Hα SURVEY OF THE MILKY WAY AND MAGELLANIC CLOUDS

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1. Introduction

In 1990 we began an Hα survey of the Milky Way and the Magellanic clouds at ESO La Silla with a 36 cm telescope. The main goal of this survey is to study in detail complexes of HII regions, as well as the global spiral structure of our Galaxy.

The telescope is equipped with a scanning Fabry-Perot interferometer and a Photon-Counting camera; the instrument has been fully described by Amram et al. (1991). The field-of-view is 38′ x 38′ and each of the 256 x 256 pixels is 9" x 9" wide.

A detailed analysis of the transmission function of the instrument together with an example of what can be done with the data of this Survey may be found in Le Coarer et al. (1992).

2. Observation of the Small Magellanic Cloud (SMC)

The SMC has been completely covered with about 30 fields. The main results are given in Le Coarer et al. (1993) and summarized hereafter:

1) catalogue of velocities and Hα fluxes for 143 HII regions;
2) confirmation of the existence of a gradient in velocities along the bar;
3) the diffuse Hα emission shows broad profiles with several velocity components (as already observed in HI);
4) good agreement between HII and HI velocities;
5) study of the kinematics of SNR (Rosado et al. 1993).

3. Observation of the Large Magellanic Cloud (LMC)

About 40 fields have been covered on the LMC, most of them at both Hα and [O III] lines.

The most important results are related with the study of motions in bubbles; some examples are given hereafter:

1) the bubble N11B is found to have an expansion velocity around 20 km/s. Meanwhile split line profiles are observed around the O3 III stars of the youngest stellar association in N11

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(Laval et al., to be submitted). Such profiles are the signature of strong stellar winds. See Fig. 1;

2) we confirm a maximum splitting around 160 km/s for the large bubble N11 already measured by Meaburn et al. (1989);
3) the bubble N59A is found to have an expansion velocity slightly more than 40 km/s. Meanwhile split profiles are observed around an O5 V star. They are the signature of strong stellar winds;
4) we confirm that LMC1 (discovered by Meaburn, 1980) is a superbubble since we measure its expansion, found around 25 km/s (Goldes et al., to be submitted).

3. Observation of the Milky Way

About 150 fields have been already observed, which is about 70% of the planned program.

We selected interesting areas along the plane of the Milky Way between Galactic longitudes l = 280° and l = 350°. Fig. 2 shows the selected areas with the parts already covered.

These areas were selected according to their richness in HII regions (Hα or radio recombination lines) and to their strategic position for determining the number and position of the spiral arms encountered along the line of sight. Let us recall that the distances of HII regions may be obtained from their radial velocity, using a model of Galactic rotation adjusted with the

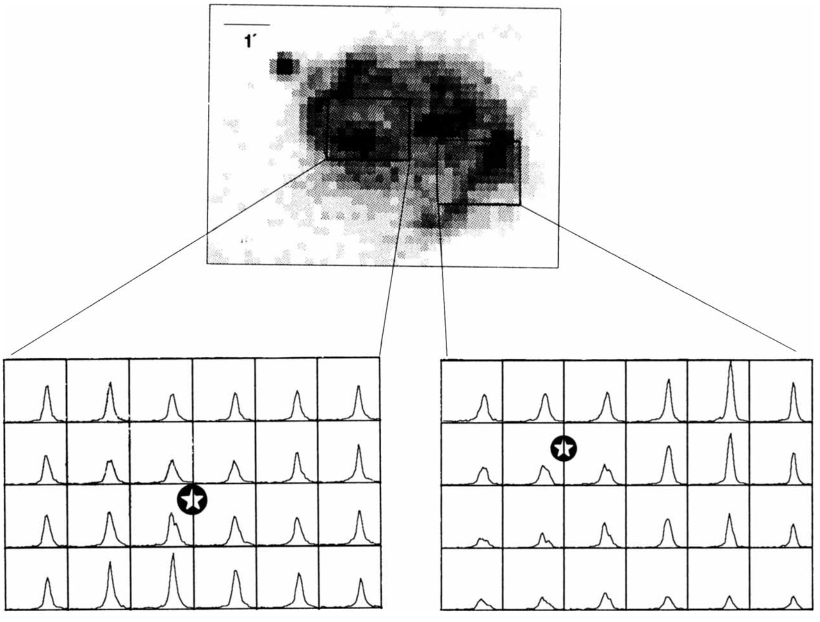

Figure 1. Profiles of the [O III] line observed in the bubble N11B (LMC) showing splitting produced by stellar winds around O3 III stars. The above monochromatic [OIII] image shows where the profiles come from. Each square contains a profile obtained over 2 x 2 pixels (covering 18" x 18").

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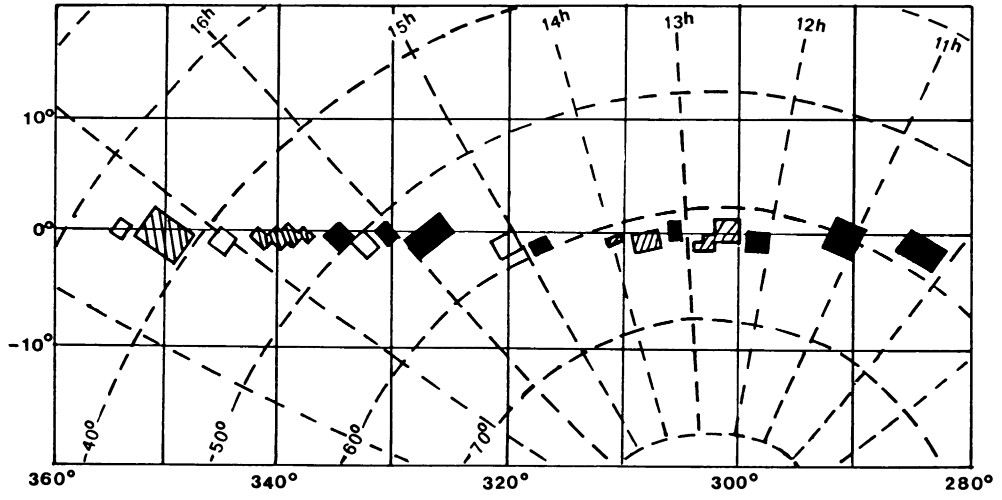

Figure 2. Map of the selected areas of our Hα Survey of the Milky Way. The areas already covered are shown black, those partly covered are shown hatched and those to be covered are shown white.

stellar distance of exciting OB stars. The complete coverage of large areas enables us to study not only the individual HII regions but also the diffuse emission of ionized hydrogen in between and thus, by continuity, to separate the large complexes designing the spiral arms.

This study, led in connection with radio results about ionized hydrogen and associated molecular gas, should allow us to determine and complete the four spiral arms model of the Milky Way suggested by Georgelin & Georgelin (1976) and now widely accepted.

About 20 fields are necessary to cover a mosaic such as the one shown in Fig. 3. It takes a long time for extracting the most useful information from the amount of data provided by this type of survey. This mosaic extends between l = 289° and l = 292° and contains several HII regions. The line of sight intercepts all along the Carina spiral arm, thus encountering HII regions at much different distances (from 3kpc to 9kpc). Typical examples of the Hα line profiles are given in Fig. 5 of Amram et al. (1991). Several velocity components may be clearly identified. The main one, at V_{lsr} = -25 km/s is related with NGC3576 and is found all over the mosaic, at a distance of some 3kpc. Other components are found at about 5 km/s, 15 km/s and 22 km/s corresponding to increasing distances along the Carina arm.

This example clearly shows the interest of this Survey. Compared with radio observations the advantage is evident, since the recombination lines of ionized hydrogen have been observed by Caswell & Haynes (1987) with a 4.4′ wide beam at the location of the maxima of continuum sources, that is to say in 11 points of the mosaic only, whereas we observe the Hα line all over the mosaic with a 9" wide pixel.

Our Survey confirms the radio velocities and extends our knowledge of the velocity field all over the observed area in a continuous manner.

Some typical results are mentioned in what follows:

1) optical detection of many radiosources (detected through radio observations of the 6cm H109α

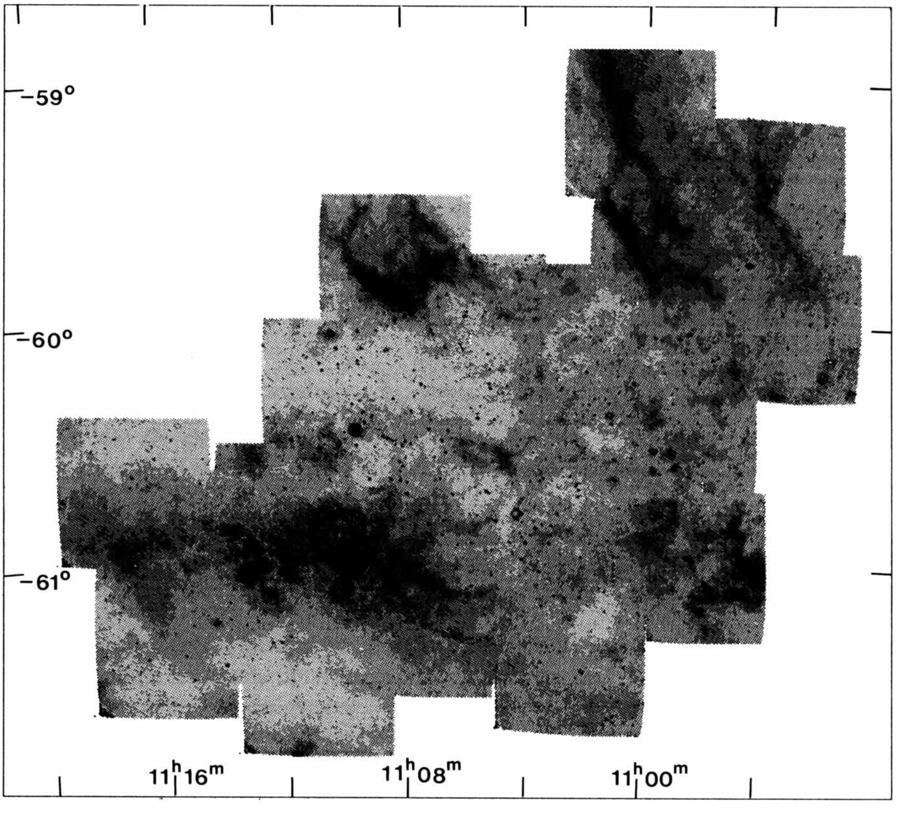

Figure 3. Mosaic of Hα fields at Galactic longitude l = 290°. The continuum emission is not subtracted here, so that stars remain visible as well as their parasitic reflections for the brightest ones. NGC 3576 is the brightest HII region in this mosaic (at coordinates 11h10mn and -61°).

hydrogen recombination line).
The farthest such HII region has been found at l = 303° with a distance around 12 kpc, on the distant part of the Carina spiral arm (Le Coarer et al. 1992);

2) separation of different spiral arms seen along the same line of sight owing to the velocities (e.g. at l = 328° as explained in Fig. 4 of Amram et al. 1991);
3) detection of faint diffuse Hα emission often overlooked when appearing along the same line of sight as brighter emissions from other HII regions. In such cases the detailed study of the line profile over the entire field of view is the only way to distinguish the different components, some of them appearing only at a few places;
4) detailed kinematical study in star forming regions.

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