# LETTERS TO THE EDITOR

## NGC 4676, A PECULIAR SYSTEM IN THE COMA CLUSTER OF GALAXIES*

In an earlier paper (Burbidge and Burbidge 1959) pictures of a number of peculiar galaxies were shown. One of the most interesting of these is NGC 4676 (Fig. 5 of that paper), which consists of two large bright nuclei, one of which has a very long, straight tail attached to it. It was pointed out to us by Dr. N. U. Mayall that the position of this object places it only about 4° from the center of the Coma cluster of galaxies. An important point to establish, therefore, is whether it can be considered to be a physical member of this cluster.

In June, 1959, spectra of both nuclei were obtained with the prime-focus spectrograph of the 82-inch telescope at the McDonald Observatory. For one the slit was placed in position angle 0°, along the long axis of the north condensation, so that it would lie along the tail which extends more than 2′. A second spectrum was taken of the south condensation with the slit along its long axis in position angle 17°5. In both spectra the emission lines Hα and [N II] λ 6583 appeared, with Hα considerably stronger than the [N II] line. Both nuclei show continuous spectra which appear to be bluer than the nuclei of normal spiral galaxies. In both spectra the lines are inclined, showing that there is an appreciable component of rotation in the line of sight. There was no extension of the emission lines along the long tail attached to the north of the two condensations.

The spectra were measured with the two-co-ordinate measuring machine at the Mount Wilson and Palomar Observatories. Since the Hα line was much stronger than [N II] λ 6583, it alone was used to determine the radial velocities and the rotations of the two nuclei.

The results that were obtained are as follows. In both condensations no departure from linearity was detected along the rotation curves, which, however, extended over only a small angular distance. In the case of the northerly one, the total extent of the nucleus over which the rotation could be measured was 17″4. The velocity range is from +6275 km/sec at the southern edge of the nucleus to +6725 km/sec, while the velocity of the center as determined from the strongest point of the continuum is +6500 km/sec. For the southern condensation the total extent was 26″0. In this case the velocity range is from +6360 km/sec at the southwest edge to +6795 km/sec. The velocity of the center as determined from the strongest point of the continuum is +6605 km/sec. These velocities are uncorrected for galactic rotation. The corrected central values are +6512 km/sec and +6617 km/sec, respectively. Thus we conclude that the mean recession velocity of the two nuclei comprising NGC 4676 is +6564 ± 50 km/sec.

The mean recession velocity for the Coma cluster has been given by Humason, Mayall, and Sandage (1956) as +6657 km/sec. This value was based on the radial velocities of 23 members. In the last few years Mayall has obtained a good many more spectra, and now radial velocities of about 50 members are known. These now include galaxies out to 200′ from the center. The mean recession velocity has now been revised to be +6920 km/sec (Mayall 1960). The line-of-sight velocity dispersion is about 1000 km/sec, while the total range in velocity is nearly 5000 km/sec. Since the velocity of NGC 4676 is only 356 km/sec from the mean, we conclude that the system is almost certainly a member of the Coma cluster.

If we use a value of the Hubble constant of 75 km/sec/Mpc (Sandage 1958) then the distance of the Coma cluster (using the new mean recession velocity by Mayall) is 92

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Mpc. At this distance 1″ = 447 pc. Thus the total linear extents of the two nuclei of NGC 4676 that are observable in the emission lines are 7.78 kpc for the northern one and 11.62 kpc for the southern one. The total rotation across the northern component is 450 km/sec, while that across the southern component is 435 km/sec. From these figures it is possible to estimate minimum masses for the two components. Since the rotation curves are linear, it is reasonable to take as a first approximation uniform spheroids to represent the two condensations. If we suppose that they are not very flattened and put $c/a = 0.5$ for both, then the minimum masses are found to be

$$3.2 \times 10^{10}\ M_{\odot} \text{ for the northerly nucleus}$$

and

$$4.5 \times 10^{10}\ M_{\odot} \text{ for the southerly nucleus.}$$

For comparison, the masses obtained if we use the Keplerian approximation are $4.6 \times 10^{10}\ M_{\odot}$ and $6.4 \times 10^{10}\ M_{\odot}$, respectively. The mean densities which are obtained for the uniform spheroid approximation are $1.8 \times 10^{-23}$ gm/cm$^3$ for the northerly nucleus and $0.8 \times 10^{-23}$ gm/cm$^3$ for the southerly nucleus.

Since the tail attached to the northerly component is at least 2′ long, it has a length of 53.6 kpc not allowing for any possible foreshortening.

It is well known that the majority of the bright members of the Coma cluster are galaxies of elliptical or S0 type which probably contain only a small amount of gas. That a peculiar system such as NGC 4676 is a member of this cluster is quite remarkable. It has been commonly thought that galaxies of elliptical type are old in evolutionary terms, though the recent identification of a number of discrete radio sources with objects of this type may give rise to some rediscussion of this point. However, both the form of NGC 4676 and its spectra strongly suggest that it is a system containing much gas and high luminosity stars and is therefore quite young in evolutionary terms. We might guess that a time scale of the order of $10^8$ years is appropriate for such a system, which from its structural form cannot be stable for very long in its present state. It might be stressed, in passing, that it is very obvious that the chance that a system such as this has been formed as a result of a collision between galaxies is very remote. We conclude that it is highly probable that this system is in the process of formation in the outer parts of the Coma cluster. The minimum mass that we obtain for the visible material of the system is about $7.7 \times 10^{10}\ M_{\odot}$. The dark matter and the matter in the extensions to both nuclei almost certainly contribute a considerable amount of mass, so that the object may very well have a mass more characteristic of an elliptical galaxy than that of an average spiral.

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