OH/IR Sources as an Example of a Successful Simultaneous Radio and Infrared Programme

Drs. E. Kreysa, G.V. Schultz, W.A. Sherwood and A. Winnberg from the Max-Planck-Institut für Radioastronomie (MPIfR) in Bonn have during the last two years simultaneously observed OH/IR sources at the 100 m Effelsberg and the 1 m ESO telescopes. G.V. Schultz reports about the results which open the door to further exciting investigations:

In the *Messenger* No. 6, September 1976, W.A. Sherwood reported on the successful discovery of infrared counterparts of type II OH/IR sources previously found in the Onsala OH survey by A. Winnberg et al. The frequency of discovering the IR counterparts was about 50 % at that time. In the meantime our detector has been improved in sensitivity by E. Kreysa and our frequency of detection with the new photometer has risen to 80 % of a sample of 40 OH sources without having to use a larger telescope.

However, we are now limited at 3.7 μm (by background radiation) to 9^m with a signal-to-noise ratio of one in one-second integration time and only a larger telescope can increase the discovery rate. On the other hand at 2.2 μm we improved the sensitivity in August 1977 to $11\overset{m}{.}7$ and still we are not at the background limit, i. e. we can improve the sensitivity between 1.2 μm and 2.2 μm without using a larger telescope. This value of $11\overset{m}{.}7$ allows us to estimate the limiting magnitude for a 15-min integration time to be $15\overset{m}{.}4$ or with the 3.6 m telescope to be $18\overset{m}{.}2$ between 1.2 and 2.2 μm in the absence of source confusion.

Having discovered an infrared source near the position of an OH source, one cannot be certain that it is really the IR counterpart of the OH source due to the positional errors of the radio and optical telescopes. Hence, we began to observe 15 out of these type II OH/IR sources two years ago simultaneously or quasi-simultaneously at the 100 m telescope in Effelsberg and the 1 m ESO telescope, approximately every 6 months. What we found is not only interesting but, in one point, extremely exciting. First, there is a general correlation between flux changes in the OH lines and in the IR band. This confirms our identifications of the IR sources as the counterparts of the OH sources. Second, we can determine different phase lags between the 1612 MHz line, the 1667 MHz lines and the IR radiation and third, we have found that there is also a phase lag between the high and the low velocity components of the 1612 MHz line of about twenty days.

The simplest model is a long period variable M star which is surrounded by expanding dust and molecule shells. All changes in flux of the star caused, for example, by variations of the surface temperature arrive at the same time at the shell, if the shell has spherical symmetry (not required in a more detailed study) with the M star at the centre. The excited OH radiation, however, has different travel times to reach the observer depending on whether it comes from the front or the back sides of the shell. A phase lag of 20 days means that the radiation from the backside requires 20 days to cross to the near side and that the diameter of the OH-molecule shell has a value of $6 \cdot 10^{16}$ cm which is the first direct observational support for the value used in the calculations of Goldreich and Scoville (*Ap.J.* **205,** 144 and 384, 1976).

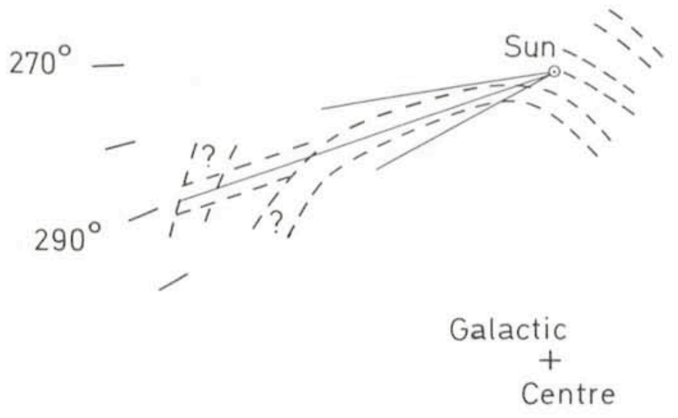
To determine the radius (or radii) of the shell, one has to measure the relative intensities of the two components carefully and many times during one cycle. This method also opens up the possibility of determining the distances of the sources if one combines the determination of the shell radii with interferometric determinations of the exact positions of maser points around the star. On the other hand, measurements of the energy distribution in the infrared wavelength region allow the temperature of the dust to be determined as well as the radius of the dust shell if the distance is known. By comparison of the radii of OH and dust shell, one may be able to see how the molecules and dust are distributed with respect to the star.

This example should show how valuable the combination of radio and IR measurements is.

Photometry of OB Stars in Carina

The spiral structure of our Galaxy has for many years been mapped by radio observations of the hydrogen 21-cm line. Similar optical observations are severely influenced by the absorbing interstellar matter in the plane of the Milky Way and we know comparatively little about the distribution of stars beyond some kiloparsecs. However, investigations of faint (and therefore mainly distant) hot OB stars in the direction of the Carina spiral arm now give a more accurate picture of this feature. Dr. Stig Wramdemark of the Lund Observatory in Sweden last year published the results of earlier observations at La Silla. He here gives an up-to-date summary of his latest observations:

The study of the spiral structure in our own galaxy is a very difficult task, primarily because of our position near its plane. From studies of other spiral galaxies it is found that good spiral tracers (i. e. objects that outline the spiral arms) are OB stars, H II regions, long-period Cepheids, late-type supergiants and Wolf-Rayet stars. A study of these young stars in our own galaxy shows that we are situated on the inner side of a spiral arm, the Local arm. The most conspicuous arm in the northern hemisphere is the Perseus arm, situated 2–3 kpc outside the Local arm. In the southern hemisphere the Sagittarius arm is probably connected with the Carina arm. A thorough study of more than 400 OB stars brighter than $V \approx 11.5$ in Carina was made by Dr. John Graham (*Astron. J.* **75,** 703). The stars have distances between



Geometry of the Carina spiral feature. The three directions in which observations were obtained are indicated on the figure.

1 and 8 kpc from the Sun. He also found that we are looking along the Carina arm at galactic longitude l ≈ 290°.

During three observing runs at La Silla (1974, 1976 and 1977) I studied some fields in the Carina direction. One area at l = 280° is situated just outside the Carina arm, another (l = 290°) contains objects belonging to the arm, and a third area (l = 298°) cuts through the arm.

Only OB stars were studied, since they are by far the most numerous ones and consequently the best for statistical treatment. Furthermore, their luminosities and intrinsic colours are fairly well known. The OB stars were measured in UBVβ. To discover fainter stars than those investigated by Graham, three-colour photographic survey plates were used for detection (U, B and V exposures were made on the same plate with slight displacements between the exposures).

Two fields along the arm, one in the plane and the other one degree below it, were examined. The results (*Astron. and Astrophys. Suppl.* **23,** 231) show that there are OB stars in both areas with distances from 1.5 to 15 kpc. About 40 of them are situated between 10 and 15 kpc. One may ask if these stars are members of the Carina arm, or if the arm bends inwards at a distance of about 6–9 kpc, as suggested by some investigators. Another possibility is that these stars are members of an outer arm as found from 21-cm radio data. This arm could be an extension of the Local arm or of the Perseus arm. It seems clear that the interstellar extinction does not increase very much from 2 to 6 kpc. Thus, in spite of the large number of young stars, practically no absorbing matter is found. An increase of the matter density occurs suddenly at 6 kpc. The increase is more pronounced in the plane than below it. This could partly explain why several investigators suggest a bending down of the Carina arm at larger distances.

A maximum of OB stars between 2 and 4 kpc displays the position of the Carina arm in the direction l = 298°. Very few stars have distances less than 1.5 kpc, which means that no connection is found between the Local arm and the Carina arm in this direction.

At l = 280°, on the other hand, a large number of OB stars were found within 1 kpc from the Sun, and the density of absorbing matter is comparatively high. This region is probably a part of the Local arm.

To get more information about the positions of spiral arms in our galaxy, the measurements of OB stars should continue. Furthermore, the spectra of some stars should be examined. In each of the studied areas there are stars with extremely high colour excesses. There may be a reason that cannot be explained from UBVβ photometry. There is another group of stars warranting a more careful examination. These come out with distances larger than 10 kpc, and since their galactic latitudes are higher than 2°, I derive distances from the galactic plane larger than 350 pc. Implicit in the reasoning is the assumption that the stars have luminosities of normal OB stars. That assumption cannot be refuted from UBVβ studies alone.

Three New Comets

The ESO 1 m Schmidt telescope has been involved in the discovery of three new comets since the last issue of the *Messenger*. One, P/Comet Schuster (1977o) is a "real" ESO comet; the two others, P/Comet Chernykh (1977l) and P/Comet Sanguin (1977p) were confirmed with this telescope, after they first had been sighted in USSR and Argentina, respectively.

Periodic comet Chernykh was found by soviet astronomer Dr. N. S. Chernykh at the Crimean Astrophysical Observatory on August 19, 1977. It was some time before the news reached La Silla, via the Bureau of the International Astronomical Union in Cambridge, Mass., USA. At that time the Moon had moved very close to the comet's expected position, but Dr. H.-E. Schuster still managed to get a 7-minute exposure on August 31, 1977, when the Moon was only 15° away. This was done on red-sensitive emulsion (098-04) behind a red filter (RG630) to reduce the influence of the moonlight. The plate confirmed the existence of the comet and helped Dr. Brian Marsden to compute the orbit, an ellipse with an orbital period of 16 years.

The discovery of periodic comet Schuster on October 9, 1977 brought the total of comet discoveries at ESO to four over a period of less than three years. Dr. Schuster noted the fuzzy trail on a plate, obtained under bad seeing condi-

Figure 1. — *Comet Chernykh (1977l) photographed with the ESO Schmidt telescope on August 31, 1977. Red-sensitive 098-04 emulsion behind RG630 filter. Exposure time 7 minutes.*