SUBSTRUCTURE IN CLUSTERS OF GALAXIES

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Rich galaxy clusters containing multiple condensations are common. This subclustering affects many cluster properties and provides insight into cluster evolution.

"Clumpy" clusters of galaxies are interesting, in part, because N-body simulations indicate that multi-component substructure occurs before complete collapse and virialization (White 1976). Interesting systems can be identified both from x-ray surface brightness maps (Forman et al. 1981) and from contour maps based on galaxy counts (Geller and Beers 1982).

Here we present optical contour maps of the four clusters identified by Forman et al. (1981): A98, A115, A1750, and SC0627-54 (Figure 1).

The correspondence between the x-ray surface brightness map and the optical contour map for A98 is excellent (Henry et al. 1981). A cosmological timing argument applied to this "two-body" system suggests that the two clumps were at maximum expansion 3.5 billion years ago and that they will coalesce in another 3 billion years (Beers, Geller, and Huchra 1982).

The cluster A115, at a redshift of 0.2, has three clumps of galaxies, only two of which (marked by arrows in Figure 1) have associated extended x-ray emission (Beers, Huchra, and Geller 1983).

The optical map of A1750 is almost exactly like the x-ray image; the cluster is <u>triple</u> in both cases. The southernmost clump has a very small velocity dispersion ($\sigma_{los} \simeq 300$ km s^{-1}) and is quite faint in the x-ray. The two large clumps of galaxies are separated in velocity by $\sim$ 1000 km s^{-1}.

The northeastern clump in SC0627-54 is again the same in both the x-ray emission and the galaxy distribution. In the southwest,

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the apparent deficiency of galaxies relative to extended x-ray emission is probably due to contamination of the x-ray image by emission from the radio source PKS 0625-545. In fact, there are also strong radio sources in A98 and A115 (3C 28) with associated high-energy radiation which presumably contaminates the x-ray observations. Upon correction for this contamination, the agreement between the x-ray surface brightness and galaxy distributions is excellent on scales $\gtrsim$ 0.12 Mpc. This agreement can be used to place constraints on the properties of the "missing mass" (Gioia et al. 1982).

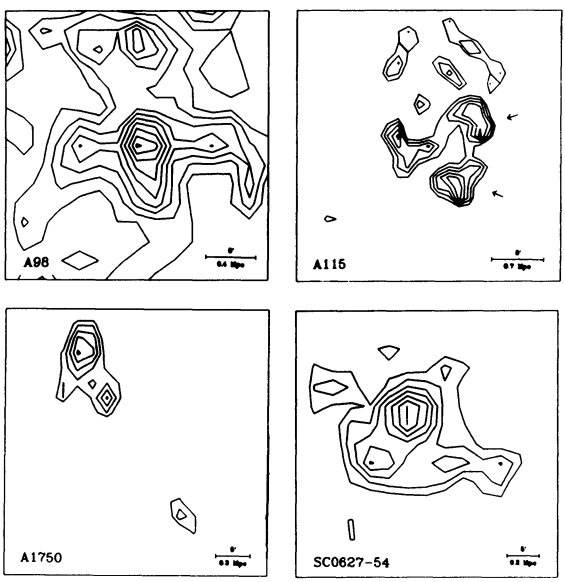

Figure 1: Galaxy surface number density maps of the original x-ray double clusters. The contour levels are linearly spaced. The binning scale is 0.24 Mpc. The lowest contour corresponds to 2 (A98), 29 (A115), 9 (A1750) and 16 (SC0627-54) galaxies/bin and is 3σ above the local background; the highest levels are 22, 36, 23, and 44 galaxies/bin, respectively. The original galaxy positions are from Dressler (A98), KPNO 4-m plates (A115 and A1750), and the ESO quick blue survey (SC0627-54). See the review by T. Maccacaro and I. M. Gioia in this volume for the x-ray contours.

REFERENCES

Beers, T. C., Geller, M. J., and Huchra, J. P.: 1982, Ap. J. 257, 23.
Beers, T. C., Huchra, J. P., and Geller, M. J.: 1983, Ap. J. (in press).
Geller, M. J. and Beers, T. C.: 1982, Publ. Astron. Soc. Pac. 94, 421.
Forman, W., Bechtold, J., Blair, W., Giocconi, R., Van Speybroeck, L., and Jones, C.: 1981, Ap. J. 243, L113.
Gioia, I. M., Geller, M. J., Huchra, J. P., Maccacaro, T., Steiner, J. E. and Stocke, J.: 1982, Ap. J. (Letters) 255, L17.

Henry, J. P., Henriksen, M. J., Charles, P. A., and Thorstensen, J. R.: 1981, Ap. J. 243, L137.
White, S. D. M.: 1976, Mon. Not. R. Astron. Soc. 177, 717.

Discussion

Dekel: Is there a correlation between having a substructure and a cD galaxy, perhaps with a double nucleus?

Geller: We do not yet have a sufficiently homogeneous sample to be able to tell.

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