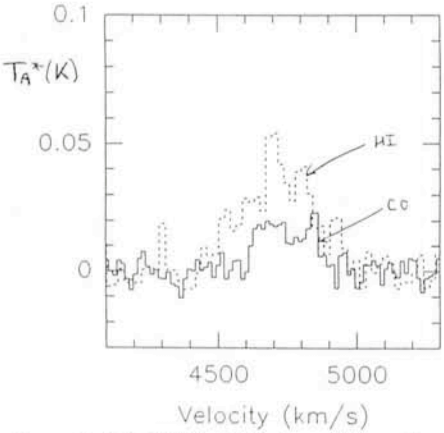

Figure 3: *NGC 7252: CO (1-0) and HI profiles towards this newly-born elliptical galaxy.*

merger between two equal-mass spiral galaxies, as suggested by its very perturbed appearance, with two tidal tails.

If the infrared luminosity L_{IR} is re-radiated by dust heated by the recent star formation, the ratio $L_{IR}/M(H_2)$ is an indicator of star-formation efficiency. These interacting and merging galaxies have the highest known ratios: $L_{IR}/M(H_2)$ of the order of 50 or greater, while it is of the order 1-3 in normal galaxies. There is also the possibility that a significant part of L_{IR} comes from dust heated by an active nucleus (in that case the emission region is highly confined towards the centre), so that the ratio $L_{IR}/M(H_2)$ is not a good indicator of star-formation efficiency. However, high $L_{IR}/M(H_2)$ ratios are still found in galaxies without nuclear activity.

The life time of the star burst can be extrapolated from these efficiencies. In time scales of a few 10^8 yrs, the merger remnants should become devoid of molecular gas. This result supports the currently well-developed idea that the merging of two spirals will form an elliptical galaxy, devoid of cold gas. An ideal object to test this hypothesis is the southern merger remnant NGC 7252, one of the pet galaxies of François Schweizer (1982). This object is conspicuous by its two tidal tails, that represent the "smoking gun" evidence of the merging of two spiral galaxies (Fig. 2). Numerous loops, shells and ripples add to the evidence. The luminosity profile is surprisingly regular and follows the $r^{1/4}$ law, characteristic of ellipticals, until a large distance. Yet this object was seen to be very rich in molecular gas (Dupraz et al. 1989): about $3\ 10^9\ M_\odot$, within 7 kpc. The observed line shape suggests that the CO emission comes from matter confined to a disk, which is also observed in Hα. This surprising result indicates that not all of the molecular gas is consumed in the star burst, as previously thought, or that matter continues to fall down onto the disk, long after the merging event.

At higher redshifts, the galaxies that can be detected in CO are all monsters: huge starburst galaxies, corresponding to interacting or merging objects, the frequency of mergers being probably higher in the past. The ultraluminous IRAS objects have luminosities larger than $10^{12}\ L_\odot$. Mirabel et al. (1988) have detected four of these monsters, possessing 1-6 $10^{10}\ M_\odot$ of molecular gas. Their $L_{IR}/M(H_2)$ ratio is between 20 and 80, much larger than in classic starburst galaxies, like Messier 82. The highest systemic velocity among these objects is 27,500 km/s, which demonstrates the ability of the SEST 15-m telescope to detect faint and broad emission lines.

This brief survey, far from exhaustive, already shows how exciting extragalactic work can be with the SEST 15-m telescope!

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Extragalactic Continuum Sources

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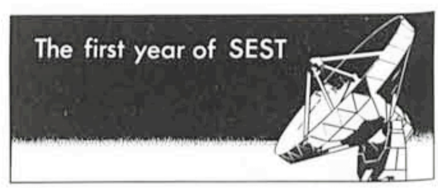

Introduction

As with most other high-frequency radio telescopes, continuum work occupies only a small fraction – currently about 5% – of SEST's total time. The importance of these observations in increasing our understanding of quasars and other extragalactic sources is, however, large.

The millimetre-to-IR observations probe the innermost parts of the radio-emitting regions of active galactic nuclei: the radio cores, possibly the beginnings of radio jets, become optically thin on mm-wavelengths, where also the outbursts reach their maximum stages. As these regions remain below the resolving power and above the standard frequencies of VLBI, high frequency flux measurements give us our only glimpses of the very cores, the still mysterious sites of energy generation and channeling in active galaxies. Long wavelengths ("long" in the case of quasars meaning everything longer than one centimetre) show only evolved structures, such as old, ejected knots; the millimetre regime is where the real action is.

Most events seen at centimetre wavelengths have their precursors on higher frequencies. This forewarning capacity is especially useful for space VLBI purposes in choosing the best "targets of opportunity" for observations. The millimetre spectrum and its variations can also tell if compact structure is present in the source, and whether it will be a good candidate for VLBI observations; with sufficient flux data it may even be possible to produce model maps of the sources. Clues to the nature of different radio sources must also be searched at high frequencies.

While SEST opens up completely new southern vistas, its location also presents some problems in continuum work. The continuum observer dreams of uninterrupted multifrequency light-curves revealing the various constituents and processes found in Active Galaxy Nuclei (AGN), but the reality usually shrinks to a scatter of isolated flux measurements. In most cases, one would greatly benefit from supporting data on other frequencies, but there are not many Southern telescopes available for that purpose.

SEST Measurements

During its first year SEST has been used for most of the purposes outlined above, with the continuum work divided roughly equally between Swedish and Finnish groups. Most of the data have been obtained at 90 GHz, although the groups have been striving to get also more 230 GHz observations.

The obvious starting point has been to get acquainted with the new part of the sky. Several surveys of the southern skies are now in progress. N. Whyborn is observing a complete sample of bright, flat-spectrum radio sources below declination −25°, and a similar survey between 0° and −25° is in progress by E. Valtaoja. These surveys are first steps in gathering basic knowledge of Southern hemisphere sources: their high frequency spectra, variability, degree of compactness, etc., data which can be used both for statistical studies and for selecting exciting individual objects as targets for future investigations.

Selected subsets of sources have also been observed: southern BL Lacs and highly polarized quasars (H. Teräsranta), radio quiet quasars (A. Kus), and sources observed in TDRS satellite space VLBI experiments (R. Booth). As the sources typically are observed at two or more epochs for variability estimates, most of the work is still in progress.

The Finnish group has used SEST to extend their long-time monitoring programme to higher frequencies. About 12 of the most active and well-known equatorial blazers have been observed roughly semimonthly in Chile. Although the "high" (i.e., Northern) declinations of some of these sources have caused some grumbling in the programme committee, the SEST data fill a crucial gap between lower frequencies (Metsähovi, Itapetinga, Crimea) and IR observations (Hawaii) in what remains the most extensive international effort to understand the radio behaviour of AGN. Multifrequency monitoring has made possible the separation of outbursts from the underlying other components, showing that shocked jet models give at least a first approximation of what is going on in variable radio sources. Much remains to be done, however: even the best observed quasar, 3C 273, continues to behave in a highly erratic and surprising manner.

Harri Teräsranta from the Metsähovi Radio Research Station summarizes the experience of the first year as follows: "90 GHz flux measurements are now relatively routine work. The actual rms levels achieved with 30 min integration times have been from 40 to 80 mJy. 230 GHz observations require good weather, and it would be better to have the observing run spread over a longer time span with several shorter sessions to maximize the chances of success. The observing times should be nearly 1 hour for one source if rms values of 0.2 Jy are to be expected."

Future Programmes

The future will probably see a shift from general surveys to dedicated monitoring of selected sources, hopefully with increasing co-operation from other Southern telescopes to get the most out of the observations. With new receivers and increased experience, submillimetre observations will come to the forefront: one of the challenges is to follow the entire early evolution of a synchrotron flare in order to develop second-generation models for the growth of shocks in relativistic jets.

Still another field where SEST's impact will certainly be felt in the future is millimetre VLBI, both on the ground and in space.

Visiting Astronomers

(October 1, 1989 – April 1, 1990)

Observing time has now been allocated for Period 44 (October 1, 1989 – April 1, 1990). The demand for telescope time was again much greater than the time actually available.

The following list gives the names of the visiting astronomers, by telescope and in chronological order. The complete list, with dates, equipment and programme titles, is available from ESO-Garching.

3.6-m Telescope

Oct. 1989: Marano/Cappi/Held, Bender et al., Kudritzki/Husfeld/Gehren/Groth/Butler/Baade/Rosa/Humphreys/Hummer, Ögelman/Gouiffes/Melnick/Hasinger/Pietsch/Pedersen, Danziger/Bouchet/Gouiffes/Lucy/Wampler/Fransson, Nissen/Schuster, Fleming, Guzzo/Tarenghi, Iovino/Shaver/Cristiani/Clowes/Pierre, de Lapparent et al.

Nov. 1989: de Lapparent et al., Guzzo/Collins/Nichol, Danziger/Bouchet/Gouiffes/Lucy/Wampler/Fransson, Gry/Jourdain de Muizon/Lagrange-Henri/Vidal-Madjar/Ferlet, Wampler, Molaro/Castelli/Bonifacio, de Boer et al., Schwope/Beuermann, Breysacher/Azzopardi/Lequeux/Meyssonnier/Westerlund, de Boer et al., Marano/Mignoli/Zitelli/Zamorani.

Dec. 1989: Barbieri/Clowes/Cristiani/Iovino/La Franca/Vio, Melnick/Gopal-Krishna/Steppe/van Drom, Ögelman/Gouiffes/Melnick, Hasinger/Pietsch/Pedersen, Danziger/Bouchet/Gouiffes/Lucy/Wampler/Fransson, Ardeberg/Lindgren/Lundström, de Boer et al., Danziger/Bouchet/Gouiffes/Lucy/Wampler/Fransson, Madejsky/Rabolli/Vega/Bassino, Hamann/Schmutz/Wessolowski, Tadhunter/Fosbury/Morganti/Danziger/Di Serego Alighieri.

Jan. 1990: Lortet/Testor/Schild, Ögelman/Gouiffes/Melnick/Hasinger/Pietsch/Pedersen, Danziger/Bouchet/Gouiffes/Lucy/Wampler/Fransson, Perrier/Mariotti/Mayor/Duquennoy, Renzini/D'Odorico/Greggio/Bragaglia, Melnick/Gopal-Krishna/Steppe/Van Drom, Surdej et al., Chiosi/Bertelli/Bressan, Nasi/Ortolani/Vallenari/Gratton/Meylan, Heske/Jourdain de Muizon.

Feb. 1990: Jourdain de Muizon/D'Hendecourt, Danziger/Bouchet/Gouiffes/Lucy/Wampler/Fransson, Ögelman/Gouiffes/Melnick/Hasinger/Pietsch/Pedersen, D'Odorico, Danziger/Bouchet/Gouiffes/Lucy/Wampler/Fransson, Wehrse/Hessman, Bergeron/Petitjean/D'Odorico, Sparks/Macchetto/Ögerle, Nørgaard-Nielsen/Joergensen/Hansen.

March 1990: Boulesteix/Capaccioli/Corradi/Le Coarer, Duval/Boulesteix/Monnet/Corado, Ögelman/Gouiffes/Melnick, Hasinger/Pietsch/Pedersen, Danziger/Bouchet/Gouiffes/Lucy/Wampler/Fransson, Reipurth/Dubath/Mayor, Capellaro/Held, Bender et al., Balkowski/Kraan-Korteweg/Maurogordato, Mazure et al.

3.5-m NTT

Jan. 1990: Danziger/Bouchet/Gouiffes/Lucy/Wampler/Fransson, Schneider/Giraud/Wambsganss, Bignami/Caraveo/Mereghetti/Mignami, Mellier/Fort/Soucail.

Feb. 1990: Miley et al., Surdej et al.

March 1990: Barthel/Djorgovski/Tytler, Danziger/Bouchet/Gouiffes/Lucy/Wampler/Fransson, Tsvetanov/Fosbury/Tadhunter, Bergeron et al., Bender et al.

2.2-m Telescope

Oct. 1989: MPI TIME, Van der Kruit/De Jong RS, Hunt/Mandolesi/Wade, Ferraro/Brocato/Fusi Pecci/Buonanno, Piotto/Bresolin/Capaccioli/Ortolani, Bertola et al.

Nov: 1989: Bertola et al., Collins/Guzzo/Nichol, Danziger/Bouchet/Gouiffes/Lucy/Wampler/Fransson, test new array (Moorwood), des Boer et al., Barbieri et al., de Boer et al., Appenzeller/Wagner/Weigelt/Barth/Weghorn/Grieger, Surdej et al.

Dec. 1989: Weigelt/Barth/Grieger/Weghorn, de Boer et al., Paresce/Panagia/Gilmozzi, Rafanelli/Capaccioli/Marziani/Schulz H. Tadhunter/Fosbury/Morganti/Danziger/Di Serego Alighieri, Reiputh/Olberg/ Cameron/Booth, Rafanelli/Capaccioli/Marziani/Schulz H.

Jan. 1990: Busarello/Longo/Feoli, Danziger/Bouchet/Gouiffes/Lucy/Wampler/Fransson, MPI TIME.

Feb. 1990: Van der Veen/Blommaert/Habing, Danziger/Bouchet/Gouiffes/Lucy/Wampler/Fransson, Schwarz/Moneti, Pottasch/Manchado/Garcia Lario/Sahu, Nota/Clampin/Paresce/Ferrari, Falomo/Maraschi/Tanzi/