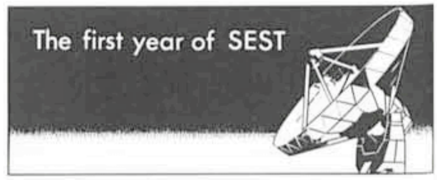
tween each dumped profile is 12 seconds, which results in an angular resolution of about 6″. This should be compared with the 46″ beamwidth of SEST at 110 GHz. The corresponding restored strip brightness distributions are seen in Figure 6, showing both sources to be double. The combination of all the strips should yield 5″-resolution maps of the two-dimensional brightness distributions of ^{13}CO isotope in Sgr B2 (N) and (M).

SN 1987 A and other Bolometer Observations at 1.3 mm



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Introduction

During August/September 1988 the bolometer group of the MPI für Radioastronomie, Bonn, visited SEST to perform continuum observations at 1.3 mm. It was the first observing time of our group at this telescope and the first sensitive test for SEST at that wavelength. The submm qualities of La Silla were another uncertainty in the mission so that it seemed more than questionable whether any astronomical data would come out of our run.

We started on August 24 to install our bolometer in the receiver cabin of the telescope. This action turned out to be quite an adventure because the access to the cabin door – 9 m above the ground – is only possible from outside via a ladder or a hydraulic platform (cherry picker). During the observing run we had to use the "cherry picker" each day in order to take the cryostat with the bolometer from the telescope, bring it back to the ground and refill with Helium. The ladder was also used very often because receiver alignments and all kind of trouble-shooting in the cabin had to be interrupted at least four times a day to experience La Silla's famous cuisine.

Sub-Millimetre Observing Conditions

The sub-mm-transparency of the atmosphere is – as in the infrared spectral region – confined to a few windows. Most of the radiation is absorbed by the water vapour content of the atmosphere so that dry sites of high altitude are ideal for observations of that kind. The first measurements of the atmospheric transmission on La Silla at 1.3 mm with SEST were quite surprising because we faced conditions as good as those on the 4200 m volcano Mauna Kea in Hawaii, the world's most famous sub-mm site. However, the joy lasted for only a few hours and then we had – despite blue skies – 9 days of only moderately good sub-mm observing weather. Together with the SEST team we used this time to test various properties of the telescope like pointing, tracking and the accuracy of the 15 m diameter surface. The short observing wavelength of 1.3 mm and the superior sensitivity of our bolometer system enabled us to detect telescope errors much more efficiently than with existing receivers at SEST. We located encoder problems which caused tracking errors and found a misalignment of the subreflector that distorted the beam shape.

Unfortunately, SEST was not yet equipped to record our continuum data by the telescope computing system and no on-line reduction of the signals was possible. Likewise, our own PC data acquisition was too busy with taking data so that the strip chart records were the only way of monitoring the observations. Just as we had finished the technical tests and had most of our problems under control, heavy clouds came in and stopped further astronomical activities during the next 4 days. This was the opportunity to summarize our experience with SEST and to discuss further observations that could be reasonably done with the present state of the system. The telescope performance had turned out to be still inferior to what it was supposed to be; any efficient observing procedure was extremely difficult because of the lack of corresponding on-line reductions. Daytime observations were severely limited by an increased turbulence of the atmosphere which resulted in an overall sensitivity-loss of the system. In addition, the reflecting aluminium surface of the telescope had once burnt the subreflector, so we had to avoid the sun by an angle of 60 degrees and, as a consequence, could not reach many interesting objects. In view of all these limitations, the bad weather and the knowledge that only a few days of telescope time were left, a feeling of disappointment set in whenever the dining room was closed.

Observations – At Last!

Finally, it cleared up, the relative humidity dropped below 15 % and the average temperature fell to 3° C, much below the previous values. During the last three days we experienced excellent sub-mm conditions and started with astronomical observations. To observe faint sources with a radio or a sub-mm telescope it is essential to determine the pointing of the telescope by means of nearby strong sources with well-known positions. For that purpose we observed a sample of quasars well distributed across the southern hemisphere and selected those which were strong enough at 1.3 mm, to establish a system of pointing calibrators.

It must be noted of course that all these measurements were new for the southern hemisphere and tell quite a lot about the physical properties of the quasars: Their 1.3 mm radiation is due to fast moving electrons (synchrotron radiation). From the intensity of the emission (in combination with other radio data) one can learn about the energy of the electrons, the strength of the magnetic fields and even about the size of the emitting regions.

The sub-mm emission of most other objects, however, is – as in the near and far infrared spectral region – thermal in origin and comes from interstellar dust that is heated by nearby stars. In particular, star-forming regions are strong emitters of sub-mm radiation because young stars there are deeply embedded in dust clouds. The light at optical and infrared wavelengths is completely absorbed by dust and is re-radiated at longer, i.e. at far-infrared and sub-mm wavelengths. Thus, sub-mm emission is very often the only sign for star formation occurring in dense clouds.

Even more interesting is the search for "protostars", i.e. cool and dense objects of gas and dust which are still in a phase of gravitational contraction. Here it seems that sub-mm observations are the most promising way to detect these cool (≈ 20 K) precursors of stars. We mapped several well-known southern star-forming regions to determine the amount of gas and dust associated with them and to look for condensations which might develop into stars in the future.

Other prominent emitters of sub-mm radiation are external galaxies. Their stellar population heats the galactic dust to temperatures of 20 to 40 K. From the amount of dust one may calculate how much gas is contained in a particular galaxy. This quantity is very important because it finally determines how many stars can be created and how bright the galaxy appears in the sky. We observed a number of galaxies only accessible from the southern hemisphere in order to study the global star formation in these objects.

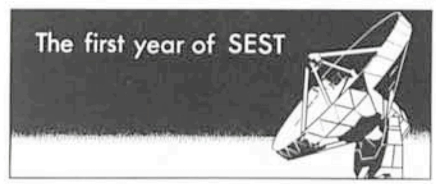
SN 1987 A Detected!

As mentioned above, observing conditions improved during the nights and they were best a few hours after midnight. That was the time when all colleagues had gone to bed and the Large Magellanic Cloud came into the field of view. Knowing all the limitations given by the imperfect performance of the telescope, on the one hand, but trusting in the excellent sensitivity of our bolometer, on the other hand, I "wasted" a few hours before sunrise and pointed the SEST towards SN 1987 A, the most spectacular event in the southern hemisphere. There was no idea at that time what signal could be expected from this object at 1.3 mm but everybody agreed that it must be extremely faint. In addition, at that time there had been no detections at wavelengths longer than 20 μm so that it was quite a challenge to try the supernova.

During the integration I was carefully watching the strip chart recorder. Sometimes, I had the impression that the pen moved in the right direction when the telescope switched from the source to the blank sky, but this could as well have been a product of my imagination. Nevertheless, after the third night of staring at the strip chart I was sure that there was a faint signal from SN 1987 A. Meanwhile our software specialists had reached a stage where they could reduce – to a limited extent – the bolometer signals from SEST. Of course, the first data I suggested looking at were those of the supernova. After a few hours, there was something to celebrate: we had detected very weak 1.3-mm emission from SN 1987 A of 29 mJy! To exclude a possible contamination by emission from the LMC, we observed two additional nearby positions, however, without any significant signal. This was the final proof that the observed flux was indeed coming from the supernova.

The origin of this radiation is not quite clear because both emission from hot dust as well as free-free emission from the ionized outer part of the former star may contribute. Combining our data with observations at other wavelengths we come to the conclusion that most of the 1.3-mm flux density is due to free-free emission; dust has formed in the former star's envelope and must be distributed in an extremely clumpy manner. Of course, it will be of interest to study the development of SN 1987 A at sub-mm wavelengths in the future and to verify this interpretation. Unlike in other spectral regions – SEST will be the only choice for that purpose in the southern hemisphere.

CO Observations of the Magellanic Clouds



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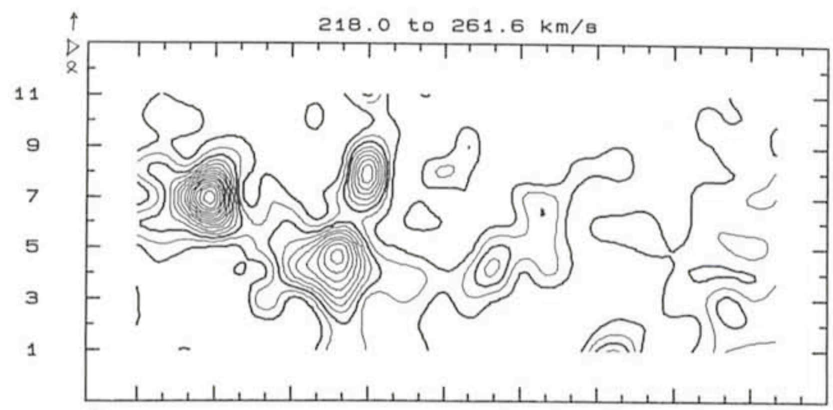
The commissioning of the SEST on La Silla has opened up a new era in the study of the interstellar medium in the Magellanic Clouds. With this telescope, for the first time extensive, detailed studies of the (CO) molecular component of the clouds has become possible. Previously, a rather limited number of sightlines had been sampled with resolutions of 1 to 2 arcmin (see review by Israel, 1984), and a CO map covering the whole LMC, but with a coarse resolution of 8 arcmin (125 pc) was obtained from Cerro Tololo (Cohen et al., 1988).

The SEST, with its 40 arcsec beam at the J = 1-0 ^{12}CO transition and its large aperture, yielding a high sensitivity, thus is a major step forward. It was immediately realized by ESO and by Sweden that a major target for the SEST would be the Magellanic Clouds, objects unique to the Southern Hemisphere, but that a systematic study would require a large block of observing time owing to the large angular dimensions of the Clouds (LMC: 720 SEST beams across; SMC: 180 beams across). This led to the designation of an ESO-Swedish SEST Key Programme 'CO study of the Magellanic Clouds', and the formation of a consortium headed by L.E.B. Johansson (Onsala) and F.P. Israel (Leiden) to conduct this programme.

The programme aims at a systematic study of the CO content of the Magellanic Clouds. Several aspects are of importance. Foremost is a determination of the CO to H_2 ratio, as H_2 is the major molecular component of the interstellar medium, thought to be present in galaxies in amounts comparable to those of H I. This ratio is almost certainly lower than Galactic in low-metallicity, UV-rich galaxies such as the Magellanic Clouds due to stronger photodissociation in such environments. Clue to this important ratio can be obtained from a comparison of (area, position) integrated CO intensities with



Map of the N 160/N 159 region in the LMC in the J = 1-0 ^{12}CO transition integrated over the velocity range 218 to 261 km/s. The two CO clouds slightly left of the centre of the map are associated with N 159. The bright CO cloud at the left is located in a visually inconspicuous region between N 159, N 172 and N 173. The much weaker CO cloud just right of the centre is associated with N 160 (from Booth et al., 1989).