

# Galaxy Cluster with a Vibrant Heart

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*Photographed 10 September 2015 from the Hubble Space Telescope, this image shows the region of sky around the distant galaxy cluster SpARCS1049+56. It took the light of the cluster 9.8 billion light-years to reach us. The cluster houses at least 27 galaxies, probably more, and has a combined mass equal to 400 trillion Suns. (Image credit: NASA, ESA, Digitized Sky Survey 2).*

**S**INCE THE Hubble Telescope was first launched into space on April 24, 1990, from space shuttle Discovery, it has discovered galaxies and star systems well beyond that of which earthbound telescopes are capable.

Its latest discovery is a rare and gigantic galaxy cluster at the centre of which is a heart overflowing with new stars. This unexpected find, suggests that behemoth galaxies at the cores of these massive clusters can grow significantly by feeding off gas stolen from another galaxy.

The galaxy was initially discovered using NASA/ESA's Spitzer Space Telescope in orbit 353 miles above the Earth and the Canada-France-Hawaii Telescope, located on Mauna Kea, in Hawaii, and confirmed using the W.M. Keck Observatory, also on Mauna Kea.

Follow-up observations using the NASA/ESA Hubble Space Telescope in circular orbit 347,2 miles above the Earth, allowed the astronomers to explore the galaxy's activity.

The Spitzer Telescope is designed to detect infrared light, so it can detect the warm glow of hidden, dusty regions of star birth. Follow-up studies with Hubble in visible light helped to pinpoint what was fuelling the new star formation. It appears that a smaller galaxy merged with the monster in the middle of the cluster, lending its gas to the larger galaxy and igniting a violent episode of new star birth.

"Usually, the stars at the centres of galaxy clusters are old, red or dead, essentially stellar fossils," said Tracy Webb, of McGill University, Montreal, Canada, lead author of a new paper on the findings accepted for publication in the *Astrophysical Journal*. "But we think the giant galaxy at the centre of this cluster is furiously making new stars after merging with a smaller galaxy."

#### ALMOST INCOMPREHENSIBLE

Galaxy clusters are massive families of galaxies bound and grouped by ties of gravity. Our own Milky Way resides in a small galaxy group, called the Local Group, which itself is on the periphery of the vast Laniakea supercluster of 100 000 galaxies. (Laniakea is Hawaiian for "immeasurable heaven.")

The cluster in the new study, referred to by astronomers as SpARCS1049+56, has at least 27 galaxies, and a combined mass equal to nearly 400-trillion suns. It is located 9.8-billion light-years away in the Ursa Major constellation.

"What we are seeing now is something that occurred before our solar system was formed 4.6-billion years ago," said one scientist.

What makes this cluster unique is its luminous heart of new stars. At the core of most massive galaxy clusters lies one hulking galaxy that usually does not produce new stars very quickly.

SpARCS1049+56 seems to be bucking the

trend, instead forming new stars at an incredible rate.

The galaxy dominating the cluster SpARCS1049+56 is rapidly spitting out an enormous number of stars — about 860 new ones a year. Our Milky Way makes only about one to two stars per year.

"With Spitzer's infrared camera, we can actually see the ferocious heat from all these hot young stars," said co-author Jason Surace, from NASA's Spitzer Science Centre at the California Institute of Technology, in Pasadena. "Spitzer detects infrared light, so it can see the warm glow in the fuzzy regions where stars are believed to form."

"The Spitzer data showed us a truly enormous amount of star formation in the heart of this cluster, something that has rarely been seen before, and certainly not in a cluster this distant," said co-author, Adam Muzzin, of the University of Cambridge, UK.

Follow-up studies with Hubble in visible light helped confirm the source of the fuel, or gas, for the new stars. A smaller galaxy seems to have recently merged with the monster galaxy in the middle of the cluster, lending its gas to the larger galaxy and igniting a fury of new stars.

"Building on our other observations, we used Hubble to explore the galaxy in depth — and we weren't disappointed," added Muzzin. "Hubble found a train wreck of a merger at the centre of this cluster. We detected features that looked like beads on a string."

Hubble specifically detected features in the smaller, merging galaxy called "beads on a string," which are pockets of gas that condense where new stars are forming. Beads on a string are telltale signs of collisions between gas-rich galaxies, a phenomenon known to astronomers as wet mergers, where "wet" refers to the presence of gas. In these smash-ups, the gas is quickly converted to new stars.

The new discovery is one of the first known cases of a wet merger at the core of a distant galaxy cluster. Hubble previously discovered another closer galaxy cluster containing a wet merger, but it wasn't forming stars as dynamically.

#### DRY MERGERS

Other galaxy clusters grow in mass through dry mergers, or by siphoning gas towards their centres. Dry mergers involve the coming together of two galaxies lacking in gas. The two just mix their existing stars, rather than causing the birth of any new ones.

Typically, galaxies at the centres of clusters grow in mass through dry mergers at their core, or by siphoning gas into their centres.

For example, the mega galaxy cluster, known as the Phoenix Cluster, grows in size by sipping off gas that flows into its centre.

The astronomers now aim to explore how

# Brightest Cluster Galaxy

Tidal Tail



Photographed 10 September 2015 by the Hubble Space Telescope, this image, using data from Spitzer and the Hubble Space Telescope, shows the central region of the galaxy cluster SpARCS1049. The brightest cluster galaxy in the centre of the cluster is currently undergoing a wet merger which produces enormous amounts of new stars. The tidal tail — an indicator of the merger — as well as the brightest cluster galaxy itself are shown. (Image credit: NASA/STScI/ESA/JPL-Caltech/McGill)

common this type of growth mechanism is in galaxy clusters. Are there other “voracious eaters” out there similar to SpARCS1049+56, which also feed on gas-rich galaxies?

SpARCS1049+56 may be an outlier — or it may represent an early time in our Universe when table manners didn't exist. →



**Above:** The image on the left shows the Phoenix Cluster, located about 5.7 billion light years from Earth. This galaxy cluster has been dubbed the “Phoenix Cluster” because it is located in the constellation of the Phoenix, and because of its remarkable properties. Until the discovery of SpARCS1049+56 stars were forming in the Phoenix Cluster at the highest rate ever observed for the middle of a galaxy cluster. The object is also the most powerful producer of X-rays of any known cluster, and among the most massive of clusters. The data also suggest that the rate of hot gas cooling in the central regions of the cluster is the largest ever observed. (Image credits: NASA/CXC/MIT/M. McDonald; UV: NASA/JPL-Caltech/M. McDonald; Optical: URA/NOAO/CTIO/MIT/M. McDonald; Illustration: NASA/CXC/M. Weiss)



**Above:** A massive cluster of galaxies, called SpARCS1049+56, can be seen in this multi-wavelength view from NASA/ESA's Hubble and Spitzer space telescopes. At the middle of the picture is the largest, central member of the family of galaxies (upper right red dot of central pair). Unlike other central galaxies in clusters, this one is bursting with the birth of new stars. (Image credit: NASA/STScI/ESA/JPL-Caltech/McGill)