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ON THE LOW STATE OF ACTIVITY OF NGC 3783

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RESUMEN. Presentamos observaciones espectroscópicas de la región nuclear de NGC 3783 de 1987 a 1989. Nuestros datos muestran variaciones en la intensidad de las líneas de Balmer y del continuo y una comparación con datos publicados, indica que el espectro obtenido en mayo de 1988 corresponde al estado más bajo de actividad hasta el momento reportado en esta galaxia. Se ha usado para investigar la población nuclear estelar, la cual es precisamente vieja (> 5 Gyr), tiene metalicidad solar y contribuye con un 50% de la luz nuclear a λ5600 A en este espectro. Durante el período cubierto por nuestras observaciones, la luminosidad de la línea Hβ aumentó por 3.1×10^{41} ergs/s.

ABSTRACT. We present spectroscopic observations of the nuclear region of NGC 3783 from 1987 to 1989. Our data show variations on the intensity of the Balmer lines and continuum and a comparison with published data indicates that the spectrum obtained in May 1988 corresponds to the lowest state of activity so far reported to this galaxy. It has been used to investigate the nuclear stellar population, which is mainly old (> 5 Gyr), has solar metallicity, and contributes with 50% of the nuclear light at λ5600 A in this spectrum. During the period covered by our observations the luminosity of the Hβ line increased by 3.1×10^{41} ergs/s.

Key words: GALAXIES-SEYFERT — SPECTROSCOPY

. INTRODUCTION:

NGC 3783 is a southern Seyfert 1 galaxy, which was subject of several nvestigations: optical spectrophotometry has been carried out by Martin 1974), Osmer, Smith and Weedman (1974) an Penston et al. (1977); analysis of he emission line profiles has been performed by Pelat, Alloin and Fosbury 1981) and by Evans (1988); variability of the continuum and broad emission ines has been reported by Penfold (1979), Hamuy and Maza (1987), Atwood et al 1982), Menzies and Feast (1983), Morris and Ward (1988), Stirpe et al (1988), nd Evans (1989).

In this paper we present new spectra of this galaxy and compare them ith previous ones to search for limits in the emission line variability. As ne of the spectra was obtained in a low state of activity of the source, we ave used it to examine the nuclear underlying stellar population.

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II. OBSERVATIONS:

The spectra were obtained with the two dimensional photon-counting detector 2D-FRUTTI attached to the Cassegrain spectrograph of the 1.0m telescope of the CTIO (Cerro Tololo Interamerican Observatory) on March 2, 1987 and May 10, 1988. The slit width was 5" in both cases and an off-nuclear spectrum (8" North) was also obtained during the 1987 run. The spectra cover the λλ3700-7200Å range with 5Å resolution, were reduced using the IRAF package and flux calibrated with standard stars from Stone and Baldwin (1983). A redshift of cz = 2750 km/s was adopted and the data were also corrected for reddening (Seaton, 1979) adopting a color excess E(B-V) = 0.23, corresponding to the galactic and internal extinctions (Forte et al., 1987).

We have also obtained spectra with 10Å resolution on June 8, 1988 and May 8, 1989 with the Optical Multichannel Analyser (OMAIII) attached to the Cassegrain spectrograph of the 1.6m telescope at the Laboratório Nacional de Astrofisica/ON/CNPq/MCT, Brasil. These spectra were reduced following standard spectrophotometric procedures and corrected for reddening.

III. COMPARISON WITH PREVIOUS OBSERVATIONS:

We have obtained the I(Hβ)/I([OIII]λ4959Å) ratio from the available literature, and the result, including our own data, is shown on Fig.1 as a function of time in years. It can be noted the presence of a lower limit for

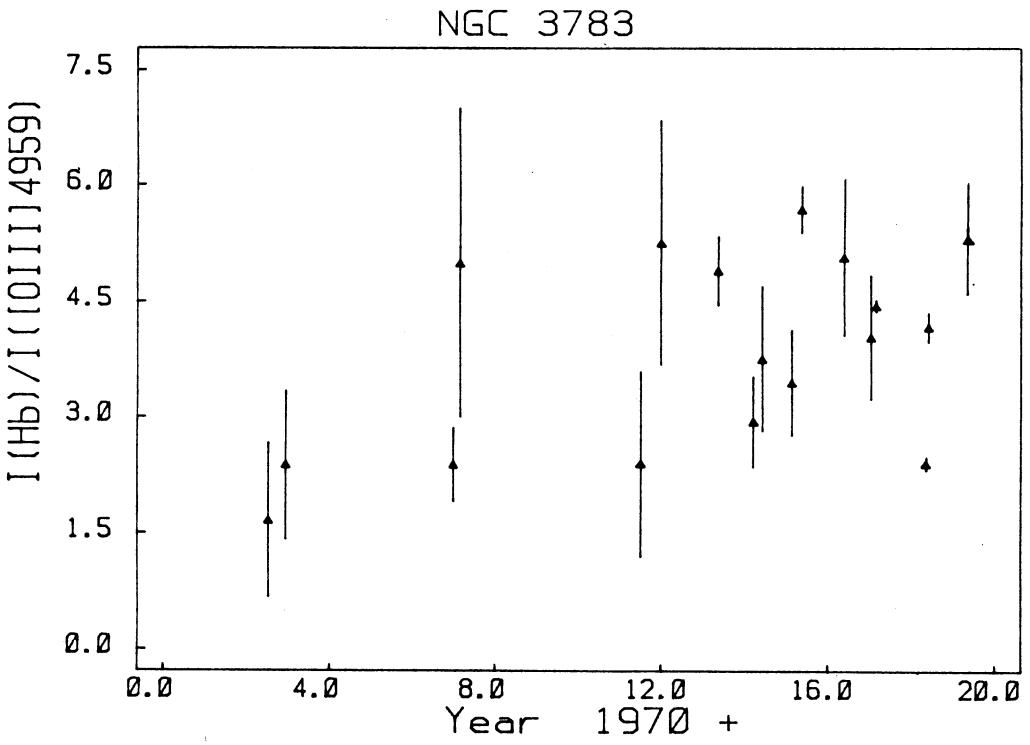

Figure 1: The ratio I(Hβ)/I([OIII]λ4959Å) versus time in years. The references for the data (from left to right) are: Martin (1974), Osmer et al (1974), Penston et al (1976), Pelat et al (1981), Atwood et al (1982), Ward and Morris (1984), Evans (1988), Evans (1989), Morris and Ward (1988), Fricke et al (1989), Bica and Alloin (1986), Stirpe et al (1988), Stirpe et al (1988), This work (2D FRUTTI), This work (2D FRUTTI), This work (OMAIII), This work (OMAIII).

he activity of the source, reached at 1972, 1977, 1981 and our May 1988 bservation, with I(Hβ)/I(λ4959Å) = 2.4. The amplitude of the variation of his same line ratio in the period is very large, with the Hβ line becoming 6 imes brigther than the [OIII]λ4959Å line in the 1989 observation. Even on the ow state the FWHM of the Hβ line is still larger than 10^3 km/s, remaining his galaxy with a Seyfert 1 spectrum. On the other hand, the well-studied alaxy NGC 1566 has I(Hβ) < 0.5 I([OIII]λ4959Å) and its permitted-line idths correspond to a Seyfert 2 spectrum when on the minimum state (Alloin et 1. 1986).

The total variation between the low state of May 1988 and the May 989 OMAIII spectrum was $\Delta \mathfrak{L}_{H\beta} = 3.1 \times 10^{41}$ ergs/s.

In Fig. 2 we have plotted the blue continuum shape (normalized at 5695Å) for our spectra. As can be seen, the continuum can vary largely in hape, from I(λ4041Å)/I(λ5695Å) = 0.72 (May 1988) to I(λ4041Å)/I(λ5695Å) = .02 (May 1989). This strong rise in the UV continuum was also reported by the BV observations of Winkler and van Wyk (1989).

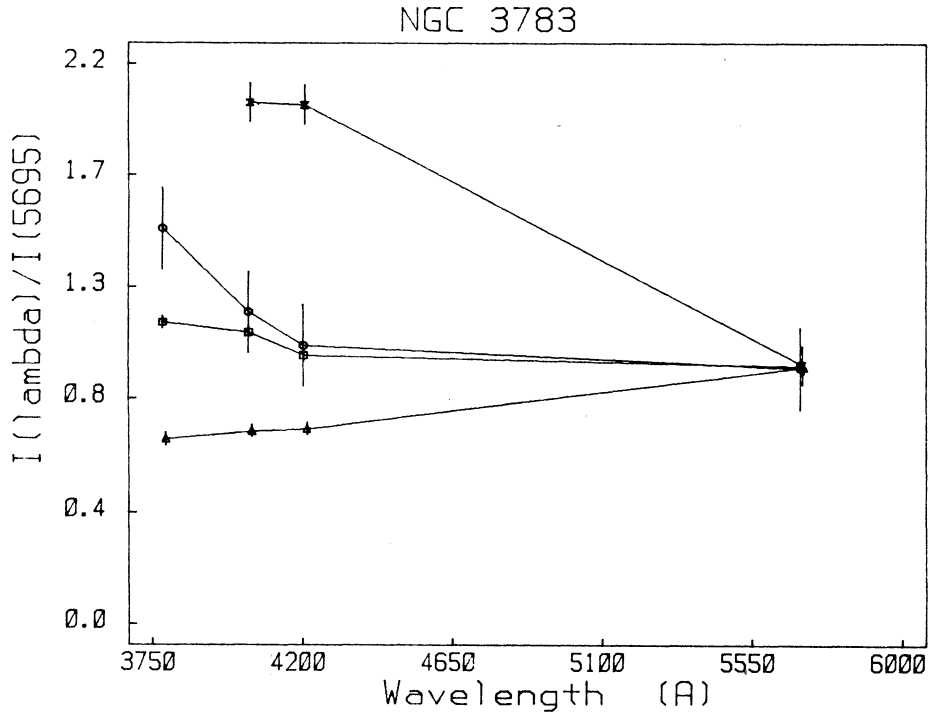

Figure 2: The intensity of the continuum, relative to λ5695 Å. The symbols are: circles - May 1985 (Bica and Alloin 1986); squares - March 1987; triangles - May 1988; crosses - May 1989.

V. THE STELLAR POPULATION:

From Fig. 1 we conclude that the May 1988 spectrum was obtained when he nuclear source was in a low state and the stellar population was clearly isible, being identified the CaII K λ3933Å and H λ3968Å, the CH G Band, the gI λ5175Å, and the NaI λ5890Å absortion lines (see Fig 3a). We have used this act to find the contribution from the host galaxy to the nuclear spectrum, ut even in this low state the absortion lines in the nuclear spectrum can be iluted by emission and the continuum flux can have a non-stellar ontribution. So, we have made a first approach analysing the off-nuclear

spectrum that is representative of the bulge stellar population. The equivalent widths of the most prominent absorption lines in this spectrum were measured (see Table 1), and togheter with the continuum shape, were used to find an appropriate stellar population template (Bica 1988). These templates provide information about the metallicity and age content of the stellar population. The selected template (S4) has a flux fraction at λ5870Å of 80% due to very old components (> 5 Gyr) and the remaining to intermediate age and moderately young stars (> 0.1 Gyr) with solar metallicity. We normalized the template in order to represent 5% of the nuclear light at λ5600Å and repeatedly subtracted it from the nuclear spectrum until MgI λ5175Å was reduced to the noise level. Figure 3 shows the S4 template (b), and the

TABLE 1. Equivalent widths and continuum

Spectral Feature	Off-Nuclear Spectrum	S4 Template[3]
[1]W(CaII K λ3933)	12.71	13.3
W(CN λ4200)	7.55	9.0
W(G Band λ4301)	7.85	7.5
W(MgI λ5175)	6.25	6.3
[2]I(λ4020)/I(λ5870)	0.56	0.68
I(λ4570)/I(λ5870)	0.72	0.86

[1] Equivalent width in Å
[2] Continuum ratio
[3] Bica (1988, Table 3)

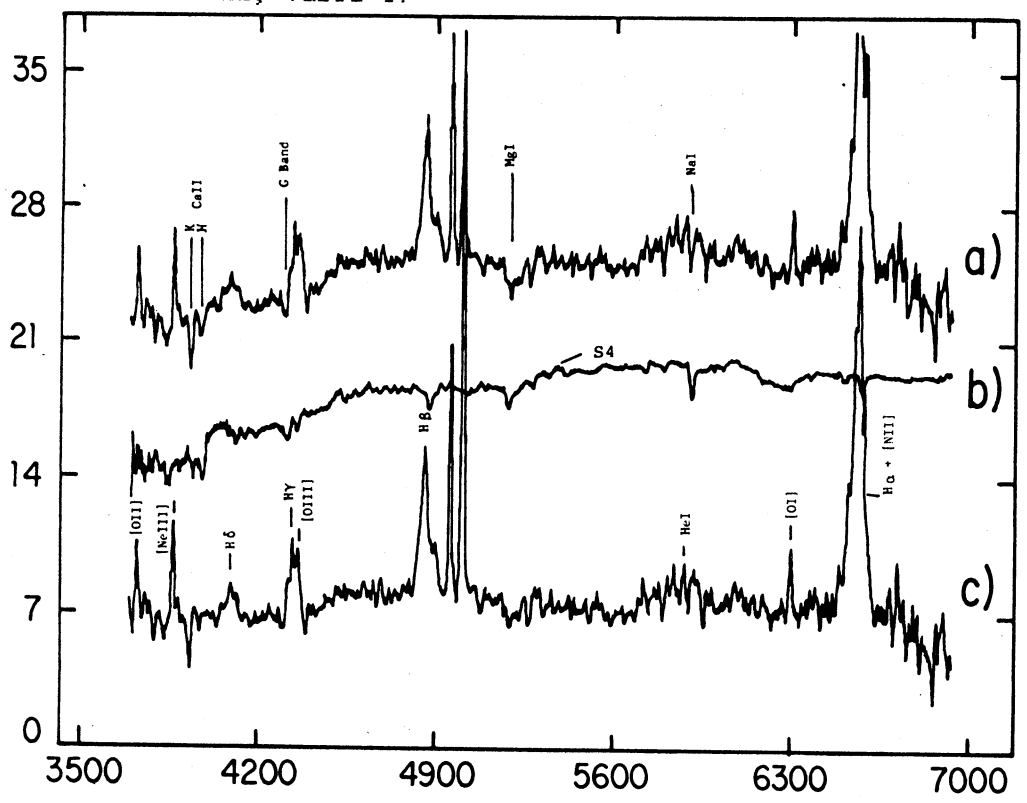

Figure 3: The 1988 spectrum before (a) and after (c) the subtraction of the stellar contribution as described in the text, and the S4 template (b). Units are wavelength in Å and vertical scale is flux in arbitrary units.

clear spectrum before (a) and after (c) the subtraction of an stellar ntribution equivalent to 50% of the continuum light at λ5600Å. This result ans that the relative contributions at λ5870Å are: 50% from a featureless ntinuum, 40% from an old stellar population, and 10% from an intermediate e and/or young stellar population.

CONCLUSIONS:

The emission line variability of NGC 3783 during the last 17 years is mmarized and we conclude by the existence of a low state of activity, where Hβ)/I([OIII]λ4959Å) = 2.4. The amplitude of the variation on this line ratio 2.4 < I(Hβ)/I([OIII]λ4959Å) < 6.4, and there is an important residual tivity in the lowest state. The total variation in the Hβ luminosity between e low state and the 1989 spectrum was $\Delta \mathfrak{L}_{H\beta} = 3.1 \times 10^{41}$ ergs/s. The ue continuum also changes substantially, with 0.72 < I(λ4041Å)/I(λ5695Å) < 02.

The nuclear stellar population provides 50% of the λ5600Å continuum ght when the galaxy is on its low state of activity. This stellar pulation is mainly (80%) composed by very old (> 5 Gyr) stars and has solar tallicity.

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