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THE FIRST DIRECT DETECTION OF RED SUPERGIANTS IN A GIANT H II REGION

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RESUMEN. Hemos obtenido espectrometría de rejilla larga en el intervalo espectral de λ3650 a 9700 A a lo largo de NGC 3310, una galaxia luminosa con brotes circun-nucleares de formación de estrellas. En una de las regiones gigantes de formación estelar, las líneas cercanas de Ca II IR en absorción (que es huella de supergigantes jóvenes) se detectó con una intensidad similar a aquella de la región nuclear. Esto es a nuestro entender, la primera detección de un triplete Ca II IR en una región H II gigante extragaláctica y confirma teóricamente predicciones de que, despueés de 4 millones de años, las estrellas supergigantes rojas deben de aparecer en brotes de formación estelar.

ABSTRACT. We have obtained long slit spectrophotometry across NGC 3310, a luminous galaxy with circumnuclear bursts of star formation, covering the spectral range from λ 3650 to 9700 A. In one of its giant star forming regions, the near IR Ca II absorption lines (a signature of young supergiants) was detected with a strength similar to that of the nuclear region. This is to our knowledge, the first detection of the IR Ca II triplet in an extragalactic giant H II region and confirms theoretical predictions that, after some 4 million years, red supergiants should appear in bursts of star formation.

Key words: **GALAXIES-STARBURST – GALAXIES-STELLAR CONTENT**

I. INTRODUCTION

The Ca II triplet (λλ 8498, 8542, 8662 A) is the most prominent absorption feature in the infrar spectrum of late type stars and normal galaxies. At metallicities higher than 0.5 solar it is very sensitive to luminosity its strength increasing with decreasing stellar surface gravity – (Díaz, Terlevich and Terlevich 1989; DTT and referenc therein) and should be strong in a young star cluster containing some luminous red supergiants, since these sta dominate the near IR light (e.g., NGC 2004, Bica and Alloin 1987). This should occur after about 4 million yea of evolution (Maeder and Meynet 1988). The cluster continuum in the region λ 3500 - 7000 A on the other han should be highly featureless since the spectra of the OB stars dominating the light in the optical range show very we absorption lines, which, for clusters younger than about 5 million years, coincide with the emission from the ioniz gas of the associated H II region (Kinman and Davidson 1981; Rayo, Peimbert and Torres-Peimbert 1982; Melnic Moles and Terlevich 1985).

This type of spectral energy distribution has been proposed by Terlevich, Díaz and Terlevich (1990;TD to explain the fact that while the MgI lines at λ 5175 A are substantially diluted in the nuclei of Seyfert type 2 and sor Seyfert type 1 galaxies, the Ca II triplet is observed at full strength. In this scenario, the nuclear activity is attribut to star formation and their associated processes (Terlevich and Melnick 1985; Terlevich, Melnick and Moles 198 Terlevich and Melnick 1987, 1988).

Peculiar Sersic-Pastoriza nuclei consist of a complex of compact emission-line regions or "hot spot found from spectroscopic work to be either HII regions (Pastoriza 1973, 1975), LINERS (Díaz 1985) or Seyferts (Pag and Edmunds 1982).

To understand the properties of nuclear and extranuclear bursts of star formation, we engaged in detailed study of nearby hot spot galaxies. NGC 3310 is a luminous Sb galaxy (Humason, Mayal and Sandage 195

with a starburst nucleus and a ring 1 kpc in diameter of giant H II regions. The detection of the IR Ca II triplet in the nucleus and in one of the regions (at ~ 10 " South) was reported by us and has now appeared in press (Terlevich *et al.* 1990) and a full account of this investigation is in preparation. We present here a summary.

II. OBSERVATIONS

The observations were made at the Observatorio del Roque de los Muchachos, La Palma, Spain, using the 2.5-m Isaac Newton Telescope. The instrumental characteristics are given below:

Intermediate Dispersion Spectrograph (IDS)
235mm camera
Blue coated GEC-CCD (400 580 pixels)
SCALE: 0.7"/pix
SLIT WIDTH: 1.5"
DISPERSION: 2.3 A/pix
SPECTRAL RANGE: λ 3650 - 9700 A
EXPOSURE TIMES: 1000 - 1800 seconds
PA OF SLIT: 347°

III. DATA REDUCTION AND ANALYSIS

Data reduction was performed at the Instituto de Astrofísica de Canarias and at the Royal Greenwich Observatory using standard reduction packages. The procedure includes subtraction of dark current bias and preflash illumination, removal of cosmic ray hits, division by a flat field and wavelength and flux calibrations. Atmospheric absorption bands were removed dividing by an F star.

1-D spectra were obtained by extracting selected pixels from a spacial profile at Hα. For this work we extracted the nucleus and a region at ~ 10" South, which we called B. Figure 1 shows the inner part of the galaxy (24" × 24") from a CCD image in Hα obtained with the 1-m JKT on La Palma (Sánchez *et al.*, in preparation) from which region B can easily be identified.

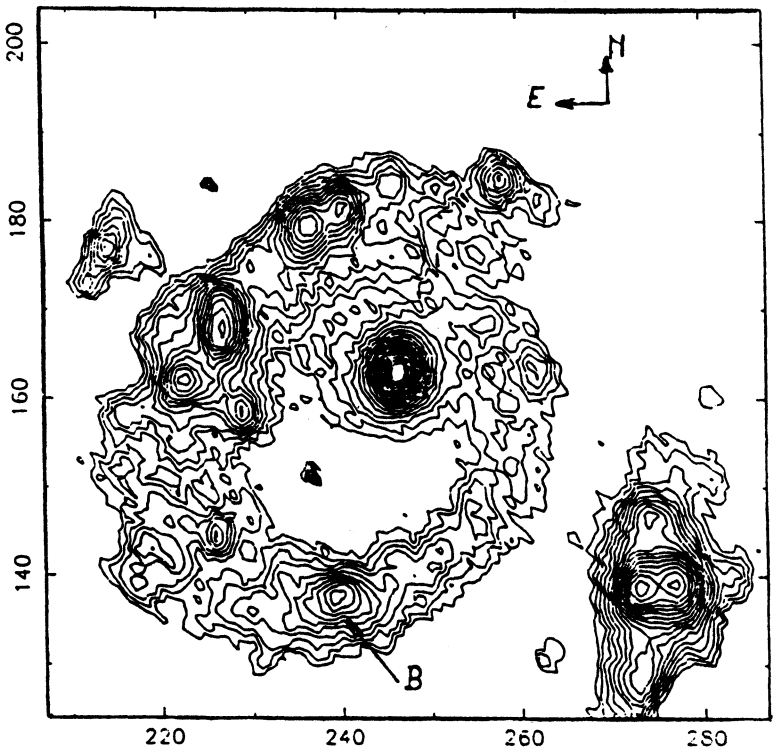


Fig. 1. Hα CCD image of NGC 3310 obtained with the 1-m JKT at La Palma (Sánchez *et al.* in preparation). The scale is 0.3"/pixel. The arrow points at region B.

IV. RESULTS

Figure 2 shows the near infrared spectra (λ_c ~9000 A). The prominent Ca II triplet in absorption, has comparable strength in the nucleus and in the region.

$$EW(CaII)_{nuc} = 6.4 \pm 0.8$$

$$EW(CaII)_B = 7.0 \pm 1.2$$

The blue spectra (λ_c ~4300 A) are shown in Figure 3 and the yellow ones (λ_c ~5400 A), in Figure 4.

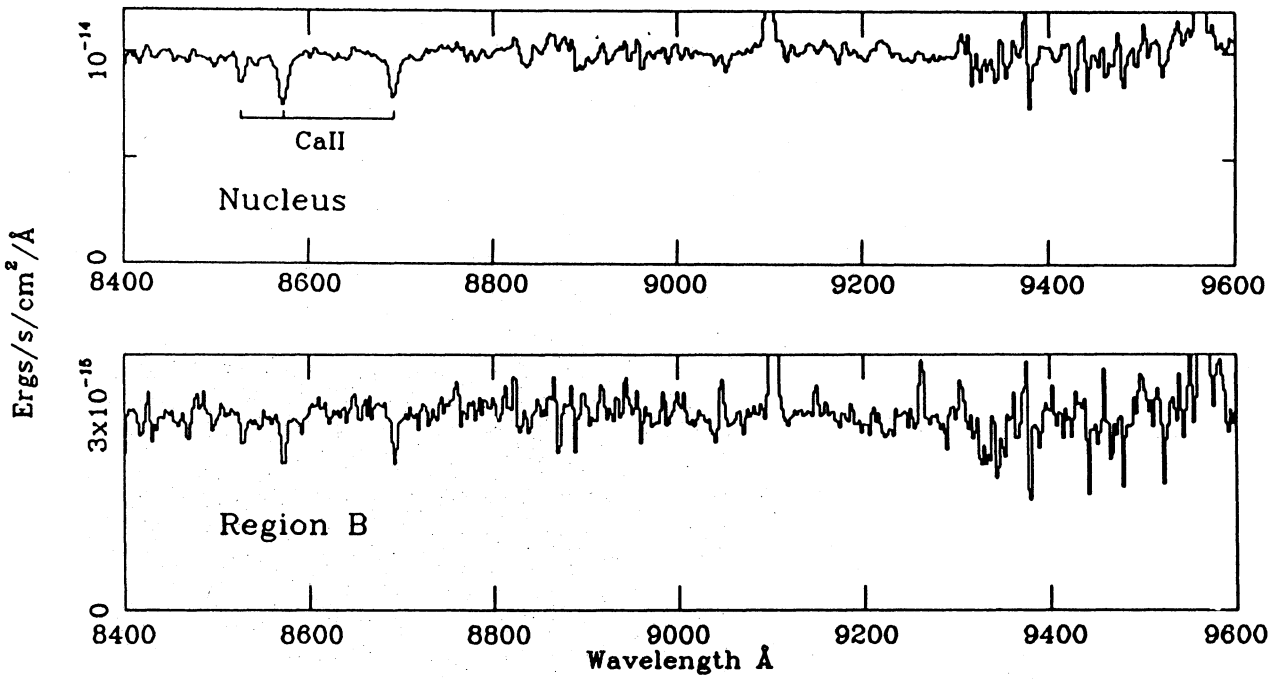


Fig. 2. Near IR spectra a) nucleus, b) region B. Strong emission lines are out of scale.

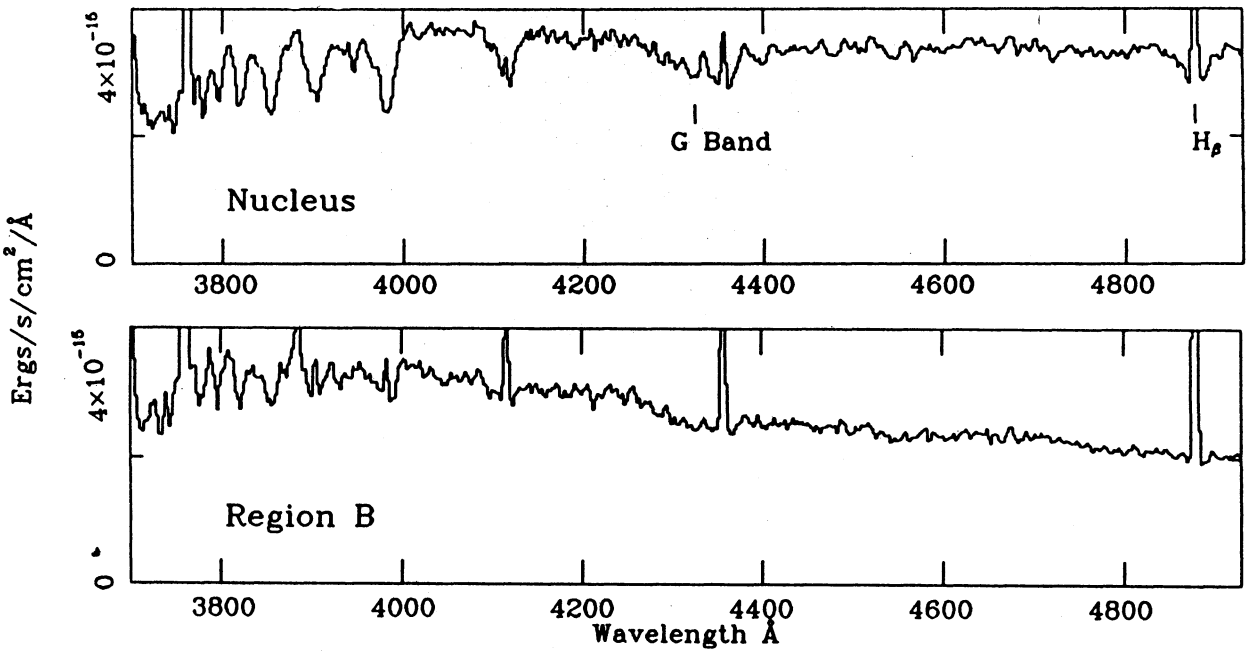
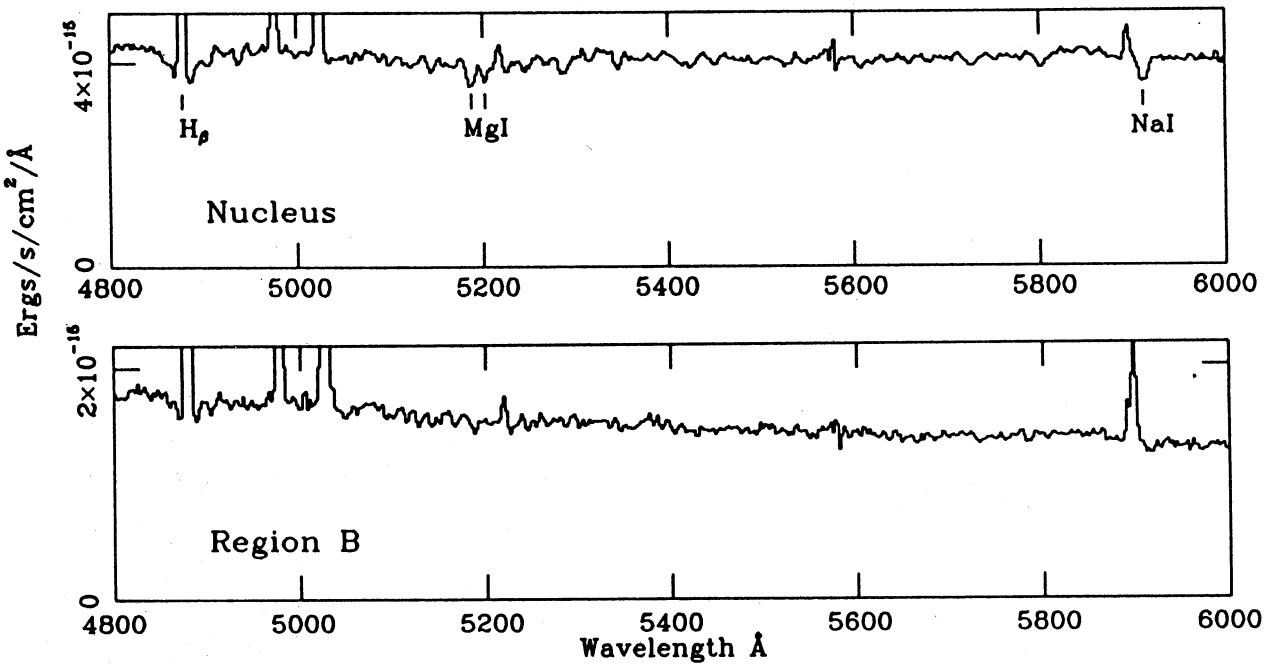


Fig. 3. Blue (λ 3700 - 5000 A) spectra for a) the nucleus and b) region B. Strong emission lines are out of scale.

The nucleus shows relatively strong absorption features characteristic of an old stellar population (G-
nd λ ~4300 A; Mg I λ ~ 5175 A; Na I λ ~ 5890 A and Ca II triplet) together with strong and wide Balmer absorption
es characteristic of a relatively old starburst. The only strong absorption features seen in region B, on the other
nd, are the near IR Ca II lines.



g. 4. Yellow (λ 4800 - 6000 A) spectra for a) the nucleus and b) region B. Strong emission lines are out of scale.

We conclude that the Ca II triplet in the nucleus of NGC 3310 probably comes from the red giant
opulation in the bulge, while that in region B originates in red supergiants already present in the star forming region.
egion B is probably older than 4 million years (because it has these young red stars; Campbell and Terlevich 1984),
id younger than 5-6 million years (because it has not yet lost its associated H II region (Dottori 1981; Copetti, Pastoriza
id Dottori 1986).

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