WHAT BENDS WIDE-ANGLE TAILED RADIO SOURCES?

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It has been generally assumed that wide-angle tailed (WAT) sources like 3C465 are formed in a manner similar to that of the more strongly bent U-shaped sources such as NGC 1265, i.e., by ram pressure arising from galaxy motion through a dense intracluster medium (ICM). The WAT sources were thought to be less strongly bent because of the smaller ratio of tail plasma flow momentum flux to galaxy velocity. However, as noted recently by Burns (1981), there is a serious discrepancy between the ram pressure model requirements for bending WATs and the dynamics of the associated radio galaxy. To bend the tails, we calculate that the galaxy must typically move at velocities of $0.7\text{-}1 \times 10^3$ km s^{-1} for distances comparable to the length of the radio tails (∿200 kpc for 3C465). This implied galaxy motion is inconsistent with the nature of the massive cD galaxies generally associated with WATs. Cluster galaxy velocity data, X-ray observations, and recent models suggest that these giant galaxies are nearly at rest at the bottoms of cluster potential wells, at most moving ∿200 km s^{-1} in an oscillatory motion of small amplitude (<0.3 of a core radius, Malumuth, 1981, private communication). Thus it appears that some other mechanism is responsible for bending WAT sources.

The actual bending of the radio tails results from an interaction between the ICM and the extended radio plasma. Pressure gradients within the ICM will distort the plasma flow from linearity. Such pressure gradients could be seen as asymmetries in the X-ray emission produced by the hot cluster gas. Therefore, by observing the distribution of X-rays from the ICM, one may be able to gain insight into the mechanism which bends the WAT sources. We undertook such X-ray observations of the A2634/3C465 field with the IPC on the *Einstein* Observatory. A comparison between the X-ray and VLA emissions (Eilek *et al*. 1981) for the inner core of A2634 is presented in the Figure. Unlike the large-scale structure, the inner X-ray emission has an anisotropic, egg-shape near the cD with the excess between the radio tails. The difference in X-ray emissivities at distances of 1'-2' on opposite sides of the cD (p.a.∿+45°) is ∿20-25%. This corresponds to a density difference of $\Delta n \sim 5\%$ if the two sides of the galaxy have about the same temperature.

What is the origin of this gas anisotropy and what does it

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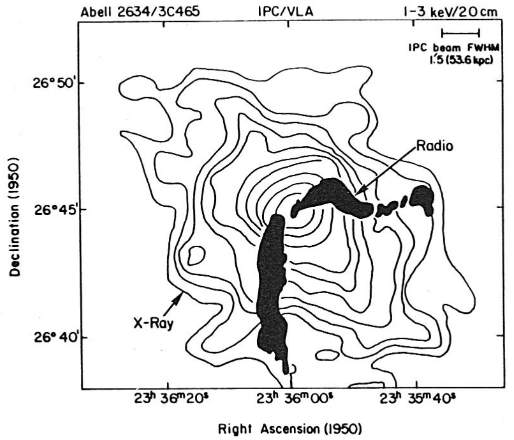

imply about the bending of the 3C465 tails? We consider briefly four models:

(1) Buoyancy--if the ICM is not spherical and the radio tails are less dense than the ICM, a buoyancy force will bend the radio streams away from regions of largest ρ_{ICM}. This is unlikely in the case of 3C465 since the radio tails appear to bend toward a region of enhanced X-ray emission.

(2) Gravitational Bending--"Heavy" tails will fall toward higher density regions in an anisotropic ICM. However, an excess mass of $\sim 10^{13}$ $M_\odot$ to the SW of 3C465 would be needed to bend the tails by gravity. No such mass is present in gas or in galaxies.

(3) Motion through a Supercluster--A2634/A2666 may form a supercluster, both at $z \sim .03$. If an intrasupercluster medium exists and A2634 is moving through that medium, it is conceivable that a ram pressure gradient transmitted through the A2634 medium might bend the radio tails. In this case, however, one would not expect to see distortions in just the inner parts of the cluster ICM, but possibly throughout.

The above models do not require motion by the cD, but none seem to be in agreement with the X-ray data. We consider below a model involving slow galaxy motion ($\sim$200 km s^{-1}) as a potential explanation of the X-rays.

(4) Accretion with Slow Galaxy Motion--There is evidence of radiatively induced accretion flows into the cores of rich clusters near cDs. If the galaxy associated with 3C465 is moving subsonically and accreting gas, might this produce the observed egg-shaped asymmetry? According to De Young, et al. (1980) who have studied this process for M87, $\sim$5% density enhancement is expected on the downstream side of the galaxy. This is the same excess which is implied by our X-ray data for 3C465; however, this model must be tested for a massive galaxy with high accretion to see if the results scale from M87 to a cD.

If accretion with slow motion is the answer to the X-ray anisotropy, it still does not explain the radio tails since the pressure is only $\rho_{ICM} v_g^2$ which is small compared to that needed to bend the tails. The question remains: What bends wide-angle tailed radio sources?

References

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