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From Quarks to Cosmos

The objects in observations of Perseus Cluster region

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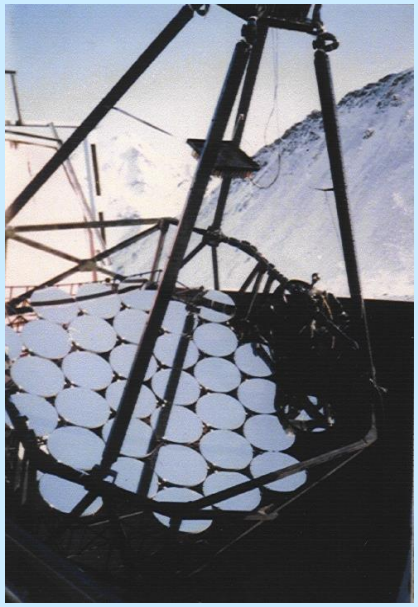

The results of 20-year observations of the Perseus cluster centering on the NGC 1275 including IC310 radio galaxy and extragalactic supernova SN 2006gy at energies 800 GeV - 45 TeV by the SHALON telescope are presented. Also, the emission from the galactic source of nonthermal radio and X-ray emission GK Per (Nova 1901) of classical nova type was found as it accompanied to the observations. For NGC 1275, it was found, that the TeV γ-ray emission at energies > 800 GeV has an extended structure with a distinct core centered at the NGC 1275 nucleus and well correlates with the photon emission regions viewed in X-rays by Chandra and anti-correlates with radio-structures. Also, the variations of TeV γ-ray flux both at year- and day- scales were found. The obtained data indicate that the part of TeV γ-ray emission is generated by relativistic jets in the nucleus of NGC 1275. Whereas, the presence of an extended structure around NGC 1275 and the slow rise of the γ-ray flux is the evidence of the interaction of cosmic rays and magnetic fields generated in the jets at the galactic center with the gas of the Perseus cluster.

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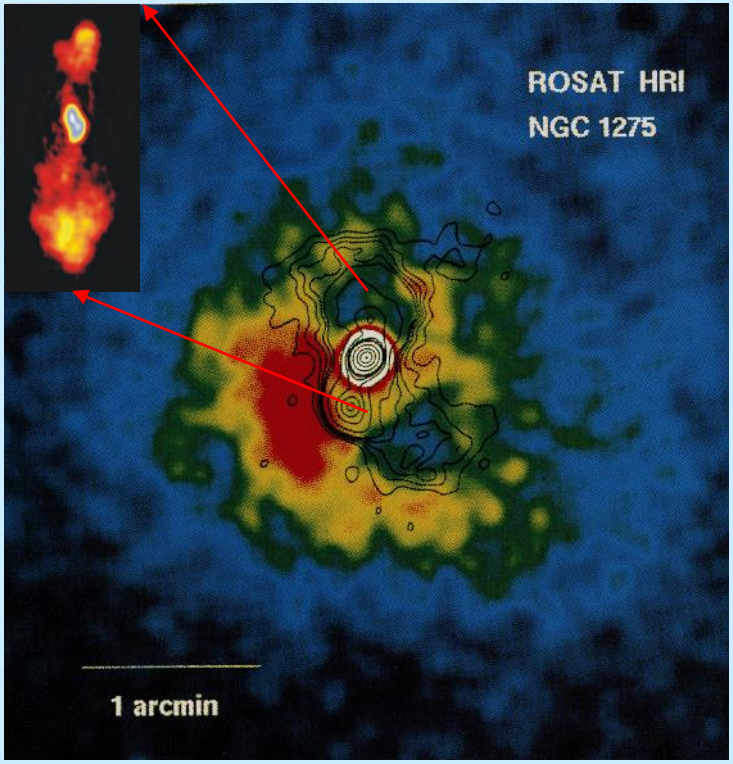
NGC 1275

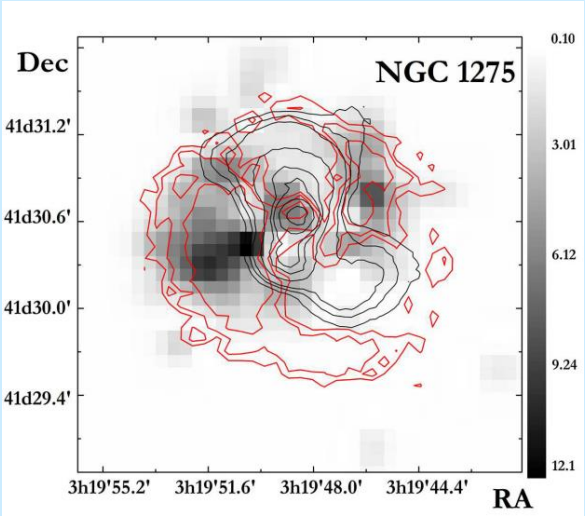


A ROSAT HRI image of the region around the galaxy NGC 1275 at the centre of the Perseus galaxy cluster. The contour lines show the radio structure as given by VLA observations. The maxima of the X-ray and radio emission coincide with the active nucleus of NGC 1275. In contrast, the X-ray emission disappears almost completely in the vicinity of the radio lobes.

NGC 1275 is a powerful source of radio and X-ray emission. In the radio band, the object found in NGC 1275, also known as 3C 84, has a powerful and compact core that has been well studied with VLBI. NGC 1275 is extremely bright in the radio band; its structure consists of a compact central source and an extended jet. The radio emission extends to large distances and shows a clear interaction with the gas inside the Perseus cluster of galaxies. ROSAT and, then, Chandra observations revealed cavities in the gas located inside the cluster, whose presence suggests that the jets from NGC 1275 sweep up numerous “bubbles” in the atmosphere of the Perseus cluster.

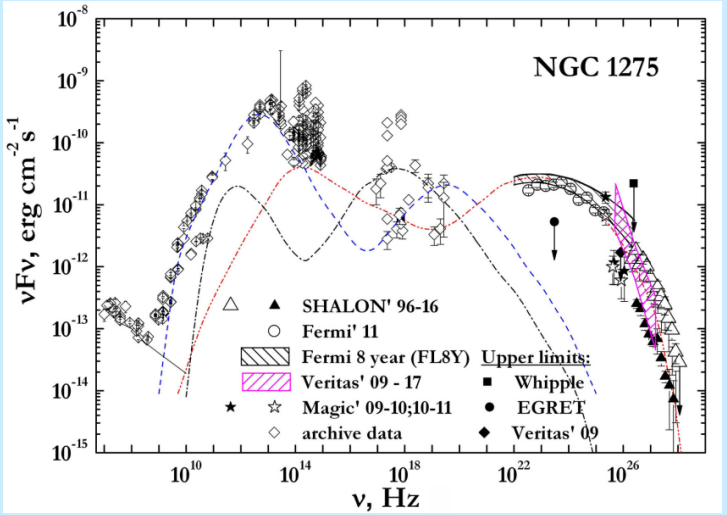
The galaxy NGC 1275 historically aroused great interest due to both its position at the center of the Perseus cluster and its possible “feedback” role (Gallagher 2009). Evidence for the “feedback” role of NGC 1275 can be obtained from ROSAT and Chandra observations, which reveal shells of hot gas and cavities that spatially coincide with the radio structures extending from the central, active part of the AGN.

NGC 1275



Long-term studies of the central galaxy in the cluster, NGC 1275, are being carried out in the SHALON experiment. Gamma-ray emission from NGC 1275 was detected by the SHALON telescope at energies 800 GeV - 40 TeV. It was found that the TeV structure around NGC 1275 spatially coincides with the X-ray emission regions. The brightness distribution of the X-ray emission and the observed TeV emission shows a sharp increase in intensity outside the bubbles blown by the central black hole and visible in the radio band. To analyse the emission related to this core, we additionally identified the emission component corresponding to the central region of NGC 1275 with a size of 32".

The structures visible in TeV γ-rays are formed through the interaction of very high energy cosmic rays with the gas inside the Perseus cluster and interstellar gas heating at the boundary of the bubbles blown by the central black hole in NGC 1275. The presence of emission in the energy range 1–40 TeV from a central region of ~32" in size around the nucleus of NGC 1275 (black triangles) and the short-time flux variability point to the origin of the very high energy emission as a result of the generation of jets ejected by the central supermassive black hole of NGC 1275.



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