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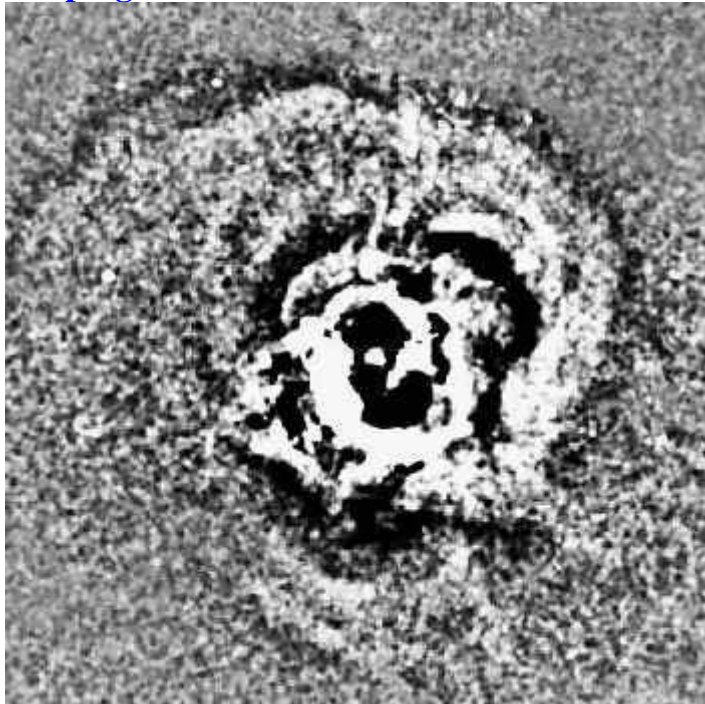
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Burping black holes



X-ray image of the central region of Perseus cluster of galaxies showing ripples in the diffuse gas caused by rising bubbles from the central source.

IT APPEARS that black holes not only devour whatever comes close to them, but they also burp. Astronomers have recently discovered telltale signs of a black hole burping away happily, perhaps after a hearty meal of innocent galaxies caught unawares.

The black hole caught savouring its meal is inside an abnormal galaxy situated at the centre of a cluster of galaxies called the *Perseus* cluster. On the face of it, seen in mundane visible light, it looks like a placid assembly of galaxies, with the central galaxy brighter than the rest.

The cluster however looks dramatically different when observed in either radio waves or X-rays. In X-rays, one finds that the cluster also contains diffuse hot gas in addition to galaxies. This gas emits copious X-rays as a result of their high temperature, which is in excess of a million degrees. Observed in radio waves, one finds that the central galaxy has two jets coming out of its opposite sides. Astronomers know that these are signs of unusual activity in the centre of this galaxy, namely, the existence of a massive black hole with billion times the

mass of our Sun.

The black hole devours all matter in its vicinity, and a part of this material is ejected with speed close to that of light in the form of jets.

This energetic material is hurled out of the galaxy, and slowly accumulates in a balloon-like cavity surrounding the galaxy.

Usually black holes feed themselves for about a hundred million years until they take a pause. This 'duty cycle' mainly depends on the supply of material that it finds in its vicinity. During this feeding time, the balloon of energetic particles is continuously blown to a large size.

After the feeding stops, this cavity then slowly detaches from the galaxy, and like a gas balloon released from a child's hands, it rises above, in this case, from the centre of the galaxy cluster to its outer regions. In the meantime, it is possible that the black hole begins to feed again, and blowing another cavity, which too rises and follows the cavity released earlier. In time, one expects to find several such cavities rising slowly through the cluster of galaxy. It is as if the black hole burps after each feeding frenzy.

Recently a team of astronomers, using the fine X-ray telescope named 'Chandra' (named in honour of the astrophysicist, Subrahmanyan Chandrasekhar, who contributed to the study of black holes) launched a few years ago by NASA, have found signatures of such rising bubbles. These bubbles rise in the ocean of diffuse hot gas which pervades the galaxy cluster, and cause ripples. Astronomers took a very long exposure X-ray photograph of the central region of *Perseus* cluster and discovered such ripples.

In fact, the spacing between the ripples, which depends on the duration of the feeding frenzy of the black hole, does seem to indicate the black hole remains active for about a hundred million years. This is consistent with what astronomers find in the case of massive black holes elsewhere in the universe, and lends credibility to their interpretation of the ripples.

Astrophysicists are now engaged in a critical analysis of these rising bubbles. According to them these bubbles must heat up the surroundings, just like the energy in sound waves in air can get absorbed and can be converted to heat. Perhaps this is one of the reasons why the gas in galaxy clusters remains hot.

Some astronomers have even tried listening to the radio waves being emitted by these bubbles and in the case of *Perseus* bubbles, these have probably been detected. This may sound like an overkill, but astronomers want to be sure that they do not miss any part of this cosmic show of gluttony.

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