Invisible light discovers the most distant cluster of galaxies

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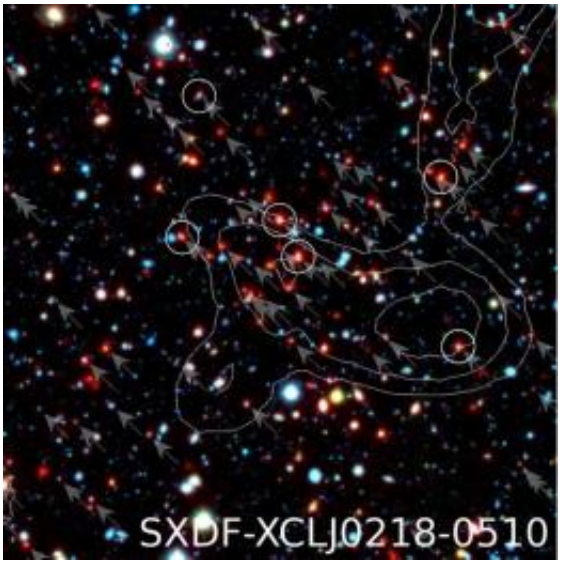

The image is 3.4 arcmin on a side (1 arcmin is 1/60th of a degree), which corresponds to 5,700,000 light years in the universe 9.6 billion light years away. The arrows indicate galaxies that are likely located at approximately the same distance, and these galaxies cluster around the center of the image. The cluster emits X-rays as shown by the contours. The circles show galaxies whose distances are accurately measured from the near-infrared observations and have been confirmed to be at 9.6 billion light years away. Though the number of the confirmed members may be small, the combination of the X-ray detection and the confirmation of massive galaxies unequivocally prove a real, gravitationally bound cluster.

(PhysOrg.com) -- An international team of astronomers from Japan and

Germany has discovered the most distant cluster of galaxies known so far-9.6 billion light years away.

The universe hosts a multitude of galaxies. Galaxies are not uniformly distributed in the universe, but are arrayed in filamentary structures. Filaments permeate the universe and form a gigantic cosmic spider web. Galaxies clusters, where many galaxies live together, are often located at the knots of the filaments. The most distant cluster known - at least until now - is located some 9.2 billion light years away. A team of astronomers from Japan and Germany has discovered an even more distant cluster of galaxies using light invisible to human eyes.

The universe is a time machine; that is, you can go back in time as you look deeper into the universe. Astronomers have used this principle in search of clusters in a distant past. But, the expansion of the universe forces distant galaxies away from Earth at large velocities, shifting their light away from visible wavelengths to infrared wavelengths. This shift makes the light from the distant universe invisible, which has impeded progress over the years. The powerful capability of Subaru's near-infrared eye MOIRCS, though, now enables astronomers to peer deeper back into the early universe.

Tanaka and collaborators found a candidate in a very distant cluster of galaxies in the constellation of Cetus. MOIRCS was used to measure the distances to massive galaxies in the candidate cluster. "MOIRCS has an extremely powerful capability of measuring distances to galaxies. This is what made our challenging observation possible," says Tanaka. The team succeeded in measuring the distances and confirmed that several galaxies actually have congregated at a distance as far as 9.6 billion light years away. He adds, "Though we confirmed only several massive galaxies at that distance, there is convincing evidence that the cluster is a real, gravitationally bound cluster."

Galaxy clusters host a vast amount of matter heated to extreme temperatures. Every material emits light; but at such high temperatures, the emission is so blue that the light is not visible to the human eye. The team used the orbiting X-ray observatory XMM-Newton to search for invisible light from the cluster. According to Finoguenov, X-ray expert on the team, "Despite the difficulties in collecting X-ray photons with a small effective telescope size similar to the size of a backyard telescope, we detected a clear signature of hot gas in the cluster."

The combination of observations in invisible wavelengths - near-infrared and X-ray - has led to the discovery of the cluster at 9.6 billion light years away, making it the most distant cluster known today some 400 million more light years away. The cluster is an ideal laboratory for studying the evolution of galaxies. Also, a collection of such distant clusters can be a sensitive probe of the origin of the universe. The team is continuing their search for more distant clusters.

The paper has been accepted for publication in *The Astrophysical Journal Letters*.

More information: "A spectroscopically confirmed X-ray cluster at z=1.62 with a possible companion in the Subaru/XMM-Newton deep field", M. Tanaka, A. Finoguenov, and Y. Ueda, *The Astrophysical Journal Letters.*

Provided by Subaru Telescope