spiral galaxies with the 64-m Parkes Radio Telescope.

Within the Abell radius of the cluster A3627, 109 velocities have so far been reduced leading to a mean velocity of $< v_{obs} > = 4882$ km/s and a dispersion of $\sigma = 903$ km/s. This puts the cluster well within the predicted velocity range of the GA. The large dispersion of A3627 suggests it to be quite massive. Applying the virial theorem yields a mass of $\sim 5 \times 10^{15}$ $M_\odot$, i.e. a cluster on par with the rich, well-known Coma cluster – yet considerably closer. In fact, simulations show, that if Coma were at the position of A3627 in velocity space and subjected to the same foreground obscuration, the two clusters would be indistinguishable. A3627 even has – like Coma – 2 dominant cD galaxies at its core.

The most intriguing aspect of the recognition of the new cluster is its position at the approximate centre of the GA overdensity. Although very massive as a cluster, its mass contributes only about 10% of the total mass predicted for the Great Attractor. Hence, it is not "the" Great Attractor as such, but it is the prime candidate for being the hitherto unidentified centre of this large-scale overdensity. This is supported by the recent analysis of the ROSAT PSPC data of A3627 by Böhringer et al. (1996) which finds this cluster to be the 6th brightest X-ray cluster in the sky for the ROSAT spectral band and confirms its virial mass.

The results from our programme within the whole search area in combination with the Southern Redshift Catalogue suggest furthermore that A3627 is the dominant component of an apparent "great wall" structure – similar to the Coma cluster in the (northern) Great Wall – including the nearby Pavo, Indus clusters below the Galactic plane and the shallow overdensity in Vela above the Galactic plane at 6000 km/s. This whole large-scale structure embodies what has been dubbed in 1987 the then unseen Great Attractor.

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# 10- and 17-µm Test Images of the Galactic Centre: Massive Protostars Near SgrA*?


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## Abstract

We have obtained 10 and 17 micron (N and Q band) images of the central square-parsec of the Galaxy. The images were taken with ESO's mid-infrared 64 × 64 pixel array camera TIMMI (Käufl et al., 1992, 1994) at the 3.6-m telescope on La Silla. The reduced images are displayed in Figure 1a,b: in total, 4 images are shown, two at each wavelength (i.e. a linear and a logarithmic stretch) in order to emphasise the full dynamic range. The images represent 1.5 and 7 minutes net on chip integration time at each wavelength, respectively. The images indicate that the morphological structure of the innermost parsec of the Galactic Centre is rather similar at both wavelengths, but differs significantly at certain locations, in particular at the position of IRS3. This compact source projected about 2 arcsec west and 4 arcsec north of SgrA* is found to have an extinction corrected spectral energy distribution $\nu F_\nu$ peaked near 10 microns and may be a massive protostar ($L_{bol} > 10^4 L_\odot$) or a cluster of protostars near the Galactic Centre. This might be possible, as there is indeed some dense gas in the innermost parsec from which stars can form (Jackson et al., 1993). In none of our images, mid-infrared emission from SgrA* is detected. Likewise, the strongest 2-micron source (IRS7) could not be detected, neither at 10 nor at 17 microns, to a 3-sigma limiting flux of about 0.3 and 4 Jy per arcsec$^{-2}$, respectively.


## Technical Details

The N band images ($\lambda = 10.1$ micron, $\delta_\lambda = 4.0$ micron) were taken with a pixel scale of 0.66 arcsec/pixel in 1.2 arcsec seeing. Due to the high thermal background (sky and telescope) the on-chip integration time of the individual frames had to be very short (7 ms). Otherwise standard infrared techniques were employed, i.e. chopping the secondary mirror (2.5 Hz) and nodding the telescope. Sky frames were taken in a location clear of 10-micron sources. The Q band images ($\lambda = 17.15$ micron, $\Delta\lambda = 1.5$ micron) were taken with a smaller pixel scale (0.33 arcsec/pixel), a necessity due to the even higher thermal background at the longer wavelength. At 17 micron, the seeing FWHM was 1.5 arcsec – i.e. close to the diffraction limit at this wavelength at this telescope. Again, hundreds of short exposure frames were coadded, this time with an individual on-chip exposure time of 12 ms. The same chopping and nodding as for the N band images was employed, and approximately the same sky position was used. The overall on-source observing efficiency for the N and Q band integrations was 40%.

We note that the sky is fairly clear of sources at mid-infrared wavelengths, so that it is easy to find an empty sky position. The very Galactic Centre is the exception in this respect; there is no other clustering of strong mid-infrared sources in the Galaxy that rivals the innermost parsec.

The images shown have not been flat-fielded, as this appears to be unnecessary: the overall gradient in sensitivity across the array is less than 10%, and the pixel-to-pixel variations are even smaller (Käufl, 1995).

The star βGru was used as a point source calibrator (N = –3.55, Q = –3.58) and also to measure the seeing at mid-infrared wavelengths; α Cen (N = –1.52, Q = –1.55) was used, too.

## Significance of the Images

A major goal of our observation was to compare the 17-micron image to the 10-micron image in order to find out which of the well-known 10-micron sources in the Galactic Centre (Gezari et al., 1985) have a rising flux density distribution towards longer wavelengths. The high spatial resolution mid-infrared TIMMI array data are superior to earlier single-beam raster-scan observations (Becklin et al., 1978, Rieke et al., 1978). The idea behind all this was to try to search for dust-enshrouded massive protostars, similar in kind to the Becklin-Neugebauer and IRc2 objects in

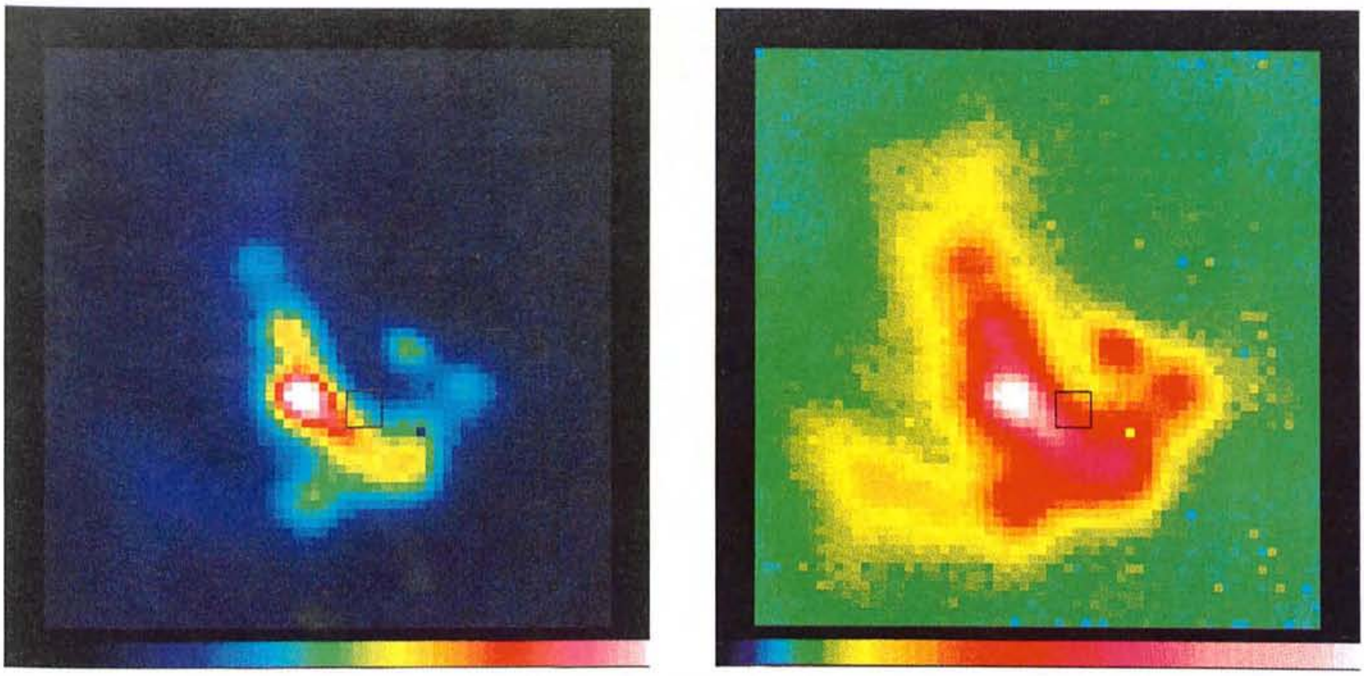

*Figure 1a (left = intensity linear, right = log intensity): TIMMI 10-micron image ($\lambda/\Delta\lambda = 2.5$) of the central $40 \times 40''$ of the Galaxy. The image scale is $0.66''$ per pixel. North is up, east to the left. The box indicates the position of SgrA*, which is however not detected to a limiting 3-sigma sensitivity of about 0.3 Jy/sq''. While much of the mid-infrared emission is due to diffuse non-stellar emission, the two isolated sources north-west of SgrA* (IRS3 and IRS6) are almost certainly powered by embedded stellar objects.*

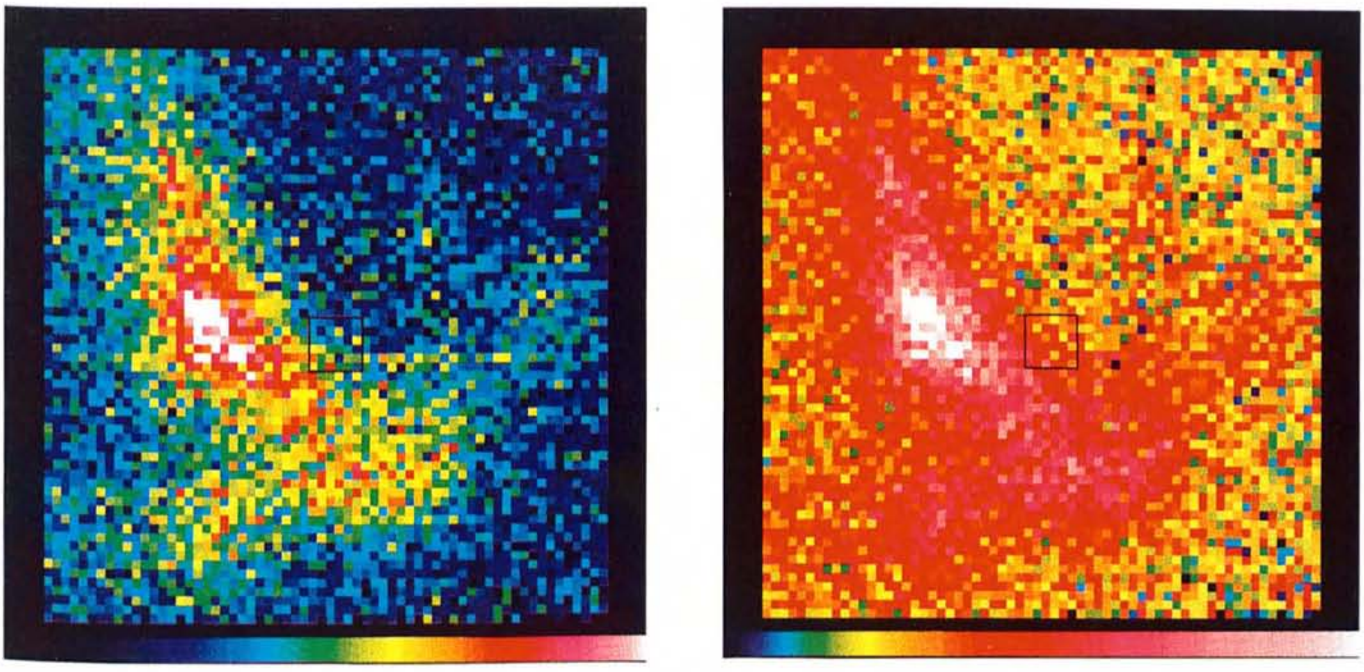

*Figure 1b (left = intensity linear, right = log intensity): TIMMI 17-micron image ($\lambda/\Delta\lambda = 11.5$) of the central $20 \times 20''$ of the Galaxy. The image scale is $0.33''$ per pixel. Note the overall similarity to the 10-micron image, except for the cocoon source IRS3 which appears to be heavily self-absorbed due to silicate dust. It is unclear whether IRS3 is a luminous evolved star or a deeply embedded massive protostar.*

the Orion Nebula (Wynn-Williams et al., 1984). Those sources would have about 0.4 and 0.2 Jy at 10 microns and similar values at 17 microns, if displaced from Orion to the distance of the Galactic Centre (8.5 kpc). This takes into account a foreground extinction of around 1 mag in the broad N band and 0.5 mag in the Q band toward the Galactic Centre (corresponding to $A_V$ = 27 mag, see e.g. Rieke and Lebofsky, 1985 for the interstellar extinction law towards the Galactic Centre). It is useful to compare our mid-infrared images to the K, L′, and M-band images of the Galactic Centre by Herbst et al. (1993) in order to more clearly isolate sources with flux density distributions rising toward longer wavelengths. A combined inspection of K, L′, M, N and Q-band images suggests at least one compact such source within a $12 \times 12$ arcsec ($0.5 \times 0.5$ pc) field around the SgrA* position: IRS3! It is a very red source in the K, L′, M images, and is bright at 10 microns (7 Jy) and even brighter at 17 microns (approx. 10 Jy). Notice that the 17-micron detection is at a much lower signal-to-noise level than the 10-micron detection. IRS3 is known to have a noticeable 9.7-micron silicate absorption feature (Becklin et al., 1978, Rieke et al., 1978), indicating a temperature gradient in a dust shell or cocoon and considerable local extinction. The question whether IRS3 is indeed a deeply embedded massive protostar or a very young embedded cluster of protostars near the Galactic Centre is thrown open here, although other explanations (a luminous evolved star such as an OH/IR star or a dust-enshrouded supergiant; Becklin et al., 1978, Rieke et al., 1978) have been considered in the past. Yet the fact that there are massive young stars such as WR stars and a cluster of HeI stars in the IRS16 complex near SgrA* (see the review of Genzel et al., 1995[1]) begs the question whether massive star formation continues in the Galactic-Centre region, even though no compact radio sources or ultracompact HII regions have been found.

It would be particularly worthwhile to extend the current 10-micron search for massive protostars to the Galactic Centre circumnuclear disk of dense molecular gas (e.g. Genzel, 1989).

A 5 × 5 mosaic of 10-micron TIMMI images would cover most of the relevant area. This TIMMI project would benefit greatly from the successful implementation of the 3.6-m refurbishment plan (M2 mirror), as it would probably enable us to reach the 10-micron diffraction limit of 0.7 arcsec. This would much improve the 10-micron point source sensitivity and the chance of detecting massive protostellar objects in the circumnuclear ring. On the other hand, ISOCAM images may soon reveal the presence (or absence) of young stellar sources in the circumnuclear disk region, albeit with poorer spatial resolution. Follow-up diffraction-limited imaging with TIMMI is likely to be needed. We hope for the best possible image quality at the 3.6-m by then.

Finally, we briefly discuss our results on IRS7 and SgrA* (which are in agreement with those of Gezari et al., 1994a,b). IRS7 – the brightest source in the 2.2-micron K-band – is not detected in our images, suggesting that this red supergiant lacks a warm optically thick dust shell. However, IRS7 is clearly detected at 7.8 and 12.4 micron (see Gezari et al., 1994a), suggesting that our non-detection at 10.1 microns may be due to absorption in the silicon feature around 9.7 microns, either locally or along the line of sight. As for SgrA*, we see no mid-infrared source at its position, which may imply that there is no or very little warm dust in the immediate vicinity of the Galactic-Centre monster. However, SgrA* has been claimed to be detected in deep 8.7-micron images (S. Stolovy, data presented at the recent ESO/CTIO conference in La Serena).

P.S. We have also obtained 10.4-micron [SI V] and 12.8-micron [Ne II] narrow-band images of the innermost Galactic-Centre region, in an attempt to study the spatial distribution of the energy and excitation sources in this region.

[1]In this review, Genzel et al. display a K-band spectrum of IRS3 obtained with their 3D spectrometer at the ESO-MPIA 2.2-m telescope. This spectrum shows a hint of weak HeI 2.06-micron emission on an otherwise featureless rising continuum, indicative of a highly reddened hot massive star. Krabbe et al. (1995) also mention that IRS3 could be a young massive star, although in their paper the HeI feature in IRS3 is barely discernible. Long ago, Rieke et al. (1978) already suspected that IRS3 could be a very young stellar object.

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# Redshift and Photometric Survey of the X-Ray Cluster of Galaxies Abell 85


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As the largest gravitationally bound systems in the Universe, clusters of galaxies have attracted much interest since the pioneering works of Zwicky, who evidenced the existence of dark matter in these objects, and later of Abell, who achieved the first large catalogue of clusters.

Clusters of galaxies are now analysed through three different and complementary approaches: optical imaging and spectroscopy, which allow to derive the galaxy content, X-ray imaging and spectroscopy, giving information on the physical properties of the X-ray gas embedded in the cluster, and from which the total dynamical mass of the cluster can be estimated, under the assumption of hydrostatic equilibrium, and, for clusters of redshifts $z \geq 0.31$ deep optical imaging of arcs and arclets in clusters.

As a complementary approach to that of large cluster surveys such as the ENACS (ESO Nearby Abell Cluster Survey) ESO key programme, we have chosen to analyse in detail a few clusters of galaxies, by combining optical and X-ray data. We present here results on the first of the two clusters observed at ESO: Abell 85.

This cluster is rich and located at a redshift $z \sim 0.055$, corresponding to a spatial scale of 97.0 kpc/arcmin ($H_0 = 50$ km/s/Mpc). Previously published data on this cluster include partial CCD imaging by Murphy (1984), redshift catalogues by Beers et al. (1991) and Malumuth et al. (1992), totalling 150 redshifts; these authors evidenced the existence of substructure in Abell 85 as well as the presence of a foreground group of galaxies. Abell 85 has a double structure in X-rays (Gerbal et al., 1992 and references therein), and is therefore not fully relaxed, as many other clusters indeed, contrarily to what was previously believed.

## Observations

We first obtained a photometric catalogue of 4232 galaxies (hereafter the MAMA catalogue) in a region of ±1° around the cluster centre, by scanning a $b_J$ photographic plate with the MAMA