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A STUDY OF THE NUCLEAR REGION OF NGC 5055. A MAGN

Paris Pişmiş
Instituto de Astronomía, UNAM, Apdo Postal 70264, México, D.F. 04510, México
Antonio Mampaso
Instituto de Astrofísica de Canarias, Spain
Minia Manteiga
LAEFF, Madrid, Spain
and
Elsa Recillas[1], and Gabriel Cruz-González
Instituto Nacional de Astrofísica, Optica y Electrónica, Tonantzintla, Puebla, México

RESUMEN

Hemos iniciado un estudio de las regiones centrales de galaxias con Núcleos Moderamente Activos (MAGN) con el propósito de encontrar sus propiedades y hacer modelos que representen su actividad. Nuestro estudio de NGC 5055 (Sbc), un ejemplo del grupo que hemos escogido, se reporta aquí brevemente. Se obtuvieron 4 espectros con rendija larga en diferentes ángulos de posición que muestran que la densidad de flujo en [N II] λ6584, así como su ancho a potencia media, son mucho mayores que aquellos de regiones H II clásicas a ±10″ del centro de NGC 5055. Esta circunstancia, junto con un flujo saliendo del núcleo (mostrado en un artículo previo) pone en evidencia que NGC 5055 es un MAGN. Se plantean otras posibles interpretaciones.

ABSTRACT

We have undertaken a study of the central regions of Mildly Active Galactic Nuclei (MAGN) with the aim of finding their properties and, possibly, a model to represent their activity. Our study of NGC 5055 (Sbc), a sample of our chosen group, is briefly reported here. Four long-slit spectra at different position angles have shown that the flux density of [N II] λ6584 as well its FWHM is much larger than those in classical H II regions within ± 10 ″ from the center of NGC 5055. This circumstance, together with an outflow from the nucleus shown in a previous paper, provide evidence that NGC 5055 is a MAGN. Other possible interpretations are also touched upon.

Key words: **GALAXIES: SPIRAL — GALAXIES: ACTIVE**

1. INTRODUCTION

NGC 5055 is a large Sbc spiral galaxy, rather regular in shape at first sight, but with a slight north to south asymmetry where the dividing line is at PA 101°, the line of nodes. Figure 1 shows a photograph taken in ultraviolet light (Fish 1961).

An early study of this galaxy by Burbidge, Burbidge, & Prendergast (1960) determined the rotation curve along the line of nodes, and estimated a total mass of $7.6 \times 10^{10}\ M_\odot$ within 8 arcmin from the center, the limit

[1] Also Instituto de Astronomía, UNAM.

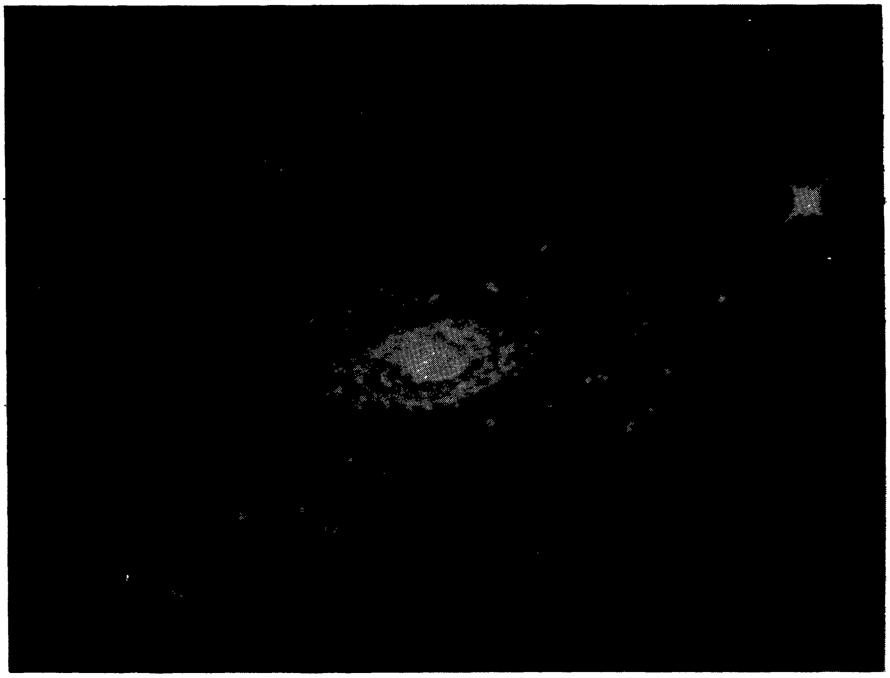

Fig. 1. A photograph of NGC 5055 in ultraviolet light (Fish 1961). North is at top, East to the left.

to which H II regions could be detected. They also pointed out a high concentration of mass in the central region. Fish (1961) carried out photometry in *UBV* bands, attempting to explain the north–south asymmetry as an effect of extinction along the plane of the galaxy. A study of the 21 cm line by van der Kruit & Bosma (1978) showed the extension of the galaxy to be 16 arcmin opposed to the 8 arcmin given by Burbidge et al. (1960).

In a more recent investigation, Fillmore et al. (1986) discuss excellent velocity data obtained along their line of nodes (PA 105°). Finally we mention our own work (Pişmiş et al. 1995) where we show long slit velocity data along four PA's, all passing through the center of NGC 5055. In that paper we comment on a feature at the linear region of the rotation curve along the line of nodes. We interpret this feature as an outflow from the nucleus of NGC 5055. The rotation curve at the neighboring PA 112° also shows the same feature, thus providing evidence of outflow from the nucleus with a projected radial velocity of 70 km s^{-1}; here is a mild case of activity.

The present report summarizes the characteristics of the emission lines of NGC 5055 near the nucleus. A detailed discussion on NGC 5055 appeared earlier by Pişmiş et al. (1995).

2. MOTIVATION

The motivation to study bulges of galaxies like NGC 5055 and several others in our project, galaxies which may have some peculiarity at their nuclear region and which are not known to be AGN, stems from the fact that such galaxies, being close to us, can be studied in detail at all possible wavelengths. With such a thorough study one can devise a model to explain the central engine which is representative for the MAGN. Now, relying on the unified conjecture of the nuclear activity at all possible energetics, one obtains a model with some physical basis rather than being mere guesswork. Such a model can be applied to the more energetic nuclei, perhaps to the complete sequence of the AGNs.

3. DISCUSSION OF THE EMISSION LINES

The spectroscopic data discussed below were obtained with the IDS spectrograph attached to the 2.5-m Isaac Newton Telescope at La Palma, Canary Islands, Spain. Some properties shown by the flux distribution of the emission lines Hα and [N II] λ6584 are worthy of discussion.

The relative fluxes of the Hα and [N II] λ6584 lines are quite unlike those in ordinary, classical H II regions. In the H II regions Hα is much stronger than the [N II] line, whereas in our spectra of the central region of NGC 5055 it is the [N II] line which is much stronger than the Hα line. A sample profile of the Hα region at the center of NGC 5055 is given in Figure 2, to illustrate this circumstance. Though greatly smoothed over

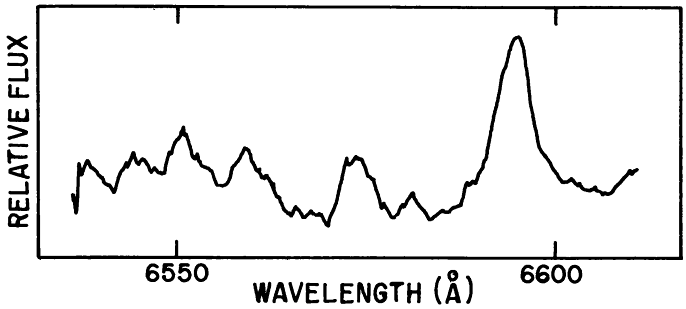

Fig. 2. A sample profile of the red spectral region of the nucleus of NGC 5055. The profile is greatly smoothed in λ. Note the high intensity of [N II] λ6584 versus Hα.

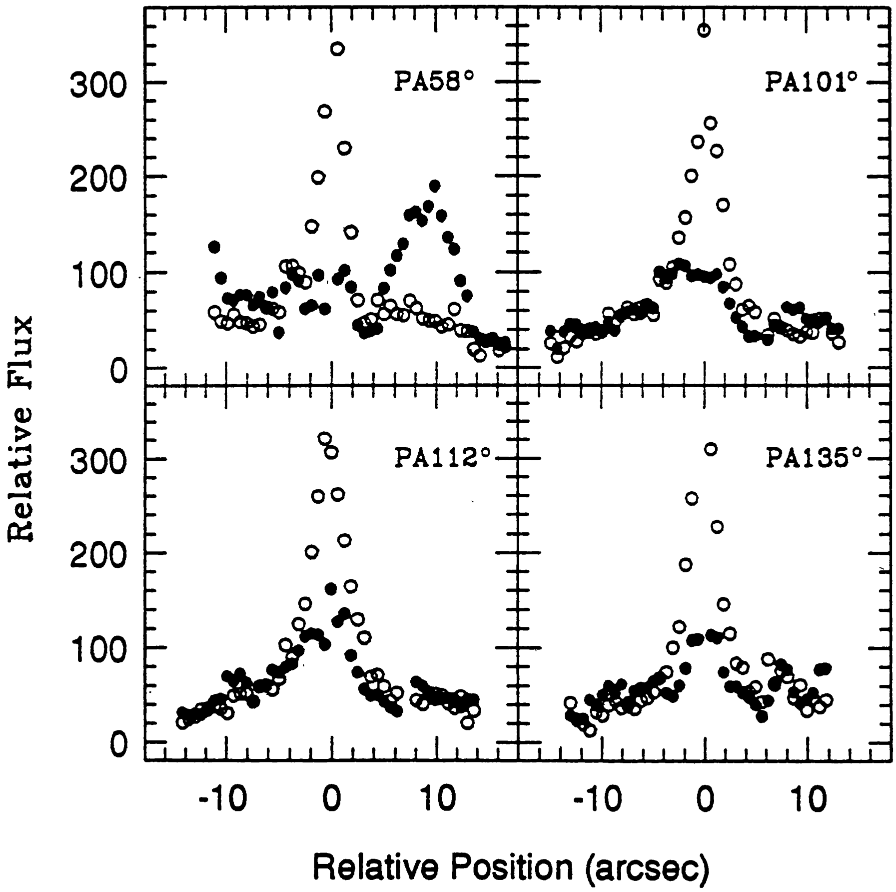

Fig. 3. Distribution of flux values of Hα and [N II] λ6584 around the nucleus at the four position angles studied. Open circles denote the flux in [N II] while filled circles, that of Hα.

wavelength, the profile shows clearly that there is some anomaly in the fluxes of Hα and [N II] near the nucleus. Both fluxes increase as we approach the center of the galaxy, but the [N II] flux increases faster towards the center, reaching far higher fluxes than the Hα. Figure 3 shows this property in detail.

The anomaly shown by the emission lines in the central region may not be explained in a unique manner. The simplest explanation is that in the central region nitrogen is overabundant. A second possibility is that the collisional excitation is very high in the bulge —where the forbidden lines are produced. Alternatively, supernovae explosions or colliding gas clouds in the dense bulge may exist, causing collisional excitation. But these arguments are quite weak. Finally, a continuous, non-thermal power law radiation field may exist in the nuclear region producing the excitation needed.

A second point worth calling attention to is the finding that around the nucleus the Hα emission shows a flat maximum. This "plateau" is seen in all four PA's (see Figure 3). We believe that the Hα absorption line produced by the F, G, and K type stars in the nuclear bulge will lower the observed intensity of Hα emission. A further possible reason may be the small number of OB stars in the bulge, hence the fainter Hα emission observed in that region.

We next consider the distribution from the center outwards of the FWHM of Hα emission line and of the [N II] λ6584 forbidden line, plotted in Figure 4 for the four different position angles. Both the Hα and [N II] lines show maxima as we approach the center. We note that not only the central region shows large FWHM values, but also in the wings of the distributions large scattered values of FWHM of [N II] are present. This situation is true as far as our observations extend (a little over $\pm$ 10 arcsec around the center); values of the FWHM of the [N II] line are also high. It may be that aside from the central non-thermal radiation field there is also an overall external effect causing shocks which produce collisional excitation of the gas. In this context

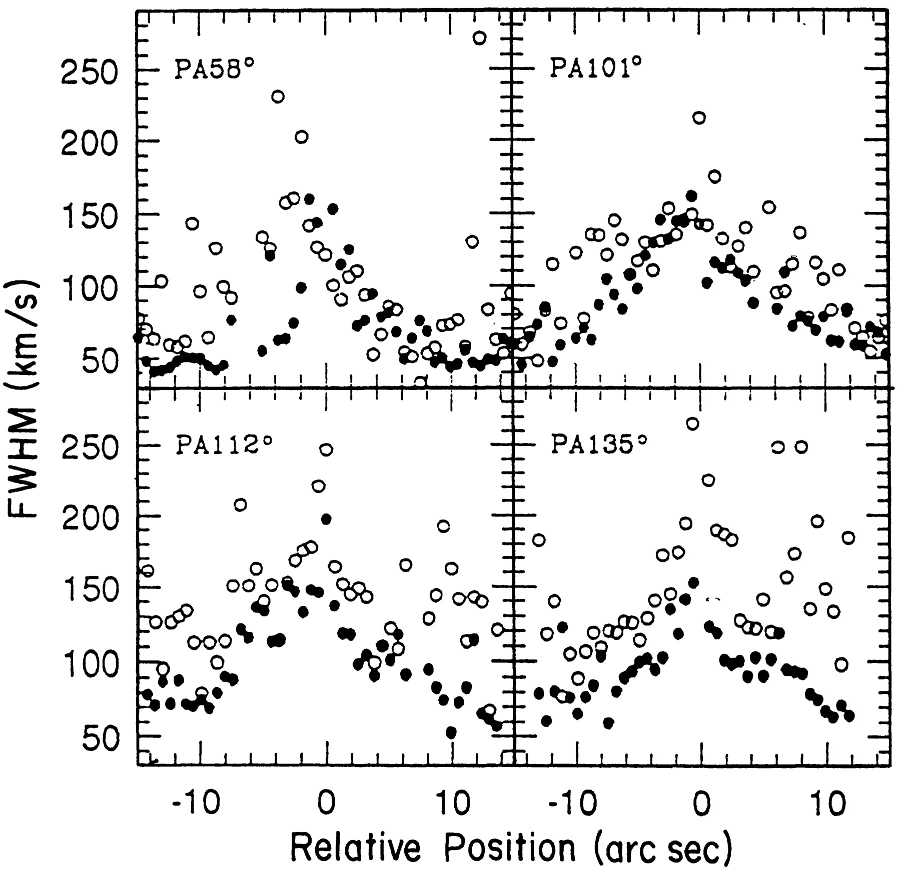

Fig. 4. The distribution of the FWHM around the nucleus along the four different slit positions. The symbols are as in Figure 3.

it is interesting to point out the east-west asymmetry in the outer regions of the galaxy guessing from the good existing photographic material (see Figure 1). In that photograph the west side has spiral arms rounder than on the east, where the arms are branching out. This is suggestive of an encounter of NGC 5055 with an intergalactic cloud at the west side. The shock produced by this encounter will propagate to the central regions, producing the extra collisional phenomenon. This phenomenon and the power law field, mentioned earlier, may together account for the FWHM results.

Based on the arguments given above, namely the anomaly in the flux distribution of [N II] versus Hα , as well as the FWHM distribution of these two lines and the outflow from the nucleus shown in paper 1, we conclude that there is sufficient evidence to suggest that NGC 5055 has a mildly active nucleus (MAGN).

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