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ON THE REDSHIFT OF NGC 4569

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ABSTRACT

The systemic velocity of the spiral galaxy NGC 4569 in the Virgo cluster is about -300 km sec^{-1}. The velocities of the nucleus and the disk do not differ significantly. The difference of 1300 km sec^{-1} found by Weedman results from an error in the disk velocity given by Humason, Mayall, and Sandage.

Weedman (1970) has recently pointed out that the nucleus of the spiral galaxy M90 (NGC 4569) in the Virgo cluster appears to have a velocity of -1300 km sec^{-1} relative to its disk. If this observation is correct, it is particularly important for the following reason.

Several galaxies are known to show large internal differences in the velocities derived from their *gaseous* components. For example, in NGC 1275 (Burbidge and Burbidge 1965) there is an extended region of gas which has Hα emission redshifted by 3000 km sec^{-1} relative to the main body of this galaxy; in the Seyfert system NGC 1566 (K. C. Freeman, unpublished) the spectrum of the nucleus has a second component of Hβ which is redshifted by 1000 km sec^{-1} relative to the other emission lines. Although the cause of these violent gas motions is not understood, the problem does not appear hopeless; there *are* known physical processes through which *gas* masses can acquire kinetic energy. Now consider M90. The spectrum of its nucleus shows gaseous emission lines and stellar absorption lines at the same velocity of approximately -300 km sec^{-1}, compared with the accepted disk velocity of $+960$ km sec^{-1} (Humason, Mayall, and Sandage 1956, denoted HMS below). The absorption-line spectrum of the nucleus (Ca II H and K, Mg I λ5175, Na I D; see below) is typical for a galaxy of this morphological type (Sab), and presumably represents the usual relatively old stellar population associated with the nuclei of these systems. Furthermore, at the f/18 Cassegrain focus of the 74-inch telescope on a night of excellent seeing, the nucleus of M90 appeared, in our opinion, definitely nonstellar when compared with a nearby star of about the same brightness. In other words, the nucleus seems fairly normal in its appearance and absorption-line spectrum, although it is known to be unusually blue (Tifft 1969) and its emission lines are unusually broad (Weedman 1970); most of its mass is probably in the form of relatively old stars. If there really is a velocity difference of 1300 km sec^{-1} between the nucleus and the disk of M90, then it is the only example known of a violent galactic event which clearly involves the stellar component of the nucleus. This raises a new and difficult problem: How can a galactic nucleus containing mainly stars be ejected from its parent galaxy?

Our purpose here is to point out that the HMS velocity for the disk of M90 appears to be incorrect. The velocities of the nucleus and disk do not differ significantly, so this problem does not yet arise.

We have two spectra of M90, taken with different Cassegrain spectrographs and RCA image tubes at the 74-inch telescope. The velocity data relative to the Sun are summarized in Figure 1. The spectra were measured with the Mount Stromlo two-coordinate measuring machine. Five nightsky lines were also measured along the length of the slit as a check on the procedure for correcting the image-tube distortion: in the direction of

the dispersion, this distortion is everywhere less than 6 μ ($\lesssim$90 km sec^{-1}) for these spectra.

Spectrum 405 is an unwidened spectrum of the nucleus alone, taken 1968 April 27, and is well exposed from λ5500 to λ7500. The dispersion is 180 Å mm^{-1}, the scale across the dispersion is 50".5 mm^{-1}, and the exposure time was 30 minutes. It shows a strong Na I D-line in absorption, blended with weak nightsky D-line emission, and also shows Hα and [N II] λ6584 in emission; the three galaxy lines are all at about the same redshift of −300 km sec^{-1}, in good agreement with Weedman's velocity for the emission lines alone of −330 km sec^{-1}. The probable error of 25 km sec^{-1} assigned to the single absorption line is an estimate based on our experience with lines of similar quality in spectra of galaxies taken at the same dispersion. All other probable errors shown in Figure 1 are

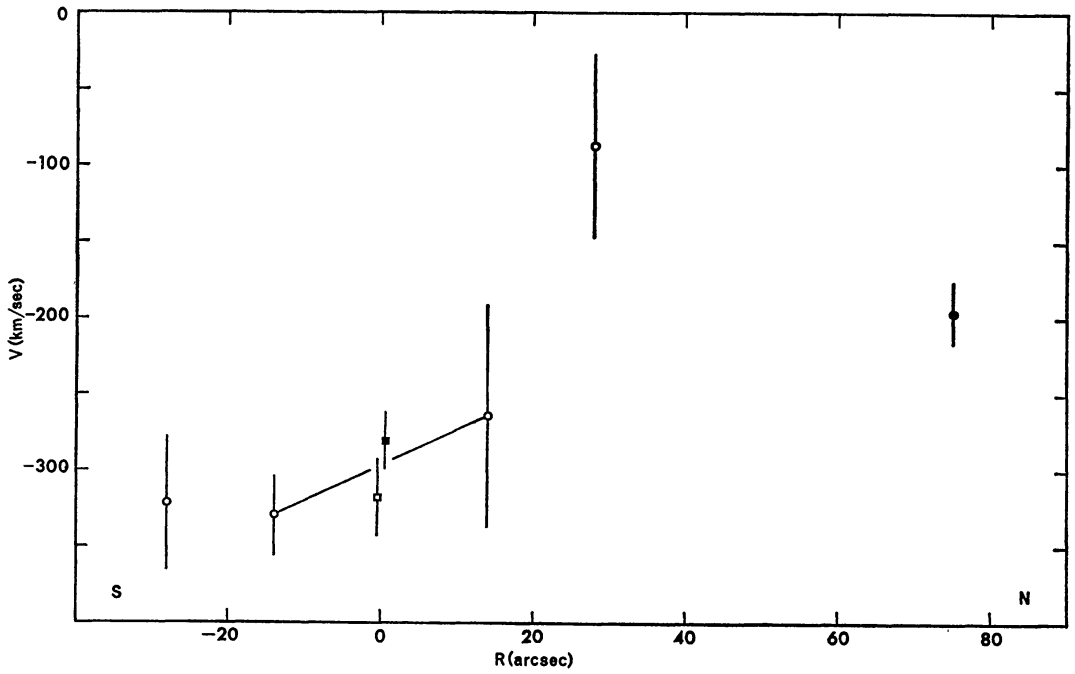

FIG. 1.—Radial velocity against distance from nucleus in M90 at position angle 10°. Spectrum 1280: *open circles*, mean values for Ca II H and K and Mg I λ5175 absorption lines from disk; *filled circle*, mean value for Hα, λ6584 from emission region in disk. Spectrum 405: *open square*, Na I D-absorption from nucleus; *filled square*, mean value for Hα, λ6584 emission from nucleus. The two points are displaced slightly from $R = 0$ for clarity. Error bars show probable error.

internal errors associated with the mean velocity from two or three lines (see legend to Fig. 1).

Spectrum 1280, taken 1970 May 1, was exposed for 68 minutes to bring up the galactic disk within 2′ of the nucleus. The nucleus itself was held stationary at the center of the 4′-long slit; to reduce scattering of light from the nucleus in the photographic emulsion, light from the inner ±3″ of the galaxy was prevented from reaching the image tube by a mask which is built into the decker unit immediately above the slit. The diameter of the seeing disk on this moonless night was about 1″. The slit was in position angle 10°, the dispersion is 200 Å mm^{-1}, the scale across the dispersion is 70".3 mm^{-1}, and the wavelength range of good definition is 3100–7500 Å. Three narrow absorption features, Ca II H and K and the Mg I blend at λ5175, can be seen in the disk out to about 1′ from the nucleus, and are readily measurable out to about 30″. Velocities were measured at 14″ and 28″ on both sides of the nucleus; mean values for the three lines are shown in

Figure 1. The rotation of M90 is evident. Interpolation between the velocities at $\pm 14''$, as shown by the line in Figure 1 joining these points, gives a systematic velocity for the disk of M90 of -296 km sec^{-1}. This agrees well with the velocity of the nucleus derived from spectrum 405. Further confirmation of the negative disk velocity comes from Hα and λ6584 for an emission region at $R = +75''$; its velocity of -197 km sec^{-1} is also shown in Figure 1.

The spectrum was examined carefully for absorption and emission features in the disk near the HMS redshift of $+960$ km sec^{-1}, but none was found.

We conclude that (i) the systemic velocity of M90 is about -300 km sec^{-1} and (ii) there is no significant difference between the velocity of the nucleus and the disk. Note that there are other galaxies, both ellipticals and spirals in the Virgo cluster that have negative redshifts (de Vaucouleurs 1961).

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