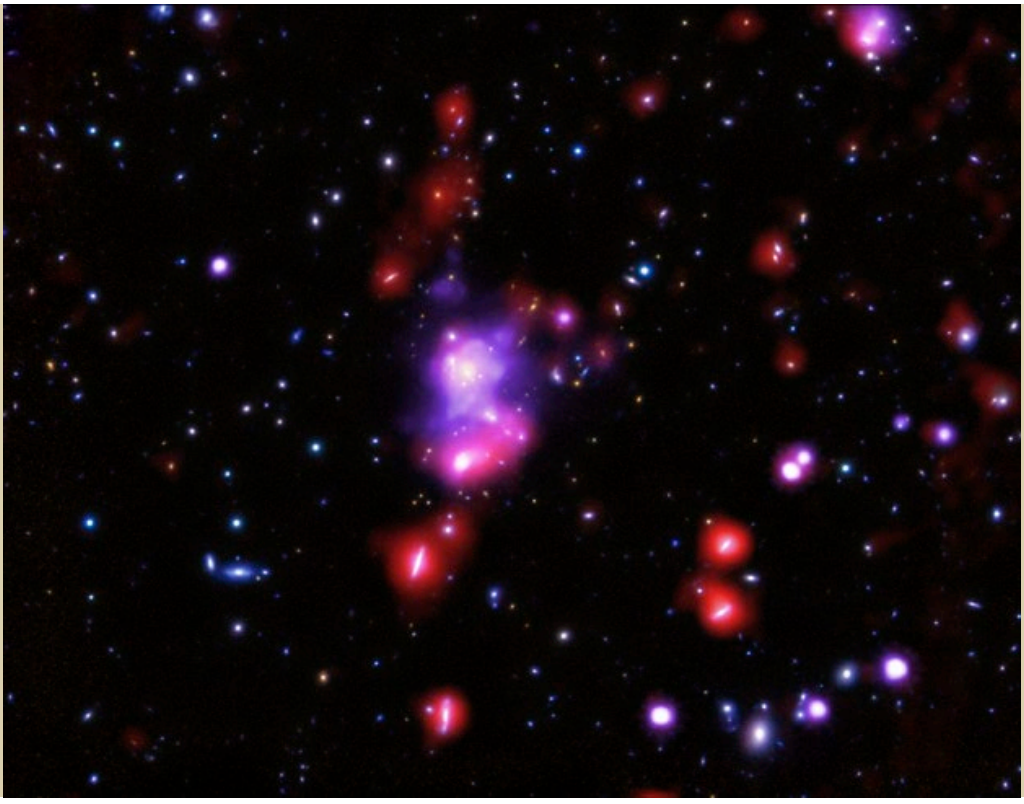

Figure 1. In this new image of the Gioiello Cluster, X-rays from Chandra are purple, infrared data from ESA's Hershel Space Telescope appear as large red halos around some galaxies, and optical data from the Subaru telescope on Mauna Kea in Hawaii are red, green, and blue. Credits: X-ray: NASA/CXC/INAF/P.Tozzi, et al; Optical: NAOJ/Subaru and ESO/VLT; Infrared: ESA/Herschel/J. Santos, et al.