NEAR-INFRARED IMAGES OF THE SERPENS MOLECULAR CLOUD CORE

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ABSTRACT:

Near-infrared images of the Serpens molecular cloud core have been carried out at UKIRT (Mauna Kea Observatory) using the infrared array camera, IRCAM. A large-scale diffuse nebulosity extending over the central part of the core is observed. Over 100 K-sources are detected in the 30 arc min^2 cloud core. Some of them are PMS objects which were previously unknown. For the first time, a near-infrared counterpart of the far-infrared source Serpens FIRS1 has been detected. The 2.2 μm source appears as a point like object at the apex of an extended knotty, jet-like nebulosity oriented towards the northwest. In addition, a group of 11 stellar objects is seen in the position of the IR/radio source SVS4. These objects are embedded in a very faint nebulosity and form one of the densest clustering of young stars found in dark clouds.

1. Introduction

Studies of young stellar associations or clusters still embedded in their parent molecular clouds are in many respects of fundamental interest for star formation theories. In the optical, these kinds of studies have been limited to the brightests members of the stellar aggregates, for the extinction produced by the interstellar material of the cloud is very high. A usual way to avoid this inconvenience has been the use of infrared techniques. In the infrared the extinction is considerably lower than in the optical, allowing us to penetrate deeper in the dark cloud environments. In addition, many of the stellar objects embedded in the clouds are still in pre-main sequence evolutionary stages or are surrounded by dense circumstellar dusty envelopes; in both cases it is expected that they mainly radiate in the infrared.

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The young stellar population embedded in several dark clouds, e. g. Taurus, Chamaeleon, Ophiucus, has been succesfully studied in the infrared up to typical limiting magnitudes K $\sim$ 11-12 mag. The recent advent of infrared arrays enables us to extend these studies to considably higher sensitivity limits and, consequently, to penetrate deeper in the cloud and detect objects of much lower luminosity. In this way, parameters like luminosity function, star formation efficiency, etc., can be estimated in a more reliable manner.

The Serpens dark cloud is a well known star-forming region. Observations at near-infrared wavelengths have been carried out by Strom et al. (1976), Churchwell and Koornneef (1986) and Gómez de Castro et al. (1988). The latter authors found that at least 12 young objects are embedded in the 3.3 arc min radius dense cloud core and suggested the likely existence of other undetected members of the Serpens young stellar aggregate. In this work we briefly describe the results of a near-infrared study of the Serpens core using the infrared camera IRCAM at UKIRT. A complete description of our results will be given in a forthcoming paper (Casali and Eiroa, 1989).

2. Observations

JHKL' infrared images of the Serpens core were carried out in April 1988 using the infrared camera, IRCAM, of the United Kingdom Infrared Telescope (Mauna Kea Observatory). The camera is equipped with a 58x62 detector array. 30 frames of $\sim$1'x1' at each wavelength were obtained, thus covering the whole Serpens core. The scale used was 1.2"/pixel and the limiting magnitude of the observations is K $\sim$17 mag. Details will be given in Casali and Eiroa (1989).

3. Results

New and unexpected aspects of the Serpens core are revealed by the infrared images. These are connected with the diffuse medium of the cloud and with the young population of stars.

A large-scale, diffuse nebulosity embedded in the core is detected at K. It extends from the north of the Serpens bipolar reflection nebula to the south in the direction of the source SVS4. No hint at all of

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this nebulosity is seen in the very deep 0.9 μm images of Gómez de Castro et al. (1988). The nebulosity coincides quite well with the south-east region of the NH_3 and far-infrared emission (e.g. Zhang et al., 1988).

130-140 stellar objects are detected in the observed area. Only around 30 objects are known from previous optical and infrared works. Many of the new stars are likely background stars, but in some cases the infrared images indicate that they are Serpens embedded objects. Three new cometary-like nebulae have been detected. One of them is located towards the north-west of the Serpens reflection nebula and the two others towards the south of this latter object. Interesting is that the new cometaries are approximately oriented in the SE-NW direction, reinforcing the alignment of young objects within the Serpens core noticed by Gómez de Castro et al. (1988).

Perhaps the two most interesting objects discovered by the infrared images are related with the sources Serpens FIRS1 and SVS4. They are the only sources of the cloud where radio continuum emission has been detected (Rodriguez et al., 1980), and in both cases the luminosity deduced from the radio observations is much larger than the total infrared luminosity (Snell and Bally, 1986).

An extended jet-like nebular object with a point source located at its south-east apex is detected at the position of FIRS1. This is the first time that an object is detected at this position at wavelengths shorter than the far-infrared range. The nebulosity is oriented in the SE-NW direction, as other Serpens young objects are. The source is only observed at 2.2 μm; it is probably a reflection nebula embedded in the core, the illuminating star being the point source at the south-east end. We cannot excluded, however, the possibility that shock excited molecular hydrogen is contributing to the K nebulosity.

The frames taken at the position of the source SVS4 reveal a group of 11 objects surrounded by a very faint nebulosity. The IR colours of these stars show an IR excess. Thus, we suggest that they are members of the Serpens young star population. Taking into account this result, the number of PMS objects in the Serpens core is multiplied by a factor of two and, consequently, the star formation efficiency and the stellar mass density are increased considerably with respect to the estimate by Gómez de Castro et al. (1988). In addition, the SVS4 stars are grou-

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ped in a region of projected size $\sim 40''$ (~ 0.05 pc after the distance estimate of Chavarría et al., 1988), and therefore they represent one of the densest clustering of young stars found in dark clouds.

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References

Casali, M., Eiroa, C.: 1989, in preparation
Chavarría-K, C., de Lara, E., Finkenzeller, U., Mendoza, E., Ocegueda, J.: 1988, Astron. Astrophys. 197, 151
Churchwell, E., Koornneef, J.: 1986, Astrophys. J. 300, 729
Gómez de Castro, A. I., Eiroa, C., Lenzen, R.: 1988 201, 299
Rodriguez, L. F., Moran, J. M., Ho, P. T. P., Gottlieb, E. W.: 1980, Astrophys. J. 235, 845
Snell, R. L., Bally, J.: 1986, Astrophys. J. 303, 683
Strom, S. E., Vrba, F. J., Strom, K., M.: 1976, Astron. J. 81, 638
Zhang, C. Y., Laureijs, R. J., Clark, F. O.: 1988, Astron. Astrophys. 196, 236

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