OBSERVATION OF THE LARGE SCALE STRUCTURES OF DARK CLOUDS

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1. INTRODUCTION

Owing to the drastic progress in infrared and radio observations of molecular cloud cores, the scenario of starformation seems to have been almost completed. However, the study of dark clouds as a whole, which is a stage of the starformation drama, is observationally insufficient. In order to understand the environment of a starforming region, it is important to study the large scale structures of dark clouds. And that gives the information about formation and destruction mechanism of dark clouds.

2. OBSERVATIONS AND ANALYSIS

As the observed areas we chose: a) the region along the Gould belt (which includes the ρ Ophiuchi region. Orion, the Monoceros region, etc.), b) a high galactic latitude region that includes reflection nebulae (Sandage 1976, Tomita 1985), and c) some other regions near the galactic plane. Table 1 shows these observed areas.

The observations were made using the 40/70/120cm Schmidt telescope at Ohuda Observatory. This telescope is equipped with an autoguider system (Ohtani *et al.* 1983). We took about 300 direct plates for starcounts, each plate has a field seven degrees free of vignetting. The emulsion is Kodak 103aD and the filter is Hoya Y50, so the observed wavelength band is V. The exposure time was about 30 minutes and the limiting magnitude is about 16.

We adopted the general starcount method (Bok 1973), because this method is a very simple and poweful tool to search for extended low extinction objects. The starcount work was carried out on the image screen of the projector by naked eye. According to Rossano *et al.* (1980), we chose the most suitable grid size for which the star number became about 50. So the resolution of the obtained extinction maps varies as a function of the grid size. We set the comparison area in the counted field for every plate, and converted the star number n to the extinction value A_V using the following formula $n/n_0 = N(m_1 - A_V)/N(m_1)$

Table 1. The List of the Observed Areas

Observed Region	Position	Area (square degrees)
High galactic latitude cloud region around celestial north pole.	$l = 90° \rightarrow 160°$ $b = +10° \rightarrow +50°$	2,000
Orion - Monoceros	$\alpha = 3^h \rightarrow 7^h$ $\delta = -15° \rightarrow +15°$	1,200
Taurus - Perseus	$\alpha = 3^h \rightarrow 5^h$ $\delta = +15° \rightarrow +40°$	400
ρ Ophiuchi	$\alpha = 16^h \rightarrow 17^h30^m$ $\delta = -5° \rightarrow -25°$	400
Cygnus	$\alpha = 19^h40^m \rightarrow 21^h30^m$ $\delta = +25° \rightarrow +55°$	500
IC 1396	$\alpha = 21^h38^m$ $\delta = +57°$	40
M8/M20	$\alpha = 18^h3^m$ $\delta = -24°$	4

where, n_0 is the average star number in the comparison area, and N(m) is the number of stars brighter than m magnitude per square degree (we adopted the data of Allen (1973) for N(m)).

3. RESULTS AND DISCUSSION

The figures show examples of the obtained extinction maps. In the Orion region (Figure 1) there are 10 arc or shell structures of dark clouds, like for example the large shell around λ Orionis. This shell has a diameter of 70 pc and a total mass of $2\times10^4 M_\odot$, and is thought to be formed by the activity of the λ Orionis OB association which contains one O8III star (λ OriA), and about 10 B type stars.

Since there are 10 shells in the volume of 250^3 pc^3, the shell number density becomes 640 kpc^{-3}. Meanwhile, in the whole of our galaxy, if we take the supernova frequency as one supernova in 30 years, and a lifetime for the shell of 10^6 y, the supernova shell's number density becomes 20 kpc^{-3}. This fact shows that in the Orion region, supernovae, stellar winds, and H II region fronts, can trigger the next generation of starformation succesfully.

Especially, for the M8/M20 region (Figure 2), we counted on a SERC I band survey film, so the resolution is about 1 arcminute. Filamentary structures surround some starforming regions. These filaments show arc like structures, and as a whole, they show a large irregular ring struc-

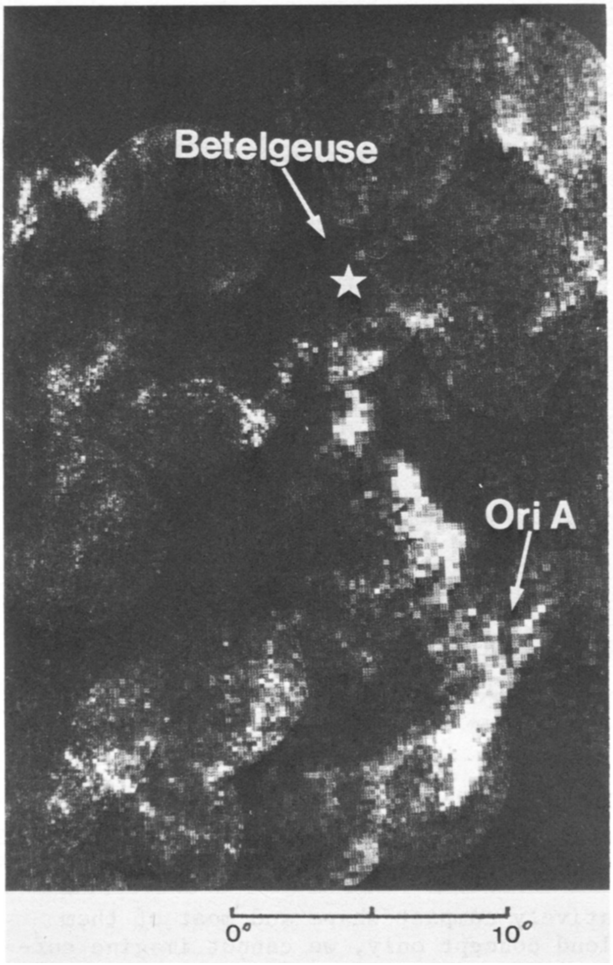

Fig. 1. Extinction map of the Orion-Monoceros region by starcount. Bright part shows the heavy obscuration. On the average the resolution is 7.5 arcminutes.The coincidence with the IRAS image is very good.

ture. Its size and mass are 40 pc and $5\times10^3 M_\odot$, respectively. This irregular ring may be due to the shocks from the complex starforming region.

The results on the morphology of the dark clouds are: Firstly, there exist many types of filamentary dark clouds. (1) Filaments or globular filaments (sausage like fragmented) joining the large dark clouds. (2) Groups of filaments intersecting each other, with starformation occurring at some intersections; these starforming cloud knots at the intersections are not so massive, less than $10^4 M_\odot$. (3) Shell or ring structures; these structures seemed to be the intermediate forms between cloud and intercloud matter, and observationally, they correspond to the extended filamentary objects detected in the H I survey (Colomb *et al.* 1980) and in IRAS far infrared images rather than radio molecular line observations.

Secondly, there are many dark clouds that belong to the usual classification, that is: globule - dark cloud complex - and giant mo-

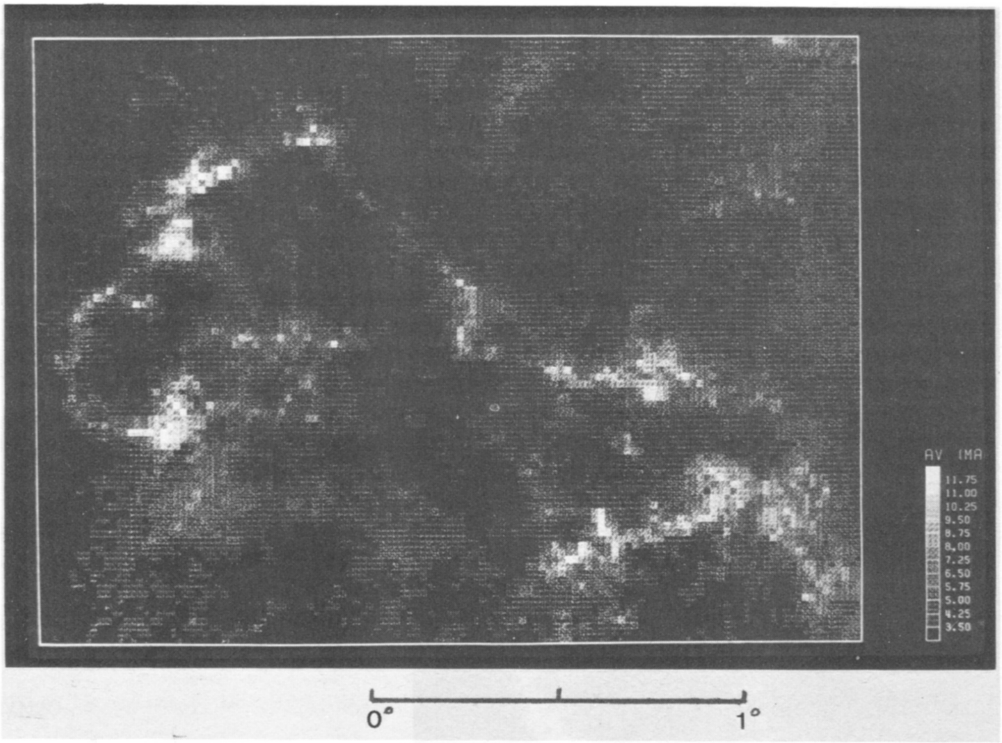

Fig. 2. Extinction map of the M8/M20 region. The resolution is 1.1 arcminutes. The H II region M8 is located in the fourth quadrant of this figure.

lecular cloud. They show a relatively compact shape and most of them have a dense core. From this cloud concept only, we cannot imagine sufficiently the scenario of cloud formation, development and destruction. Concerning this, we emphasize the importance of wide field observations of cloud interaction and large scale structure. And the discovery of filamentary structures must be explained in this connection by the dynamic activity of interstellar matter.

From the study of the Orion region, we can explain the origin of these filamentary structures by the three phase model of interstellar matter (Mackee and Ostriker 1979). The arcs and shells of dark clouds are the very late stage remnants of the activity due to H II regions, stellar winds, and supernovae. However, the destruction and coallesence of these large shell-like structures are very complex phenomena related to the gravitational and magnetic fields. For example, Miyama (1985) has done a beautiful theoretical work on the fragmentation of a sheet like cloud.

REFERENCES

Allen, C.W.: 1973, Astrophysical Quantities (Athlone Press: London).

Bok, B.J., and Cordwell, C.S.: 1973, In Molecules in the Galactic Environment, eds. M.A. Gordon and L.E. Snyder (Wiley: New York).

Colomb, F.R., Poppel, W.G.L., and Heiles, C.: 1980, Astron. Astrophys. Suppl. Ser. 40, 47.

Mackee, C.F., and Ostriker, J.P.: 1979, Astrophys. J. 218, 148.

Miyama, S.: 1985, IAU Symposium No. 115 (this book).

Ohtani, H., Ichikawa, T., Sasaki, T., Saito, K., and Tsujimura, T.: 1983, Memoires of the Faculty of Science, Kyoto University, Ser. A, XXXVI, 291.

Rossano, G.S.: 1980, Astron. J. 85, 1218.

Sandage, A.: 1976, Astron. J. 81, 954.

Tomita, Y.: 1985, Proceedings of the 3rd Asian-Pacific Regional Meeting of the IAU.

MONTMERLE: Regarding "intersecting filaments". Are some of these intersections real, or are they just a perspective effect on a given line of sight? If they are real, do you have a suggestion as to their origin?

TOMITA: I think that there are two types of intersecting filaments: a) real intersections which are due to interactions between a SN shell and a filamentary cloud, we can see an example of this type in the Taurus region; and b) apparent intersections produced by projection effects without any physical connection.

MEASUREMENT OF MAGNETIC-FIELD STRENGTHS IN MOLECULAR CLOUDS: DETECTION OF OH LINE ZEEMAN SPLITTING

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We report here the first results of an extended program to measure magnetic-field strengths in interstellar molecular clouds. The very large radio telescope located near Nançay, France, has been used to measure the Stokes-parameter I and V spectra of the 1665 and 1667 MHz lines of OH in emission and in absorption from extended (non-masing) molecular clouds. Signals in the V spectra are produced by Zeeman splitting of the spectral lines; we derive magnetic-field strengths or limits from these data.

Zeeman splitting of OH lines in absorption was certainly detected toward two sources and probably toward a third. Definite detections