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Hα Survey of the Large Magellanic Cloud

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Abstract. The LMC is being surveyed in the Hα emission line with a scanning Fabry-Perot interferometer, attached to the 36 cm telescope of the Observatoire de Marseille. The present results concern the kinematical mapping of bright nebulae; it shows that the kinetic energy involved in the gas motion is closely related to the evolutionary stage of the embedded stars. In particular, in the 30 Dor nebula, a few one-peaked line profiles remain at the boundaries of the shells , among the numerous split areas. The 50-100 pc shells exhibit a relatively usual spherical expansion, with velocities in the same range at the boundaries. On the contrary, the 10-20 pc shells of the central core show different velocities of the one-peak sides of the shells.

1. Introduction

Large field interferometric observation of HII regions at Hα wavelength is a powerful mean to study the dynamics of the ionized gas of the Magellanic Clouds, whatever the size of the nebulae. The Large Magellanic Cloud has a great number of giant hydrogen shells with diameters ranging from 20 to 220 pc, and supergiant shells with diameters between 600 to 1200 pc. A survey is being carried out with the "Hα survey" instrument of the Observatory of Marseille, which is settled at the E.S.O., La Silla. It consists of a wide field telescope (38'x38') and different scanning interferometers (Le Coarer et al. 1992; Rosado et al. 1994). The available free spectral ranges are either 8.2A (376 km s^{-1}) with a sampling step of 0.3 A (16 km s^{-1}), or 2.5 A (115 km s^{-1}) with a sampling step of 0.1 A (5 km s^{-1}). The observations can be presented in a mosaic which covers now most of the LMC.

The first results are obtained for the North-Western area, containing the bright nebulae N11, N9 and also the superbubble LMC1.

The brightest nebulae have been observed also in the light of [OIII]5007, which allows a spectral sampling step of 8 km s^{-1} for a free spectral range of 287 km s^{-1}. In the following, we announce some results for the second brightest nebula of the LMC, N11, and we emphasize the peculiarities of the largest nebula, 30 Dor.

2. The nebula N11

The nebula N11 is made of 5 spatially separated bright HII regions, which are found to have expanding gas motions as soon as the embedded O stars are beginning to evolve. Such motions are typically driven by fast stellar winds. Three HII regions with embedded dwarf O stars, do not exhibit gas motions, which, on the contrary, are observed around the evolved stellar association LH9 and inside the brightest core N11B, surrounding the stellar association LH10. This association is younger and richer into massive stars than usual (Parker et al. 1992). The moving features develop following the usual spherically expanding model, with split line profiles at the center of the nebula, and simple Gaussian profiles for the boundaries of the shells. Thus bubbles are presently being formed inside N11B. It is possible to relate the amount of the kinetic energy involved in gas motions to the power of the stellar winds; the age of the bubble may be an indicator of the age of the stellar winds.

3. The 30 Dor nebula

The major young stellar site of the LMC, the 30 Dor nebula is known for its chaotic gas motions, probably due to the powerful stellar winds of its stellar clusters, R136 being the brightest one (Canto et al. 1980; White 1981; Meaburn 1981; Cox & Deharveng 1983; Clayton 1987; Meaburn 1988; Chu & Kennicutt 1991). Our large field kinematical mapping gives the opportunity of precisely delimiting the quiet zones from the perturbed areas (Fig.1).

30 Dor was observed with the 38' field instrument with IPCS, and also with a CCD as a detector, which gives a field of 20' and an angular resolution of 4.5". The CCD was operated by Gach (1993) and le Coarer. Because of the large dynamical range of brightness, the light of the nebula was attenuated by a neutral density filter and observed through an [OIII]5007 interference filter, and an Hα interference filter. In this case, the free spectral ranges were respectively 4.8 A or 287.3 km s^{-1} (sampling step = 0.13 A or 8.0 km s^{-1}), and 8.2 A or 374.8 km s^{-1} (sampling step = 0.23 A or 13.4 km s^{-1}).

Our first interest was to find the probable boundaries of the shells studied by Cox and Deharveng (1983), who concluded that such shells are expanding. The intense semi-spherical limits of "shell 1" and "shell 2" of Cox and Deharveng, are located respectively at 3.5' at the SouthEast, and 5' at the East from the stellar cluster R136. Effectively one-peaked profiles are found along the limits,with respective velocities of 263.3 $\pm$ 5 km s^{-1} and 254.5 $\pm$ 5 km s^{-1} (Fig.2). The inner expansion velocities range from 195 to 340 km s^{-1}. Thus a radial expansion is not unlikely for these two shells.

What is occurring at the North in the very core, the brightest part of 30 Dor? The same approach was attempted, and Fig.3 summarizes the results over an area of 8.6' diameter, centered on R136. Two different velocity patterns with one-peak profiles are mixed up, corresponding to velocities of 259 $\pm$ 7 km s^{-1} and 282 $\pm$ 6 km s^{-1}. The inner very complex profiles, (shown to spread over a velocity range of $<$100 km s^{-1} and $>$400 km s^{-1} by Meaburn,1988), are detected from 205 to 350 km s^{-1}, given our sensitivity limit.

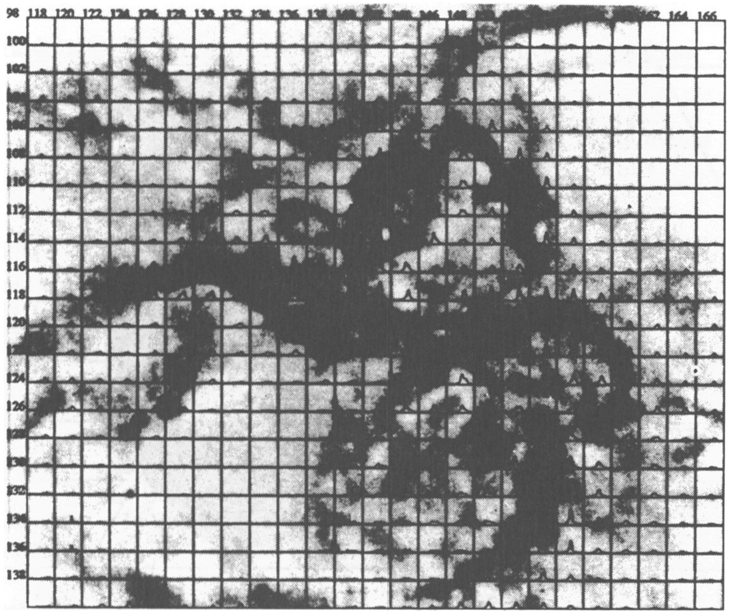

Figure 1. [OIII]5007 line profiles superimposed over an image of the central core of 30 Dor. Each square frame contains the profile averaged over 9"x9". One-peak profiles are visible, as well as splittings.

Such a velocity pattern cannot match a simple expanding model, as the previous studies have emphasized. It must be considered together with the velocity of the two components found for the HI gas by Luks & Rohlfs (1992) and for the molecular gas by Garay et al. (1993). The velocities of the ionised gas can be added over areas of almost the same dimensions as the neutral observations. The results are given in Table 1, where the first row is the heliocentric velocity given in kms-1, and the second row the intensity of the component normalized to the faintest component of the considered gaseous object. It shows that, within different sites of similar size, the same major velocity components are found, whatever the physical condition of the gas is. Luks & Rohlfs (1992) explain the reversed intensity ratio of the atomic and molecular components by the ionization of the atomic gas by the numerous blue stars located in 30 Dor. For the ionized gas, the brighter velocity component is very often the same as the main molecular one,but there is one exception inside the central core, where the 259 km s^{-1} and the 282 km s^{-1} components have almost the same intensity. Since no exciting stars are centered inside these small but intense shells, it seems probable that their exciting stars are the same ones for both velocity components.The projected distances between condensations having different velocities, can be here as small as 45" or 11 pc (for a LMC distance of 50 kpc) around R136 and in the northern loop.

It thus seems that inside a 2' radius around R136, nearby stable nebular condensations having velocities of the same value as the two neutral components

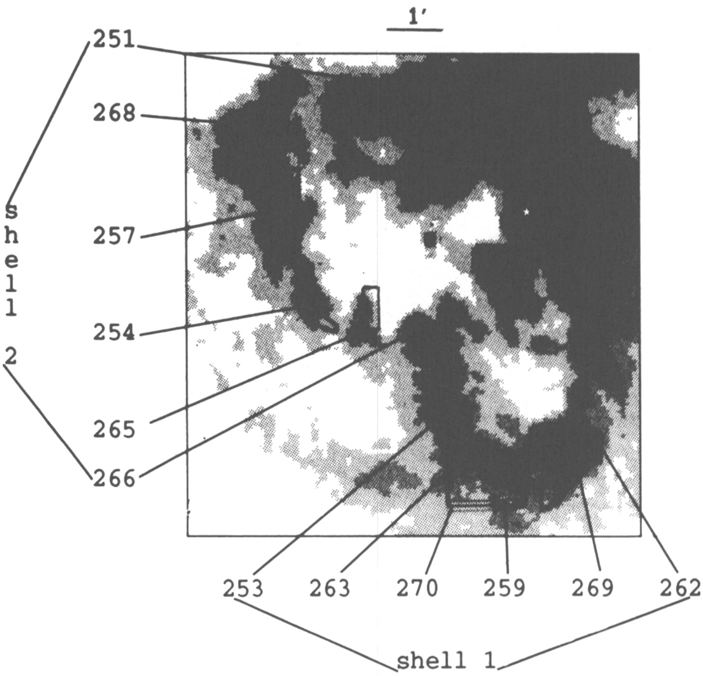

Figure 2. Map of the South-Eastern part of 30 Dor, showing the velocities of the boundaries of shell 1 and shell 2 of Cox & Deharveng (1983). The delimited areas are the only places where the line profiles are not split and can be fitted by one single Gaussian. The asterisk indicates the position of R136.

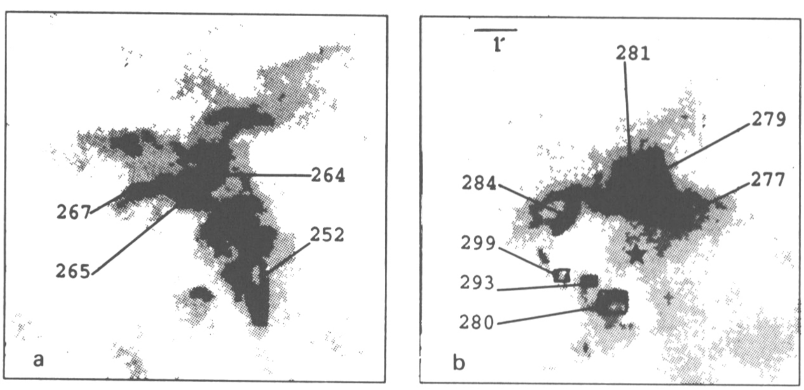

Figure 3. Same as Fig.2 for the central core of 30 Dor. The wavelength maps represent the selected velocity range of a) 256 ± 4 km s^{-1}, b) 280 ± 4 km s^{-1}.

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Table 1. Heliocentric radial velocities taken over large areas

	Size	Bright bluesh. component km s^{-1}	Bright redsh. component km s^{-1}	Faint components km s^{-1}	
HI	ϕ 15'	263	281		
		1	3		
CO	ϕ 8'8	265	283		
central core		2.5	1		
HII	7'65x8'10	259	284	225	316
central core		5.2	5.5	1.7	1
HII	8'25x6'75	262	294	219	329
shell 1		5.4	3.7	1.2	1
"	5'70x8'70	256	291	222	327
shell 2		8.6	5.8	2.3	1
"					
northern	14'25x9'00	260	296	220	
quarter		9.1	2.9	1	
"					
western	11'85x11'25	263	289	219	327
quarter		7.7	6.3	1.3	1

still coexist inside a small volume. One question is : when was their proximity maximum ? before the stellar formation or later ?

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