located in the inner 45 pc of this Giant HII region (Campbell et al. 1992). Standard ground-based observations, hindered by atmospheric seeing, showed that the massive core of this stellar cluster (known as R136) consists of three components: R136a, b and c. At one time, R136a was considered to be the most massive star ever known, with about 2000 solar masses (Cassinelli et al. 1981). With ground-based speckle techniques in the visible, Weigelt & Baier (1985) demonstrated that this object consists of at least eight stellar components, thus solving the super-massive star problem. These results have been confirmed by HST observations (Weigelt et al. 1991, Campbell et al. 1992).

The age of the cluster is supposed to lie between 3 and 5 million years, estimated from the presence of massive WN-type Wolf-Rayet stars and the lack of red supergiants. Although none of the stars in R136 is in itself exceptional, the extraordinarily high concentration of O, B and Wolf-Rayet stars represents an ideal, unique starburst laboratory – near enough to be resolved into individual stars and large enough to serve as a typical model of starbursts in distant galaxies.

Observations

The data presented here were taken on December 27, 1994 using the MPE near-infrared camera SHARP2 connected to ESO's adaptive optics system Come On+ on the 3.6-metre telescope on La Silla.

The Sharp2 infrared camera is equipped with a 256 × 256 pixel Rockwell NICMOS3 array detector and is optimised for high-resolution broad-and narrow band imaging in the 1.1–2.5 μm band (Hofmann 1993). The image scale of 0.″05 pixel, results in a total field of view of 12.8 × 12.8 arcseconds and provides Nyquist sampling at wavelengths as short as the J band on the ESO 3.6-m telescope. Wide-band filters provide colour discrimination in J (1.10–1.40 μm), H (1.45–1.85 μm) and K (1.95–2.45 μm) bands. A circular variable filter (CVF) which covers the H and K band with a spectral resolution $\lambda/\Delta\lambda \approx 60$ is also integrated. The total throughput of the optical system, including the quantum efficiency of the detector, is around 50 % in H and K band. The array detector is read out with 4 custom-designed DSP boards permitting integration times from 50 ms up to several minutes per frame.

The Come On+ system (Beuzit et al. 1995) was the first adaptive optics system open to the astronomical community and in its first two years of operation has produced many remarkable results (Léna 1994). A reference source, brighter than approximately 13th magnitude in the V band, is required for wavefront correction. This source must appear unstructured on the wavefront sensor. The central cluster of stars forming R136a itself is sufficiently bright and compact to serve as the wavefront reference in our observations.

We integrated for 190 minutes in the K band under good atmospheric conditions (≈ 1″ seeing). Significant residual triangular coma in the PSF required additional image deconvolution. We used Melnick 34, a bright and isolated star near the edge of our detector, to deconvolve the image. After 5000 iterations of the Lucy-Richardson algorithm (Lucy 1974), the resulting map of delta functions was reconvolved with a Gaussian beam of 0.″12 FWHM, which corresponds to the 3.6-metre telescope's diffraction limit in K.

Results

The left-hand side of Figure 1 shows a short exposure taken in H band with the AO system switched off, while the right-hand side shows our final adaptive optics K-band image. For the first time in this wavelength region, the central stellar minicluster R136a is clearly resolved into several components. The dynamic range between the brightest and the faintest sources is approximately 9 magnitudes. The whole image reveals more than 400 stars above the 3-sigma detection level, the faintest of which are 20th magnitude in K, which corresponds to a lower mass limit of 2–3 $M_\odot$ (Forestini 1993). Assuming a cluster age of 3 million years those stars are still evolving on the pre-main sequence. This detection limit is valid in the outer parts of our field; due to crowding, it is lower in the central region. Transparencies showing the comparison between these images can be obtained from the authors.

Figure 2 displays the central region as previously observed by the refurbished HST (Hunter et al. 1995). Despite the fact that HST's spatial resolution is about twice ours, we see essentially the same sources as observed by Malumuth et al. (1994) plus some additional red objects. Our observations, which also include H- and J-band images, can be combined with HST stellar observations in U, B and V bands in order to minimise photometric errors and estimate the small-scale variations of dust extinction in the dense core of this stellar cluster. A combination of HST and adaptive optics data covers a wide spectral range and enables us to investigate individual stellar types, varying IMF slopes, and the duration of the starburst. The results of this analysis will be presented in a forthcoming issue of *The Messenger.*

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The H_2 Structure of OMC-1: Disruption of a Molecular Cloud

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Introduction

The first detection of infrared quadrupole emission of H_2 in any astronomical object was almost twenty years ago in what is now known as OMC-1 (Gautier et al. 1976). OMC-1 covers an area of approximately 1.5 arcminutes square, located in the giant Orion Molecular Cloud, at a distance of about 450 pc. It contains the much studied Becklin-Neugebauer object and Kleinmann-Low nebula as well as a number of compact infrared emission sources. According to Genzel and Stutzki (1989), BN-KL is a very dense, clumpy molecular core in which most of the radiation emanates from only a few major luminosity sources, of which IRc2 and BN are the most important. BN itself is considered to be a young star of mass 15 $M_{\odot}$; IRc2 is a similar object, somewhat more massive than BN at 25 $M_{\odot}$.

Maps of OMC-1 in the light of the H_2 1–0 S(1) transition at 2.121 μm were first obtained by Beckwith et al. (1978). The maps had an angular resolution of 13.5″ and 5″ and showed two extended lobes and several emission peaks. At this resolution the spatial intensity distribution was rather smooth. For many years these observations remained the standard for OMC-1. They were often used to compare the H_2 emission with detections of other molecular species. More recent H_2 images of the northwest tip of OMC-1 show a general patchy and filamentary or jet-like structure (Burton et al. 1991, Allen & Burton 1993).

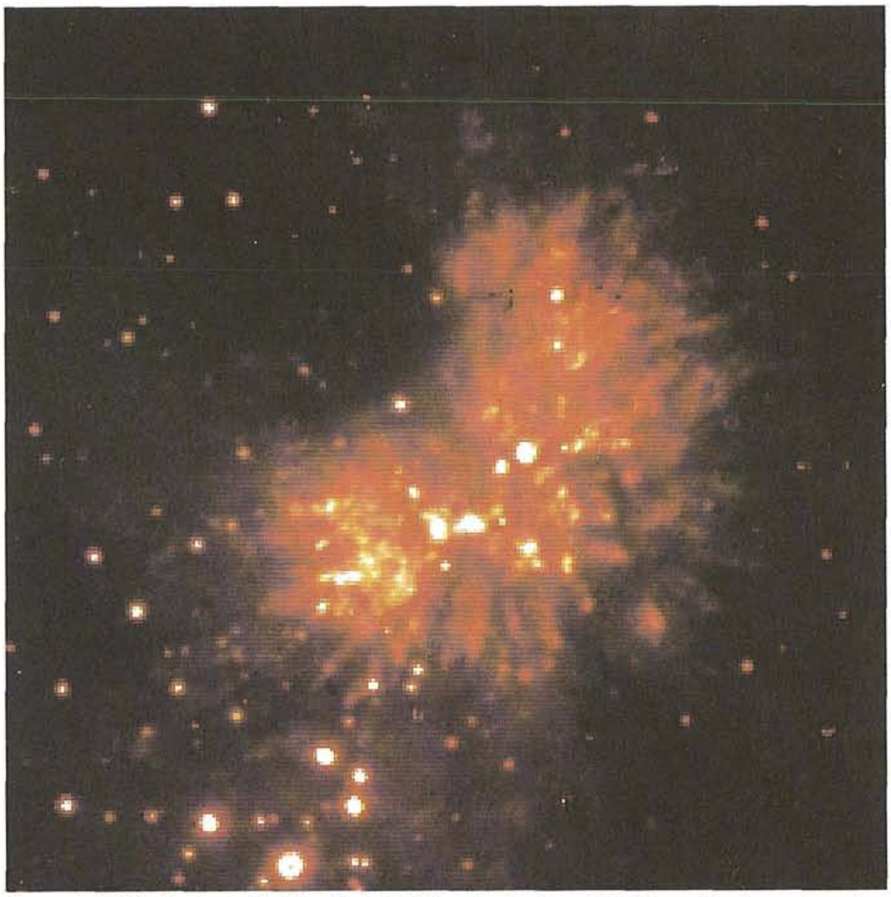

Figure 1. *OMC-1 in the light of the H_2 1–0 S(1) emission line at 2.121 μm. The trapezium stars are visible at the bottom. North is at the top, east to the left.*

Fabry-Perot Observations

A series of images of OMC-1 was obtained during the nights of December 29 to 31, 1993 with the 2.2-m telescope and IRAC2. The Fabry-Perot filter was centred at 2.121 μm. It had a bandwidth of 1.5 nm corresponding to a velocity spread of about 200 km/sec. The accuracy of the wavelength setting was 0.5 nm. The detector was a 256 × 256 NICMOS array. IRAC2 can be used with various objectives providing different image scales. We chose lens LC which provides a field of view of about 2′ and a projected pixel size of 0.5″. Integration times were 5 minutes on source and 5 minutes on two background positions. Subtraction of the background images also removed the rings of thermal emission from the warm FP rather well. The seeing conditions were excellent and the measured FWHM of the stellar images was 0.7″.

The H_2 Structure of OMC-1

In Figure 1 the resulting H_2 image of the OMC-1 is shown. It covers all of the area originally mapped by Beckwith et al. (1978). In the north (top) are Beckwith's Peaks 5 (which nearly coincides with IRc9) and Peak 1. Near the centre of our image, south and slightly east (left) of the line of Peaks 5 and 1, BN shows up brightly. Peak 3 is resolved into two bright sources, south-east of BN. IRc2 coincides with a hollow structure in the H_2 emission map. East-south-east of Peak 3, Peak 2 is a bright, highly structured region.

With the exception of these sources, our image shows that most if not all of the H_2 emission in OMC-1 is due to near-linear jet-like features, which expand in all directions except the north-eastern quadrant. The H_2 structure of OMC-1 in Figure 1 looks as if it were produced by a highly dynamic or even explosive event. There are several short but well recognisable jets in the south and west. There is also a long, strong jet going almost due north. Tracing these jets back towards the centre, they appear to come from the region around IRc2. In the north-western quadrant and north of east-south-east it is more difficult to trace individual jets through the cloud.

The jets have the appearance of wakes such as might be produced by the bow shocks of "bullets" of dense material fired through the molecular gas. Along the path of the jets there are also knots of brighter emission, probably indicating that the emitting gas in these regions is above average density. In the southwest quadrant in particular, a number of the jets appear to terminate in these brighter knots. The northern jet passes through a bright ring of emission and emerges much weaker in intensity. If the two emission structures are indeed connected, it would appear as if the "bullet" hit a clump of denser material, causing a radially expanding density wave, before passing through.

The jets we measure typically have a projected length of 1.6×10^{12} km. Assuming that the measured H_2 linewidth (Nadeau & Geballe 1979) of 40–100 km/s gives a lower limit for the velocity of the "bullets", such a track could be produced in ~ 500 years. This compares with the estimate of 1000 years by Allen & Burton (1993) for the age of their jets, which are located further away from IRc2 than those presented here. At this expansion velocity, the jetheads will have moved an observable 1″ in 20 years from now. The phenomenon of the molecular cloud disruption is thus extremely short-lived and OMC-1 provides a unique opportunity to observe it.

Conclusions and Outlook

The new Fabry-Perot images of the Orion Molecular Cloud OMC-1 confirm it to be an object generated by a highly dynamic – even explosive – event, and unlike any other astronomical object known. We seem to witness the dynamic processes by which newly-formed massive stars disrupt their parent molecular cloud. OMC-1 appears to be made of numerous linear, jet-like structures, which are responsible for producing nearly all the nebular emission. The dynamic structure is best described by the wakes of dense "bullets" ploughing through the surrounding molecular gas. The jets appear to diverge from the region around IRc2 in all directions apart from the north-east quadrant. More information on the region – including temperature profiles for the most interesting features — should be obtained by observations in other H_2-sensitive wavelengths and by carefully directed high resolution spectroscopy.

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Combined Optical and Near-IR IRAC2 Photometry of the Bulge Globular Cluster NGC 6553

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The bulge region of our Galaxy contains a number of globular clusters whose study can provide important information about the history of the Galaxy formation conditions after the initial collapse of the spheroid. The age, dynamical and chemical conditions of the bulge are the crucial parameters to be investigated. Unfortunately, they are hardly observable in the optical wavelength due to the heavy extinction in the direction of the Galactic plane.

For these reasons we have started a systematic study of a sample of metal-rich clusters in the infrared using IRAC2 withe the new NICMOS3 detector 256 × 256 pixels, mounted at the MPI/ESO 2.2-m telescope at La Silla (Chile).

Here, we present the results of combined visual and near-infrared photometry in one of the most metal-rich globular cluster NGC 6553 ([Fe/H] ~ –0.2). The optical counterparts come from Ortolani, Barbuy and Bica (1990).

1. Introduction

NGC 6553 (α = 18^h 05^m 11^s; δ = –25° 55' 06" (1950.0); [Fe/H] = $^{+0.2}_{-0.4}$ (Ortolani et al., 1990) is a low-latitude galactic globular cluster belonging to the metal-rich cluster family. These objects are projected in the direction of the galactic bulge and form a unique homogeneous sample of bulge population, so the correct determination of their age is crucial for the determination of formation epoch of the inner bulge. Their peculiar c-m diagrams are dominated by blanketing effects giving anomalous tilted HBs and a turnover on the giant branches (Ortolani et al., 1990, 1991, 1992, 1993a, 1993b, Bica et al., 1991). Recently (Bertelli et al., 1994), derived a whole set of solar and super-solar metallicity models which reproduce these characteristics, a major step towards modelling metal-rich pop-

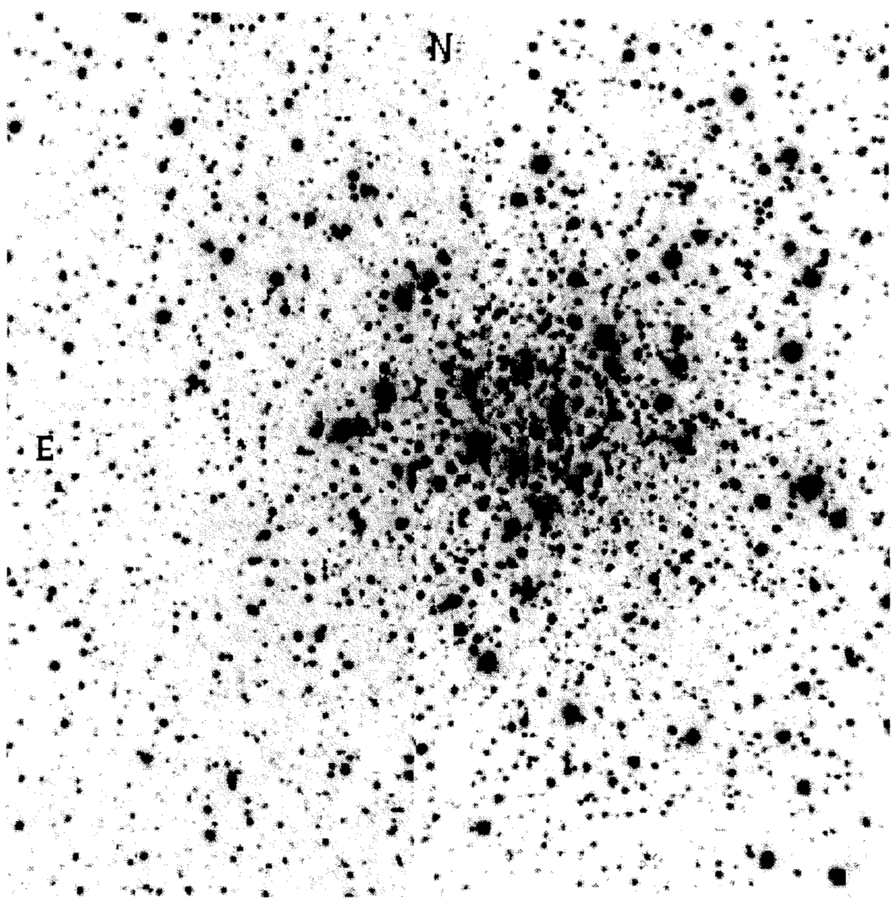

Figure 1: *NGC 6553 composite field as observed with IRAC2 0.5 arcsec/pixel mode, field size ~ 4 arcmin^2.*