Hubble sees magnetic monster in erupting galaxy

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This stunning image of NGC 1275 was taken using the NASA/ESA Hubble Space Telescope's Advanced Camera for Surveys in July and August 2006. It provides amazing detail and resolution of the fragile filamentary structures, which show up as a reddish lacy structure surrounding the central bright galaxy NGC 1275. These filaments are cool despite being surrounded by gas that is around 55 million degrees Celsius hot. They are suspended in a magnetic field which maintains their structure and demonstrates how energy from the central black hole is transferred to the surrounding gas. By observing the filamentary structure, astronomers were, for the first time, able to estimate the magnetic field's strength. Using this information they demonstrated how the extragalactic magnetic fields have maintained the structure of the filaments against collapse caused by either gravitational forces or the violence of the surrounding cluster during their 100-million-year lifetime. This is the first time astronomers have been able to differentiate the individual threads making up such filaments to this degree. Astonishingly, they distinguished threads a mere 200 light-years across. By contrast, the filaments seen here can be a gaping 200,000 light-years long. The entire image is approximately 260,000 light-years across. Also seen in the

image are impressive lanes of dust from a separate spiral galaxy. It lies partly in front of the giant elliptical central cluster galaxy and has been completed disrupted by the tidal gravitational forces within the galaxy cluster. Several striking filaments of blue newborn stars are seen crossing the image. Image: NASA, ESA and Andy Fabian (University of Cambridge, UK)

NGC 1275 is one of the closest giant elliptical galaxies and lies at the centre of the Perseus Cluster of galaxies. It is an active galaxy, hosting a supermassive black hole at its core, which blows bubbles of radio-wave emitting material into the surrounding cluster gas. Its most spectacular feature is the lacy filigree of gaseous filaments reaching out beyond the galaxy into the multi-million degree X-ray emitting gas that fills the cluster.

These filaments are the only visible-light manifestation of the intricate relationship between the central black hole and the surrounding cluster gas. They provide important clues about how giant black holes affect their surrounding environment.

A team of astronomers using the NASA/ESA Hubble Space Telescope Advanced Camera for Surveys have for the first time resolved individual threads of gas which make up the filaments. The amount of gas contained in a typical thread is around one million times the mass of our own Sun. They are only 200 light-years wide, are often surprisingly straight, and extend for up to 20 000 light-years. The filaments are formed when cold gas from the galaxy's core is dragged out in the wake of rising bubbles blown by the black hole.

It has been a challenge for astronomers to understand how the delicate structures withstood the hostile high-energy environment of the galaxy cluster for more than 100 million years. They should have heated up,

dispersed, and evaporated over a very short period of time, or collapsed under their own gravity to form stars. Even more puzzling is the fact that they haven't been ripped apart by the strong tidal pull of gravity in the cluster's core.

A new study led by Andy Fabian from the University of Cambridge, UK, published in *Nature* on 21 August 2008 proposes that the magnetic fields hold the charged gas in place and resist forces that would distort the filaments. This skeletal structure has been able to contain and suspend these peculiarly long threads for over 100 million years. "We can see that the magnetic fields are crucial for these complex filaments - both for their survival and for their integrity", said Fabian.

The new Hubble data also allowed the strength of the magnetic fields in the filaments to be determined from their size. Thinner filaments are more fragile, requiring stronger magnetic fields for support. However, the finer the filaments, the more difficult they are to observe.

The filamentary system in NGC 1275 provides the most striking example of the workings of extragalactic magnetic fields so far and is a spectacular by-product of the complex interaction between the cluster gas and the supermassive black hole at the galaxy's heart. Similar networks of filaments are found around many other, even more remote, central cluster galaxies. They cannot be observed in anything like the detail of NGC 1275, so the team will apply the understanding gained here to interpret observations of these more distant galaxies.

Source: ESA/Hubble Information Centre