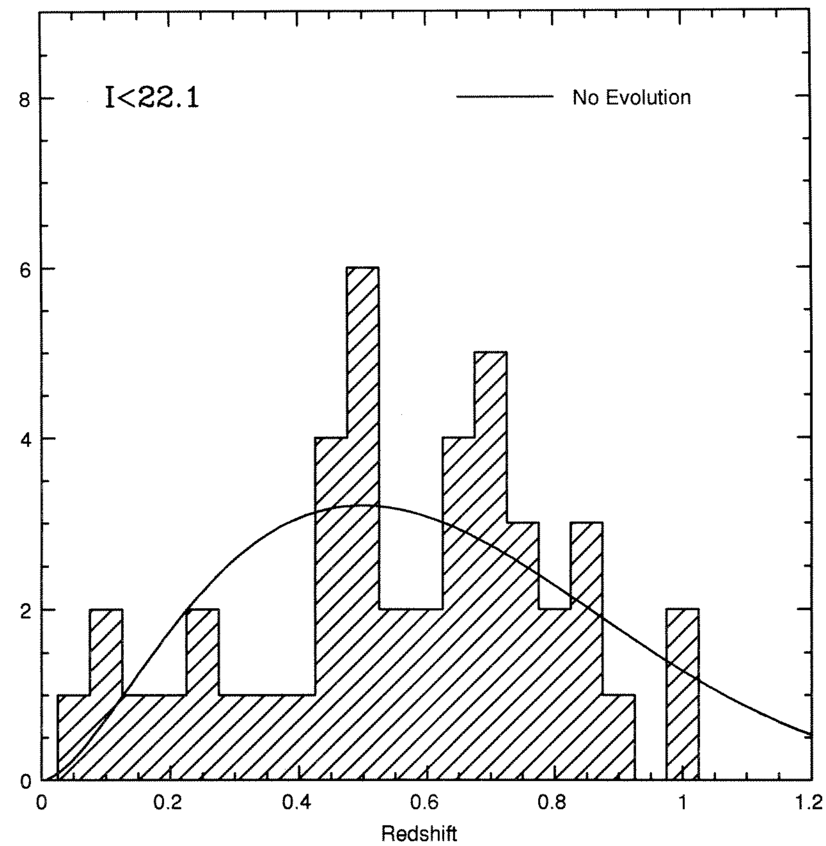

Figure 14

NGC 595: A Big Good'ol HII Region?

Giant extragalactic HII regions (GEHRs) are sites of intense star formation. OB associations are formed totaling 10^3–10^5 $M_\odot$. Hence vast quantities of gas are ionized due to the presence of copious amount of UV photons. It follows that these objects have large Balmer luminosities allowing their detection in distant galaxies. GEHRs are thus used to determine (1) chemical abundances and (2) the star formation rate in galaxies along with (3) their spiral structure. They are also used (4) as distance indicators. Albeit their importance, the nature and stellar content of GEHRs are poorly known. Our goal is to study in detail the dynamics of such objects. We expect to find contributions from the following hydrodynamical processes: supernova explosions, stellar winds from massive stars, gas flows originating from the parent molecular cloud(s) being dissociated and turbulence. All this mechanical energy has an impact on the energy budget of a galaxy. In order to quantify this impact correctly, the frequency and relative importance of these processes amongst GEHRs has to be determined. Such a project was started in collaboration with J.-R. Roy (Université Laval) who described briefly in bulletin no 26 our Fabry-Perot observations of NGC 2363. I report here preliminary analysis of the kinematics of NGC 595 in M33.

PALILA was used (f/8 -> f/2 focal reducer) on the CFHT with a Photon Counting Camera acting as detector (256 x 256 pixels). The field of view was 5' x 5' (1 pixel = 1".2). The [OIII] 500.7 nm velocity field was measured using the Université Laval high resolution Fabry-Perot interferometer (FWHM = 8.4 km/s). The free spectral range of the interferometer was scanned in 40 steps of 7.5 km/s each. The total integration time was 26240 s spread over 3 nights. The software written by Jacques Boulesteix was used to perform the data reduction. The final product is a data cube (X x Y x velocity) similar to what one obtains from radio aperture synthesis line observations.

NGC 595 is the second largest GEHR in M33 (dist = 724 kpc). Courtès et al. (1987) in their H_α survey of M33 depicts it as having a core-halo morphology with an intricate filamentary structure. Drissen et al. (1990) found 10 WR stars in its midst making it richer in such stars than 30 DOR and NGC 604. These authors conclude that NGC 595 is an evolved GEHR (4-6 x 10^6 yr). Viallefond et al. (1983), using radio continuum and H_α data, conclude that NGC 595 has no non-thermal radio emission (no SNR!), little extinction (1.5 m, global value) and needs the equivalent of 15 O5 stars to produce the needed amount of ionizing UV photons. Their 6 cm continuum map shows strong intensity gradients on its eastern and western sides, indicating the presence of neutral material. Indeed, Deul and van der Hulst (1987), in an HI survey of M33, found the HII region to be sitting in a HI hole and surrounded by an ellipsoidal, thick HI shell expanding at a velocity of 18 km/s. Wilson and Scoville (1992) detected a two-component molecular cloud located in the southern half of the HII region. The molecular material is probably behind the ionized gas. Table 3 summarizes these observations.

Table 3
Summary of the Gas Characteristics

Gas	Size (pc)	V_{lsr} (km/s)	Mass ($M_\odot$)
HII	112 x 182	-197	3.7 x 10^5
HI	120 x 180	-191	2.5 x 10^4
H2	40 x 45	-188	5-8 x 10^5

Figure 15 shows a contour map of the [OIII] line emission from NGC 595. The field of view is 1'.25 x 1'.25. The HII region is composed of two bright cores and a fainter halo. A 30" long filament extends northerly from the eastern core. Similarly there is a 15" faint extension south of the nebula. The numbers seen in Figure 16 indicate the position of some of the WR stars detected by Drissen et al. Figure 16 has a scale identical to Figure 15 and presents the individual [OIII] profiles binned 2 x 2. Many profiles are asymmetric or possess two components - one at -180 km/s the other one at -220 km/s. The overall mean radial velocity of the [OIII] gas is about -197 km/s. The WR stars 2, 3 and 10 are located in two-component-profile areas. Localized bubble like expansion of the ionized gas is possible since the mid-value of the two components is very close to the overall mean velocity of the object. The other WR stars do not appear to affect the ionized gas. In addition some areas containing two-component profiles do not seem to contain WR stars. Looking at the overall ionized gas behavior, a north-south radial velocity gradient is present across the object. The gas velocity in the southern part of the nebula is similar to the molecular cloud's. An east-west gradient is also present, but in this case the ionized gas' velocity at the eastern and western boundaries is similar to the HI gas' velocity. Software is now being written for an in depth look at the behavior of the line widths.

As mentioned above our data have not been fully analyzed yet. Nevertheless, we believe that more than one phenomenon are involved in the kinematics of NGC 595. Probable candidates are: the Champagne effect (the dissociation of the molecular cloud produces ionized gas flows resulting from the pressure discontinuity between the dense cloud and the inter-cloud medium), a snow plough effect by the WR stellar winds and the ionization of the HI shell again producing gas flows but of smaller amplitude than those originating from the molecular cloud. More work is needed to determine the relative importance of all these effects on the overall kinematics of this object. The ambiguous correlation between the presence of two-component profiles and WR stars is confusing. Order of magnitude calculations indicate that NGC 595 has a dynamical age of about 10^7 yr, similar to the conclusion drawn by Drissen et al from the quantity of WR stars present in this object.

Two mechanisms may be at the origin of the HI feature: the dissociation of the molecular gas ($H2 \rightarrow HI$) or/and a bunching up of the interstellar HI by the expansion of the shock front preceding the HII region's ionization front (another snow plough effect). Its expansion may be a combination of the action of thermal expansion or the "rocket effect". The energy needed for the measured expansion is 10^{51} erg. However, we cannot reject the hypothesis that the whole gas complex is rotating around a roughly north-south axis at about 6 km/s. The layout of the different gas components associated with NGC 595 is very similar to those encountered in old star forming regions in our galaxy like Sh 142 (Joncas et al. 1985) and Sh 184 (Roger and Pedlar 1981)... but of course at a much larger scale. Hence the answer to the question in the title seems to be "yes."

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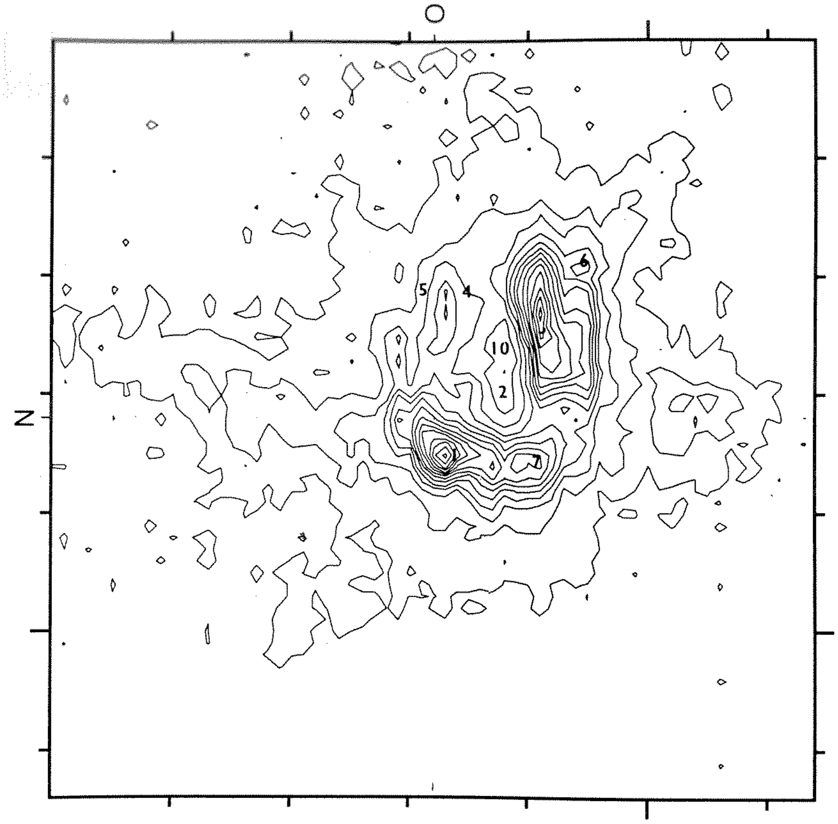
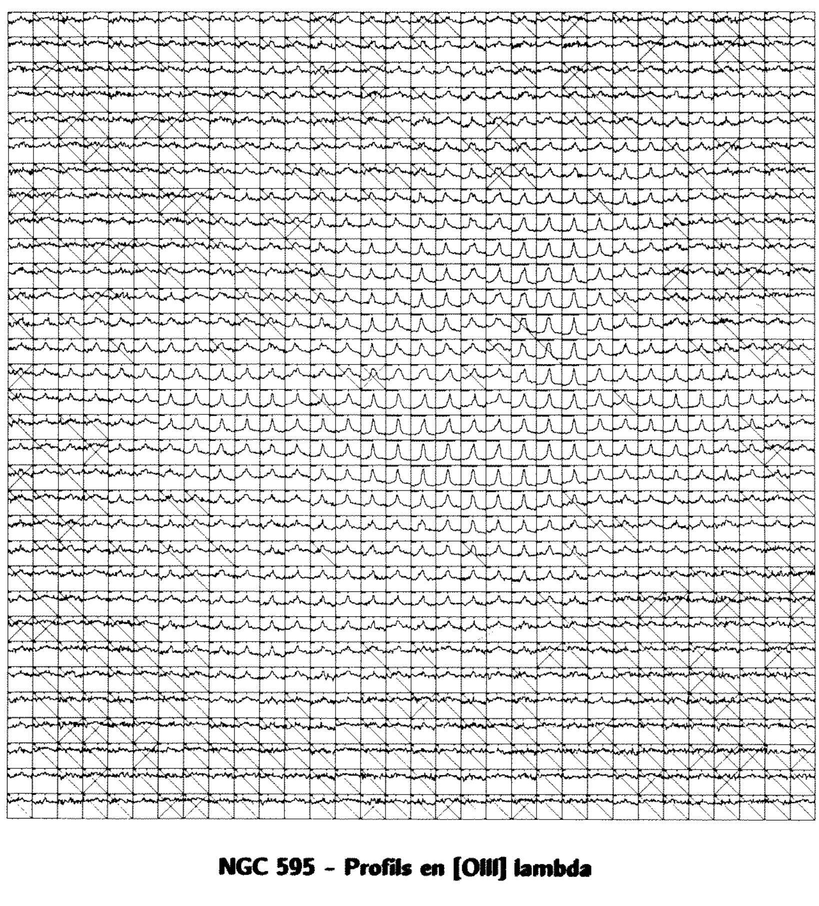


NGC 595 - Image monochromatique en [OIII]

□ = 1 pixel

Figure 15 ⇑

Figure 16 ⇓



NGC 595 - Profils en [OIII] lambda