Bubble, bubble: Searching through the rubble of supernova remnants

A study of supernova remnants – material blown out into space during death throes of giant stars – has shown that a bubble of gas enveloping our Solar System is being shoved backwards by the debris of another, more recent, supernova.

Over the last few million years, several stars have exploded within the Milky Way and they have left behind bubbles of expanding, hot gas that radiate low-energy X-rays. The Solar System sits within one of these shells, known as the "Local Hot Bubble". A study using data from the XMM-Newton Space Telescope has shown that the "Loop 1 Superbubble", the remnants of some more recent supernova explosions, is expanding faster than the Local Hot Bubble and is compressing an area of cool dense gas, known as the Wall, that lies between the two shells. Although astronomers have known for some time that the Local Hot Bubble has an hourglass shape, pressure and density measurements from this new study provide evidence that Loop 1's compression of the Wall is causing the hourglass's "waist".

"The X-ray radiation from the bubbles is very faint. In order to see them, we've had to remove all the light from stars, nebulae and cosmic rays the images, leaving only the weak X-ray signal. It's the astronomical equivalent of looking at an aquarium, ignoring the fish and looking only at the water," said Michelle Supper, who is presenting the results at the RAS National Astronomy Meeting in Leicester on 5th April.

"We've taken long-exposure images of ten small areas of sky in the direction of the Loop 1 Superbubble, then removed all the bright objects and studied what's left. Each structure emits a unique X-ray signal, like a fingerprint, that reflects its temperature and chemical composition. This means that, when we come to analyse the images, we can tell which bits of radiation originated from Loop 1, the Wall or the Local Hot Bubble," Supper explained.

Together with Dr Richard Willingale, also from the University of Leicester, Supper developed mathematical models to represent each of the structures and then produced a geometrical model from which she could work out the distances to the structure boundaries and the pressure and density of the interstellar plasma within the structures.

Loop 1 is thought to be expanding because it is being inflated by winds originating from a group of stars known as the Scorpius-Centaurus Association. Supper's measurements of physical properties of the Wall showed that its density increases fourfold, reaching a peak near the most indented region of the Local Hot Bubble. The pressures also peak around this point, indicating that the Wall is pushing into the bubble at in this region. The chemical analysis showed that the highest concentrations of gases are found at the centre of the Loop 1 Superbubble and levels decrease dramatically in the expanding shell of the bubble.

"Not many astronomers are looking at these structures at present but this study has shown there are many more mysteries to solve!" adds Supper. "We found that X-ray emissions in an area near the galactic plane are much higher in energy than expected but we don't know yet whether we've discovered a new X-ray source or whether its an extension of the very high energy radiation coming from the centre of the galaxy. We hope that this study will also give us an insight into the distribution of the Galactic Halo, a mysterious X-ray signal that can be detected faintly above and below the disc of the Milky Way.

Source: Royal Astronomical Society