An Absorption Feature and Filamentary Structures in the Central Galaxy of the Centaurus Cluster, NGC 4696

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It has been known for a long time that clusters of galaxies are often extended X-ray sources. It is now generally accepted that the X-ray emission is due to thermal bremsstrahlung (free-free radiation) from a tenuous ($n_e \sim 10^{-3}$ cm^{-3}), hot ($T \sim 10^8$ K) intracluster gas. For several clusters the X-ray gas consists of both a hot and a cool ($T < 3 \times 10^7$K) component. The cool intracluster gas may be cooling, resulting in instabilities in the inflowing gas, giving the filamentary structure as observed around NGC 1275, the central galaxy of the Perseus Cluster (Fabian and Nulsen, 1977, *Mon. Not. R. Astr. Soc.*, **108,** p. 479). The system of filaments in M87 in the Virgo Cluster is also considered as evidence of matter falling into the galaxy (Ford and Butcher, 1979, *Astrophys. J. Supp.*, **41,** p. 147).

Since the Centaurus Cluster has a low temperature X-ray component of $kT \sim 2.4 \pm .3$ keV it could be another case of a cooling core with filaments, as pointed out by A. C. Fabian and Nulsen. We shall here report very preliminarily on some very interesting optical features in NGC 4696, the central galaxy in the Centaurus Cluster.

NGC 4696 was observed on July 6 – 7, 1982, with the new ESO CCD camera during its testing phase on the Danish 1.5 m telescope at La Silla by H. Pedersen. A blue (Johnson B) 20 min. exposure and a red (broader than Johnson R and maximum around 7700 Å) 10 min. exposure under good seeing conditions (~ 2″) were obtained.

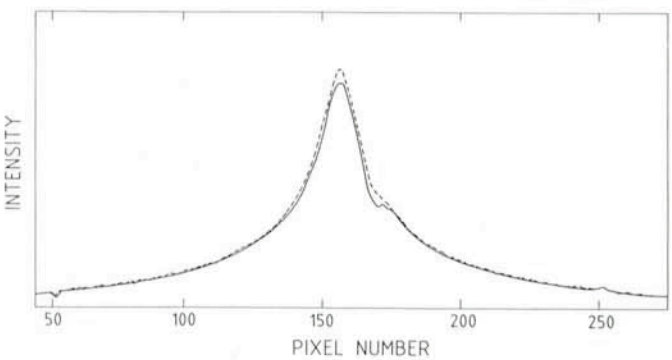

Fig. 1: *The profiles through the "horse shoe" south of the centre of NGC 4696. —— blue exposure; – – – – red exposure (unit along the x-axis: 47).*

In Fig. 1, we have given the red and the blue profiles through the central region of the galaxy. We have normalized the two exposures so that they agree in the outer parts of the galaxy. It is clearly seen that blue light seems to be missing in the central region. Profiles through different parts of the central region confirm this conclusion. Fig. 2 shows the residual "Red" light (the red exposure minus the normalized blue exposure). A fairly regular structure running east-west 6″ (~ 1 kpc) south of the nucleus is very evident and obviously it extends in a "horse shoe" around the nucleus to the west and northwest. Indication of this feature was found by Shobbrook (1966, *Mon. Not. R. Astr. Soc.*, **131,** p. 351). The horse shoe is typically redder than the galaxy by Δ (B - R′) $\sim^{m}!12$ corresponding roughly to Δ(B – V) $\sim^{m}!05$. The most obvious way to interpret this structure is that the redden-

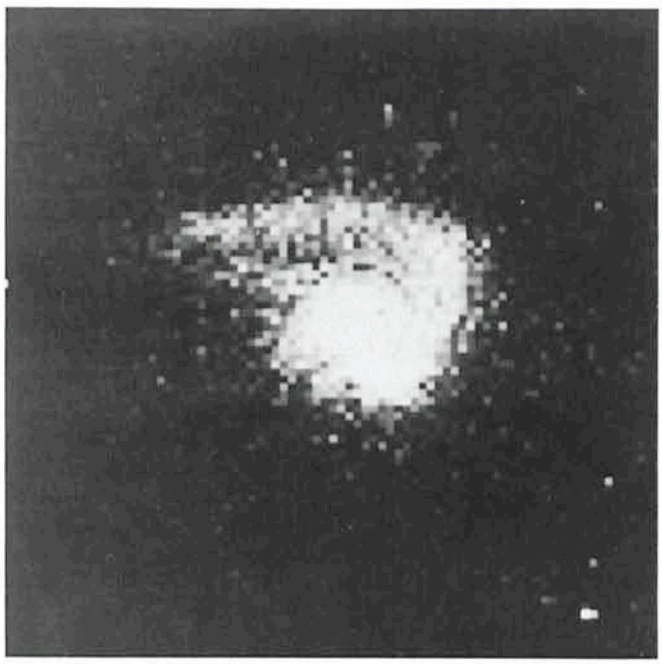

Fig. 2: *The residual red light in NGC 4696. Orientation: South up, east to the left. Angular size of the figure: 40″ × 40″.*

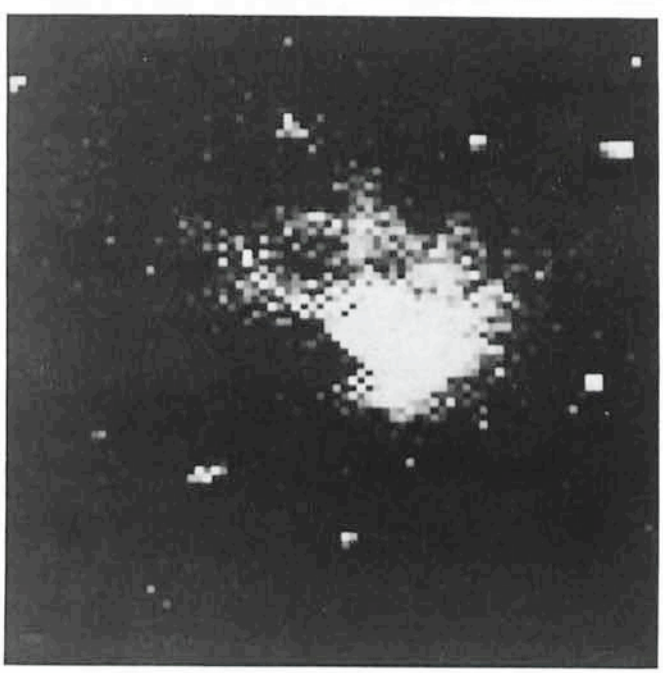

Fig. 3: *The H_α + [N II] exposure of NGC 4696. Same orientation and angular size as Fig. 2.*

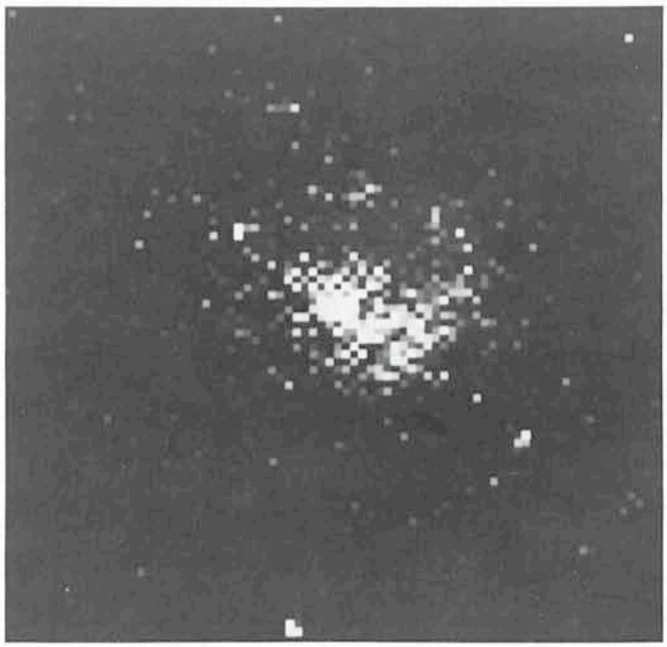

Fig. 4: *The [S II] exposure of NGC 4696. Same orientation and angular size as Fig. 2.*

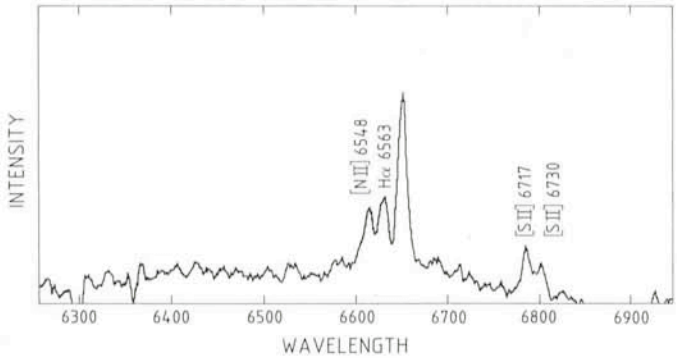

Fig. 5: *The IDS spectrum of the spectral region around H_α + [N II] and [S II] for the area of the "horse shoe" north-west of the centre of NGC 4696.*

ing is caused by an absorbing dust lane. The dust lane which extends more than 180° around the centre could be situated in gas compressed in a shock due to the motion of the galaxy through the hot intracluster medium. Numerical simulation of this phenomenon has been given by Gisler (1976, *Astron. Astrophys.*, **51,** p. 137), who obtained structures similar to the one we observe.

On May, 28–30, 1982, we observed NGC 4696 with the CCD camera on the Danish 1.5 m telescope through filters covering redshifted H_α + [N II] and [S II]. The band width of the filters was ~ 100 Å. A "continuum" band around 6900 Å was also observed.

In Fig. 3 we show the H_α + [N II] exposure of NGC 4696 with the continuum subtracted. Several filaments are clearly seen south and west of the nucleus. This agrees with results very recently obtained by A. Fabian and collaborators with the AAT (private communication). Fig. 4 shows the [S II] exposure of NGC 4696 again with the continuum removed. Filamentary structures south and west of the nucleus are evident also in the [S II] light.

The data in Fig. 2, 3 and 4 suggest a strong connection between the absorption feature and the filamentary structure since only very faint emission is seen outside the absorbing dust lane.

IDS spectra at a dispersion of 116 Å/mm were obtained in different positions of NGC 4696 on May 25–26, 1982, using the 3.6 m telescope. As an example we display in Fig. 5 the spectrum of a 4″ × 4″ region 5″ north-west of the centre where we noticed strong emission in Figures 3 and 4. The similarity to emission lines from filaments in M 87 as observed by Ford and Butcher is striking, indicating similar physical conditions in the filaments.

The optical observations, presented here together with the X-ray observations suggest that we are in fact observing cooling intracluster gas accumulating on the central galaxy of the Centaurus Cluster.

These observations make up the first part of a survey of clusters with a low temperature X-ray component.

Follow-up observations in the UV of NGC 4696 by IUE will be performed in the near future.

IUE Observations of Variable Seyfert 1 Galaxies

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Introduction

The emission spectrum of Seyfert 1 nuclei is similar to that of faint quasars. The ionization of the gas is attributed to a central source emitting a non-thermal radiation (X, hard UV). These spectra are characterized by broad hydrogen and other permitted lines; sometimes strong narrow forbidden lines and cores to the permitted lines are also seen.

The width of the broad permitted lines, typically 3,000 to 10,000 km s^{-1}, is due to high relative velocity of the emitting clouds (or filaments). Although the clouds, with a density $> 10^9$ cm^{-3}, are optically thick in the Lyman continuum, the whole nebula has only a small coverage factor of the central source (10 % at most). The permitted emission lines are thought to originate at a distance of ~1 pc, or less, from the central source, while the narrow line-emitting region, of considerably lower density (Ne ~ 10^4), is located at much larger distances, ~100 pc to 1 kpc (Fricke, K.J., and Kollatschny, W., *The Messenger,* **26,** 9).

Ultraviolet (UV) observations of Seyfert nuclei are interesting for several reasons. The study of highly ionized species, such as C IV, Si IV, NV, which are observed in the UV, but not in the optical, gives us some knowledge of the range of ionization in Seyferts. Furthermore, the stellar contribution in the UV is small, facilitating the study of the non-thermal continuum. Moreover, comparing with ground-based observations of highly ionized gas in high-redshift quasars, luminosity effects in the line ratio can be investigated (since quasars are more luminous than Seyferts).

The monitoring of NGC 4151, using the International