Cosmic furnace seen by X-ray observatory

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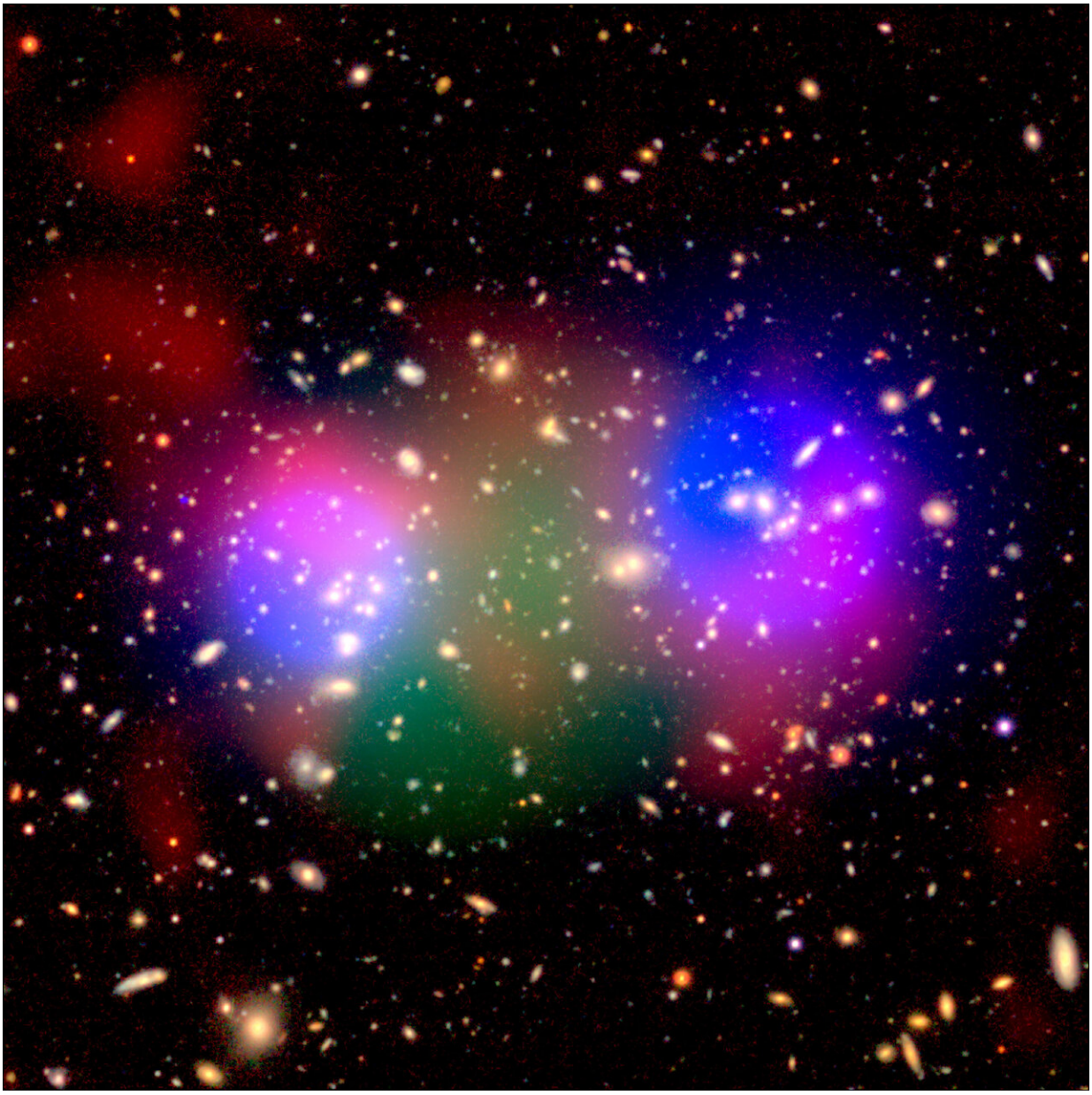

Credit: Radio: GBT Green Bank Observatory/National Science Foundation

(NSF); Optical: Subaru Tele-scope, National Astronomical Observatory of Japan/HSC-SSP collaboration; X-ray: European Space Agency (ESA)/XMM-Newton/XXL survey consortium.

This burst of color shows a fascinating discovery: a galaxy cluster acting as a cosmic furnace. The cluster is heating the material within to hundreds of millions of degrees Celsius—well over 25 times hotter than the core of the sun.

The cluster, named HSC J023336-053022 (XLSSC 105), lies four billion light-years from Earth and was independently discovered by both ESA's space-based XMM-Newton X-ray Observatory and NAOJ's Subaru optical-infrared telescope in Hawaii, U.S.. XMM-Newton detected the cluster via the international XXL survey, which is exploring two large areas of space outside our galaxy.

Galaxies are not distributed randomly throughout the Universe, and instead exist within groups and larger clusters. These aggregations can be mammoth and sometimes contain many thousands of individual galaxies in a single structure, all embedded in clumps of invisible dark matter. Different sub-groups of galaxies can also form within a single cluster, as shown here by the two blue-purple circles on either side of center. These circles mark the locations of two sub-clusters within HSC J023336-053022 which are slowly moving towards and colliding with one another, shock heating gas to intense temperatures in the process.

To create this image, three different international teams of astronomers explored observations of the cluster across the electromagnetic spectrum , in order to isolate and pinpoint different aspects of this region of space. These aspects are shown here in different colors. Individual galaxies within the cluster show up in orange, and dark matter—which maps the

location of the two sub-clusters—in blue (via optical observations from Subaru). Hot, dense gas shows up in green (X-ray from XMM-Newton), while hot, thin, high-pressure gas shows up in red (radio from the Green Bank Telescope in Virginia, U.S.). This gas is something known as the 'intracluster medium', which permeates galaxy clusters and fills the space between galaxies.

The addition of radio observations makes this image special, as many studies of collisions within or between galaxy clusters have not captured this shock-heating process—which is represented visually in the region where green changes to red—in radio. This process releases immense amounts of energy and heats already scorching gas to temperatures tens of times hotter. Before shock heating, the gas sits at around 40 million degrees Celsius—already some 2.7 times hotter than the core of the sun.

Provided by European Space Agency

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