Seyfert's Sextet: "The Mystery Persists"

S. Tamburri, G.Trinchieri, A. Wolter, J. Sulentic
(INAF - Osservatorio Astronomico di Brera, Milano)
(Instituto de Astrofisica de Andalucia, Granada)

Seyfert's Sextet (SS, a.k.a. HCG79) is one of the most compact and isolated galaxy aggregates in the local Universe. The group involves four accordant redshift galaxies (H79abcd, z=0.0145, Hickson et. al 1992), plus a largely dissolved remnant (H79f) as well as a background galaxy (H79e, z~0.066).

In the context of galaxy structure evolution, groups are expected to become more prominent in the X-ray band as they grow older.

H79 arguably represents the most evolved group in the local Universe based on its compactness (~1.3 arcmin ~23 kpc), number of early-type members and fraction of total light in a diffuse component (~40-50%). The detection of some diffuse radio continuum emission in H79 provides another reason to expect a diffuse X-ray component associated with the group potential as mapped by optical light.

Yet ROSAT PSPC data suggested a relatively weak X-ray halo in the region of the Sextet (28±11 net counts corresponding to f_X~9.49·10^{39} erg s^{-1} for kT=0.5 keV, Pildis et al. 1995, Nishiura et al. 2000).

What was the distribution of the unresolved ROSAT emission?

Fig.1 Optical image of the Seyfert Sextet adapted from Palma et al. 2002.

HCG 79	v_r (km s^{-1})	Morphological type	D_L (kpc)	L_B (10^9 $L_\odot$)
a	4292	E3	8.1	7.9
b	4446	S0	6.5	8.7
c	4146	S0	5.3	3.5
d	4503	Sd	7.6	1.4
e	19809	Sc	--	--
f	4095	Dissolved remnant	5.1	0.7

Tab.1 Properties of the member galaxies of Seyfert's Sextet and the discordant galaxy H79e. Data are taken from Durbala et al. 2008.

Mean galaxy separation ~7.2 kpc.
Mean group velocity ~4400 km s^{-1}.
Velocity dispersion ~121 km s^{-1}.

CHANDRA DETECTION

Observation performed by Chandra back-illuminated CCD S3 (ACIS-S in imaging configuration) for ~70 ks.

Chandra data reveal that the X-ray emission arises both in HCG79 and from a background galaxy cluster.

Main Contributors to the X-ray Emission near SS:

- discrete emission from galaxies a, b, d, e;
- diffuse emission from a background galaxy cluster;
- diffuse emission between galaxies?

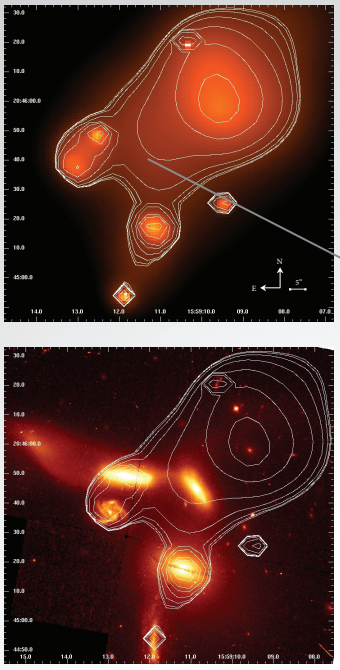
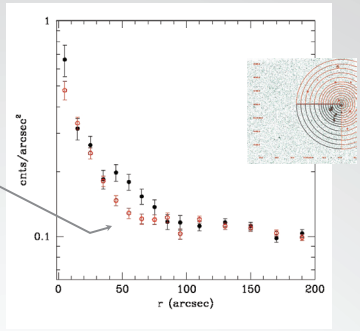


Fig.3 X-ray contours overlaid on an optical image of HCG79 taken from the HST archive data (WFPC2, F555W filter).

Fig.2 Adaptively smoothed Chandra image with isointensity contours in the 0.5-5 keV energy band.



Radial profiles centered on the peak of the cluster's emission. The regions used to derive them are showed in the small inset: black for SE region, red for other 3 quadrants.

The excess in the radial profile coincides with the group.

This is the signature that some X-ray emission is present in the Sextet.

SPECTRAL ANALYSIS

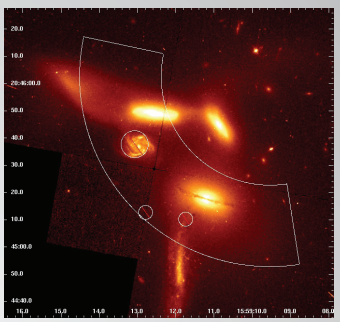
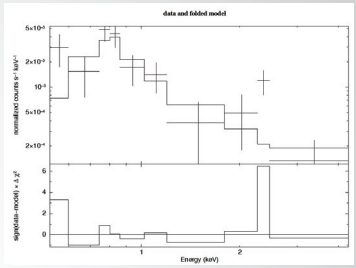
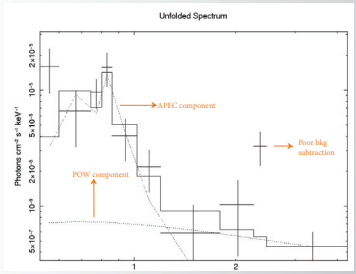


Fig.4 Region used to extract the spectrum.





Spectral models for X-ray emission including the counts of the X-ray point sources associated to the optical galaxies: H79a and H79b; the unrelated point sources are excluded;

Background includes the cluster's emissiom;

Net counts: 183.1±24.2;

The spectrum contains 15 net counts per bin;

A single plasma component cannot account for residual high energy tail; a power-law is added to account for it;

Spectral model: APEC+POW: kT=0.45, Γ=0.45, abundance fixed at 50% of the solar value and N_H frozen to the galactic value (N_H=3.8·10^{20} cm^{-2}).

Object	L_X(10^{39} erg s^{-1}) 0.5-5 keV	F_X(10^{-15}erg cm^{-2} s^{-1}) 0.5-5 keV
HCG 79 global emission	3.1	15.6
H79 a	2.2	4.5
H79 b	1.5	3.2
H79 d	2.5	5.3

Tab.2 Luminosities and X-ray fluxes of HCG79 and of the point sources associated to the optical galaxies detected in the X-ray band.
The total luminosity of the plasma component in HCG79 is not much more than the sum of the luminosity of the single galaxy.

IS THE NW SOURCE A CLUSTER OF GALAXIES?

We studied first the "cluster's emission", the source to the NW of SS, to understand its extension and how much it contaminates the area of SS.
Background selected in an annulus centered on the NW source with 80"< r < 130", where the profile is flat.

We found: kT~6 keV with large uncertain, χ^2_ν=1.3 for 28 dof, z=0.3 (Palma et al. 2002) and N_H=3.8·10^{20} cm^{-2} fixed.
In the 0.5-2 keV band :
L_X~7.5·10^{42} erg s^{-1}, f_X~2.9·10^{-14} erg cm^{-2}s^{-1}

In the 2-10 keV band:
L_X~1.5·10^{43} erg s^{-1} f_X~5.52·10^{-14} erg cm^{-2} s^{-1}.

These might be reasonable values for a cluster of galaxies but we need more redshift information to confirm its nature.

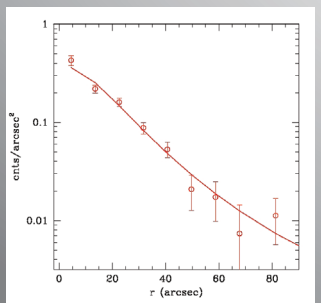


Fig. 6 Azimuthally averaged net profile, fitted with a β model 1-D; β=0.7±0.2 and r_c=25.5"±7.9" (~109 kpc at z=0.3).

THE X-RAY EMISSION ASSOCIATED TO THE GROUP IS LOW

The 183±24 net counts corresponding to L_X=3·10^{39} erg s^{-1}, detected excluding the point sources, are plausibly associated to the galaxies.

RESULTS AND CONCLUSIONS

HCG79 represents a direct challenge to standard ideas about how groups evolve and to expectations about their X-ray emission.

The lack of diffuse X-ray emission from this highly evolved group suggests that groups evolved much more slowly and quietly than suggested in earlier merger scenarios. This slow process of dissolution can persist for a Hubble time (Athanassoula et al. 1997) if groups are embedded in massive DM halos.

We cannot exclude the presence of a very weak intra galaxy emission. But in any case the global L_X is low compared to other compact groups such as HCG92 (Trinchieri et al. 2005), HCG16 (Belsole et al. 2003) and SCG0018 (Trinchieri et al. 2008).

References

Athanassoula, L., Makino, J., & Bosma, A. 1997, MNRAS, 286, 825
Belsole, E., Sauvageot, J. -L., Ponman, T.J., Bourdin, H. 2003, A&A, 398, 1B
Durbala, A., del Olmo, A., Yun, M. S., Rosado, M., Sulentic, J. W., Plana, H., Iovino, A., Perea, J., Verdes-Montenegro, L., Fuentes-Carrera, I. 2008, AJ, 135, 130D
Hickson, P., Mendes de Oliveira, C., Huchra, J. P. & Palumbo, G. G. 1992, ApJ, 399,353
Morita, U., Ishisaki, Y., Yamasaki, N.Y., Ota, N., Kawano, N., Fukazawa, Y., Ohashi, T. 2006, PASJ, 58, 719M
Nishiura N. et al 2000, AJ, 120, 2355N
Pildis, Rachel A., Bregman, Joel N., Evrard, August E. 1995, ApJ, 443, 514
Palma, C., Zonak, S.G., Hunsgberger S.D., Charlton, J.C., Gallagher, S.C. \& DUrrell, P.R. 2002, AJ 124, 2425
Trinchieri, G., Iovino, A., Pompei, E., Dahlem, M., Reeves, J., Coziol, R., Temporin, S. 2008, A&A, 484, 195
Trinchieri, G., Sulentic, J., Pietsch, W., Breitschwerdt, D., 2005, A&A, 444, 697T