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VERY HIGH VELOCITY GAS IN GIANT EXTRAGALACTC H II REGIONS

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ABSTRACT. As part of a systematic survey for the search of high velocity gas in giant extragalactic H II regions, we have observed the five largest and brightest H II regions in M 101. We have found two types of peculiar emission profiles: *i)* a broadening of the Hα emission line at low intensity, in excess of the values expected for the typical gaussian profile and *ii)* a very broad component (FWZI > 3000 km s^{-1}) for Hα + the [N II] doublet, located at NGC 5471.

RESUMEN. Como parte de un programa para la búsqueda de gas a alta velocidad en grandes regiones de H II extragalácticas, hemos observado las cinco regiones mas grandes y brillantes de M 101. Hemos encontrado dos tipos de perfiles peculiares: *i)* un ensanchamiento de la línea de Hα en emisión a baja intensidad, en exceso de los valores esperados para un perfil gausiano, y *ii)* una componente muy ancha (FWZI > 3000 km s^{-1}) para Hα y el doblete de [N II], localizada en NGC 5471.

Key Words: GALAXY-H II REGIONS — INTERSTELLAR-KINEMATICS

NTRODUCTION

It is well known that the kinematics of H II regions present a complex structure evidenced by spectral lines showing a broadening larger than the thermal component, with velocities ranging from w km s^{-1} to supersonic speeds. Furthermore,these lines are not always gaussian and the existence nultiple components and velocity gradients have been proved to exist. In the case of giant extragalactic I regions (GEHR), a long standing problem has been the existence of turbulent motions in the regions. dissipative nature of turbulence requires a mechanism of continuous energy supply. The likely existence upernovae remnants within the complexes (Richter and Rosa 1984) and the stellar winds from massive s (e.g. Rosa and Solf 1984) must be taken into account when explaining the overall dynamical state he gas, as a possible source for the turbulent motions observed. Since both kind of phenomena should duce gas at high velocities, the gas could be detected by spectroscopic techniques.

Chu and Kennicutt (1986) started an observational program for the search of gas at high ocities, examining the Hα profile in a sample of over 30 GEHR. Their main aim was the detec- of supernovae remnants (SNR). Nevertheless, due to the limited spectral range used (40 Å) and ir moderate S/N ratio, it was pointed out by Vilchez et al. (1989) that it could exist the danger nissing the detection of low intensity gas at very high velocities (> 10^3 km s^{-1}).

To test this hypothesis, we have started a systematic survey for the detection of high velocity at low intensity levels, with the use of CCD detectors, long slit spectroscopy, and high signal-to-noise io. In this paper we present our preliminary results for a survey in the five largest HII complexes in 01.

II. OBSERVATIONS

We have used the IDS Cassegrain spectrograph of the 2.5m Isaac Newton Telescope at the Roque de los Muchachos Observatory, La Palma, Canary Islands. The detector was a GEC CCD, read out as 578 x 385 pixels. The spectral dispersion was 0.7 Å pixel^{-1}, with a total spectral range of 400 Å, permitting the observation of Hα, the [N II] $\lambda\lambda$ 6548, 6584 doublet, and the [S II] $\lambda\lambda$ 6717, 6731 doublet. The seeing was typically 1 arcsec during the observations. The slit was oriented along the bright knots of the multiple–core regions NGC 5471, 5462, 5461, 5455 and 5447. In the case of the regions of M 101 with chain–like morphology, the slit was oriented along the main axis of the region. In addition, IPCS (Image Photon Counting System) spectra were previously obtained for the regions NGC 5471 and 5461 with the same telescope. The data were reduced with the use of the FIGARO software package. Full details o the observational setup and the reduction procedure will be published in a forthcoming paper (Castañeda, Vilchez and Copetti 1989).

III. RESULTS AND DISCUSSION

We performed a systematic analysis of the line profiles along the slit. The CCD spectra were corrected by bias and flat and removed all the cosmic rays signal individually. The average position for the maximun of the Hα flux for each integration was selected as zero point. One–dimensional spectra were extracted coadding three rows ($\approx$ one arcsec), and each spectrum was analyzed individually. The local electron density at each point was determined from the [S II] doublet ratio, solving a five level atom with the values of transition probabilities and collision strengths from the compilation of Mendoza (1983). Figure 1 and 2 illustrates contour plots for the regions NGC 5461 and 5471, respectively. We have found two kind of peculiar emission profiles in our survey.

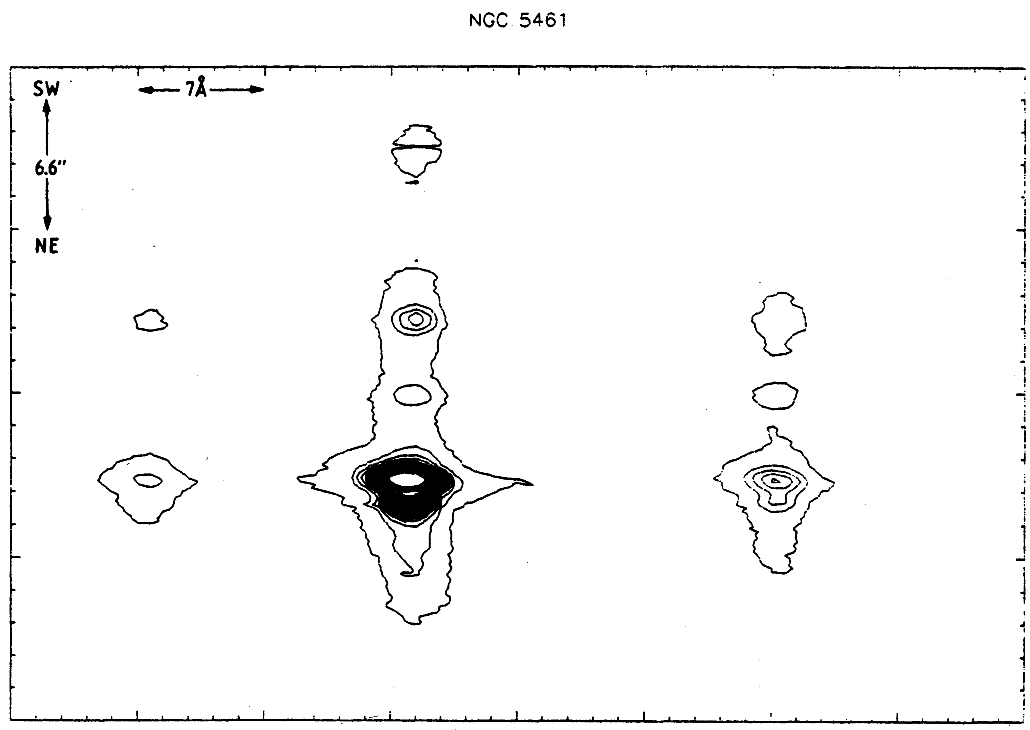

Figure 1: Contour plots of Hα + [N II] $\lambda\lambda$ 6548, 6584 for the long slit spectrogram of NGC 5461. The slit is oriented along the major axis of the region. Position Angle is 66°.

NGC 5471

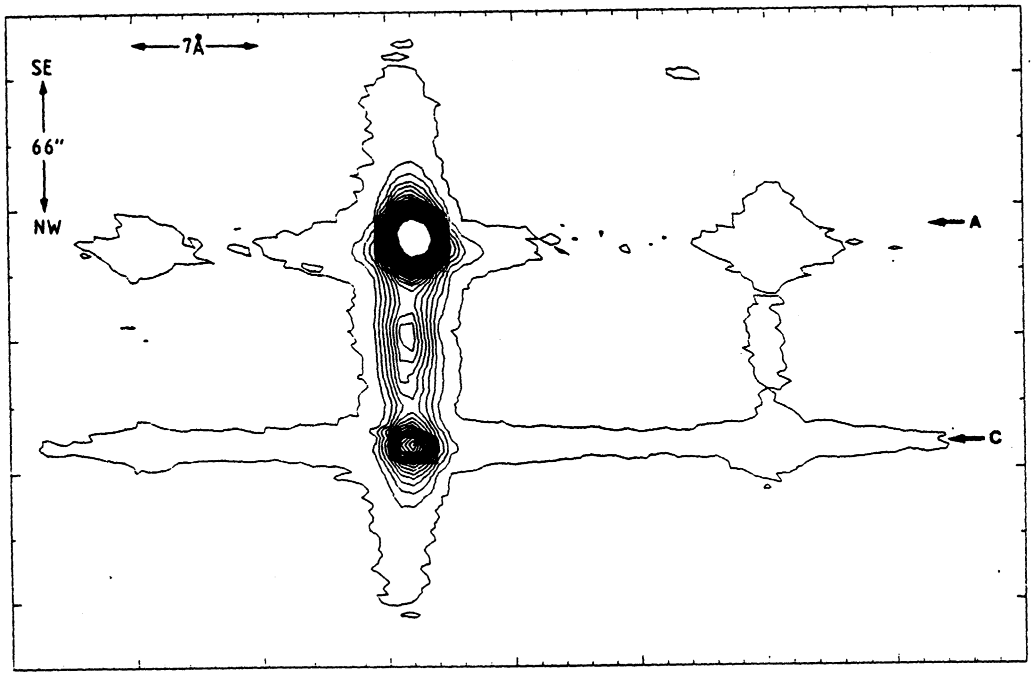

Figure 2: Contour plots of Hα + [N II] λλ 6548, 6584 for the long slit spectrogram of NGC 5471. The slit is oriented to cover knots A and C. Note the broad wings at the position of knot C. Position Angle is 308°.

i) A broadening in the Hα emission profile at low intensity (< 10 % of peak intensity) larger ıan the values expected for a gaussian profile, in the same positions discovered by Chu and Kennicutt 1986): knots A, B and C of NGC 5471 (Skillman 1985) and the brightest knot in NGC 5461. Our values re, in general, in good agreement with the CK values, tough our resolution is lower. We have quoted in 'able 1 the values of FWHM, at 10 % and 5 % of peak intensity. For each position the density obtained :om the [S II] doublet is indicated.

ii) Very broad emission at low intensity level (≤ 2 % of peak intensity). That feature was found at he position of knot C. The size of the region were the high velocity gas is present is less than one arc sec,

Table 1. Velocity Widths of the Hα Line

PARAMETER	N 5471-Knot A	N 5471-Knot B	N 5471- Knot C	N 5461
Density[a]	(373 ± 14)	(461 ± 16)	(151 ± 27)	(424 ± 10)
$FWHM_{H\alpha}$	31 (75)	65 (62)	35 (40)	55 (72)
FW–10 %[b]	110 (134)	189 (200)	111 (86)	140 (150)
FW–5 %[c]	167 (194)	245 (250)	188 (115)	183 (180)

Notes: *a)*: electronic density in cm^{-3}; *b)*: full width at 10 % of peak intensity (in km s^{-1}); *c)*: full width at 5 % of peak intensity (in km s^{-1}).
Values of widths in parenthesis are from Chu and Kennicutt (1986).

and the broad component has a contribution of ≈ 15 % to the total flux of the lines. Figure 3 illustrates the emission profile at this position; notice the red asymmetry on the line profiles of Hα and [N II] λ 6584, and the emission feature around 6605 Å. If that emission feature would correspond to Hα emission, it would imply a redshift of 1700 km s^{-1}. The asymmetry on the line profiles could indicate the presence of a collimated/wind–driven outflow.

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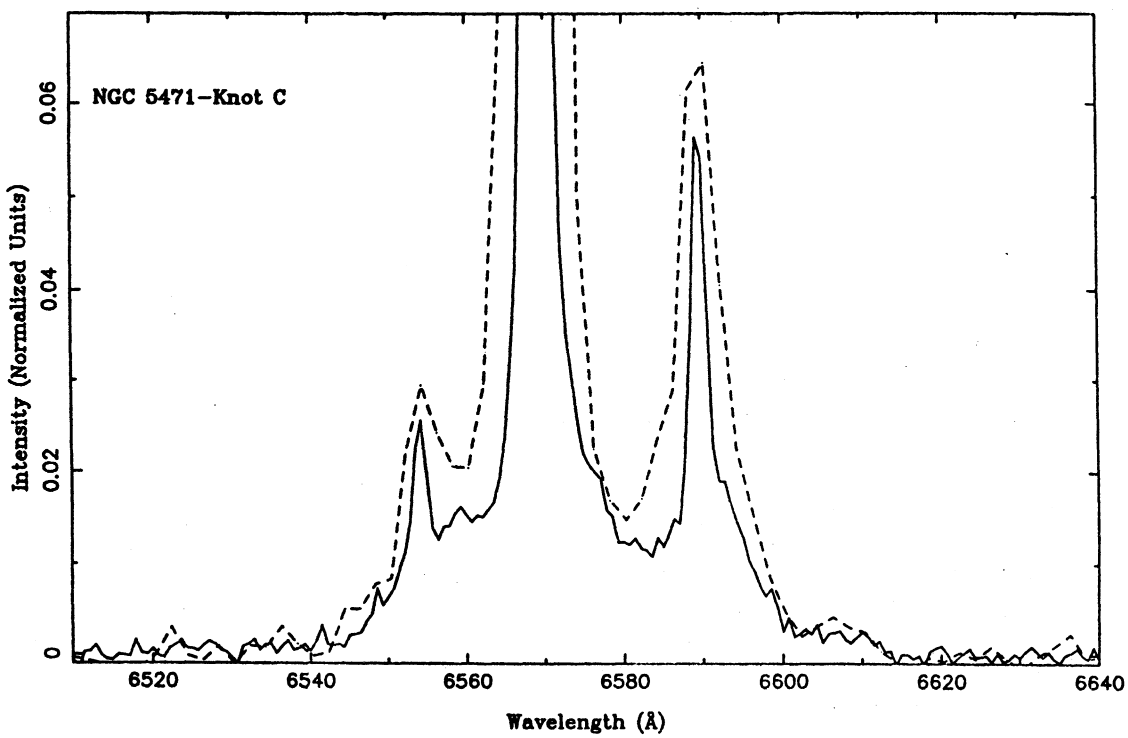

Figure 3: Comparison of the spectra obtained for knot C with the CCD detector (continuous line) and the IPCS (dashed line), both normalized to peak intensity in Hα (from Castañeda, Vilchez and Copetti 1989)

After a careful analysis of possible instrumental effects we have concluded that the extended wings in the emission lines are real and not produced by the detector, instrumentral profile, or non–uniform slit illumination. We must point out that the same profile is observed in the four independent CCD observations at the same point.

The existence of the first type of broadening seems to indicate the presence of supernova remnants (see Chu and Kennicutt 1986 and references therein). For example, spectrophotometry at intermediate and high resolution (Skillman 1985) and radio observations (Sramek and Weedman 1986) appear to show the existence of one (at knot B) and probably two more (knots A and C) remnants in NGC 5471. Nevertheless, the evidence is not conclusive for the presence of a SNR at knot C. In addition, we have not detected the presence of WR stars at the position where the high velocity gas is localized. We expect to continue the observations of that peculiar feature in the near future. As a first step to ascertain the nature of the phenomenon, we will observe the lines Hβ and [O III], to determine the dynamical state of the ionized hydrogen, and separate the high velocity gas component from the extended nebular emission.

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