Near-Infrared Photometry of Protostars

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The Programme

For several years our group at Stockholm Observatory has been involved in a far infrared study of star-forming regions. This project, which is performed in collaboration with the University of Groningen in the Netherlands, consists of mapping molecular clouds, where we have indications of star formation, with a two-channel photometer. The photometer is fed by a 60 cm telescope which is carried to 35 km altitude by a helium-filled balloon. The two channels of the photometer are sensitive between 60 and 200 microns. In the clouds we are studying there are objects strongly believed to be protostars. These stars heat up the dust surrounding them, and the dust then reemits the stellar radiation at far-infrared wavelengths. In this way we can study this type of very young objects although they are totally obscured in the visual part of the spectrum. We have studied several objects in which known near-infrared (1 to 5 microns) sources are lying. In fact we used the existence of near-infrared sources as one of our indicators for on-going star formation. The balloon data made it possible to assign an accurate total luminosity to each of these sources.

Studies of T-Tauri stars have shown them to be variable, and since these stars are supposed to be low-mass young objects one would assume that even younger stars also should be variable, on a timescale that could be hours, days or years. A search for this variability would have to be done in the near infrared, since the sensitivity of the far-infrared photometer is not sufficient to spot any change less than a factor two in luminosity. All this is valid for low-mass stars, and it is not known if high-mass protostars also show variability, but since we had observed both high and low-mass sources with the balloon telescope, we decided to make a near-infrared study of these objects. In order to search for variations, we set up a programme where we would use the 1 m photometric telescope on La Silla to observe about 10 objects which met the following conditions. First, old near infrared observations should be available, so we have something to compare with, on a long timescale (a few to about 10 years). Secondly, they should have been observed with the balloon telescope so that we know the luminosity of the source and therefore its mass. In order to spot short timescale variations (hours, days), we decided to observe each object several times every night. The programme should also be repeated about a year later to search for further possible changes.

Observations and Results

The observations were performed in November 1980 and December 1981, each observing period consisting of 7 nights. We were lucky with the weather and lost only 2 of them. Reduction of the observations was made at Stockholm Observatory, with a software package developed by Dr. P. Lindroos. Preliminary reductions of the data showed that the mean extinction coefficients at La Silla (1) could be used and this gives us an estimated error in the K filter (2.2 micron) of 0.05 magnitude. Some of the results are presented in Table 1. The values given there for 1980 and 1981 are mean values of all observations in these years. Regarding short timescale variations we cannot conclusively prove anything. In several cases there seems to be a variation of the order of 0.1 magnitude in the span of one day, but since our error in K is only half that value, such a variation cannot be ascertained unless more accurate observations are performed, which means the use of the 3.6 m telescope. However, on the long timescale the situation is different. As can be seen from the table, several of the sources have varied significantly. This strengthens the case that we are here observing young objects. Both Rosette IRS and NGC 2264 IR, according to our balloon observations, are high-mass objects, and there seems to be a significant variation over the timespan of a few years.

Another part of the project was mapping in the K-band several areas where we would expect to find protostars from other indications, such as proximity to Herbig-Haro objects and CO temperature peaks. Several sources not previously reported in the literature were found, and the analysis of this part of the project is still taking place.

TABLE 1.

Object	K(1980)	K(1981)	K(Previous)	Ref
I1551 IRS5	9.43(6)	9.52(7)	8.94(10)	2
HH 1 CS-star	8.10(2)	8.26(1)	8.20(1)	3
Rosette IRS	6.99(1)	7.00(1)	7.41(20)	4
NGC 2264 IR	5.21(1)	5.18(3)	4.88(6)	5

Table 1: *The values listed are magnitudes in the K filter. For the 1980 and 1981 numbers, the digit within parentheses is the standard deviation in units of 1/100 of a magnitude. The column "K(Previous)" gives values that have been found in the literature as marked by the column Ref. The numbers in parentheses here are the quoted errors cited.*

References

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A New Infrared Telescope

An important facility for Italian astronomy has been formally inaugurated on October 15, 1982 with the presence of the President of the National Research Council, E. Quagliariello, the Director General of ESO, L. Woltjer, H. Debruner on behalf of the Hochalpine Forschungs-Stationen and various other Italian and Swiss authorities. The new 1.5 m Cassegrain telescope is located on the Gornergrat (3,150 meters). The site can be easily reached from Zermatt by train under almost any seasonal condition. This point was proven on the day of the ceremony when an intense, early-fall snow storm amused and shocked some participants, at least those coming from sunny Italy!

The project to build this instrument arose within the Italian scientific community in the 70s and was well supported by C.N.R. A working group led by C. Occhialini-Dilworth and O. Citterio with participants from various institutions (Milano, Bologna, Firenze, Roma) led to the completion of the telescope in 1979. Its optics and mechanics were optimized in order to take full advantage of the site excellence for infrared work. Indeed, the statistics indicate that especially in the winter period the