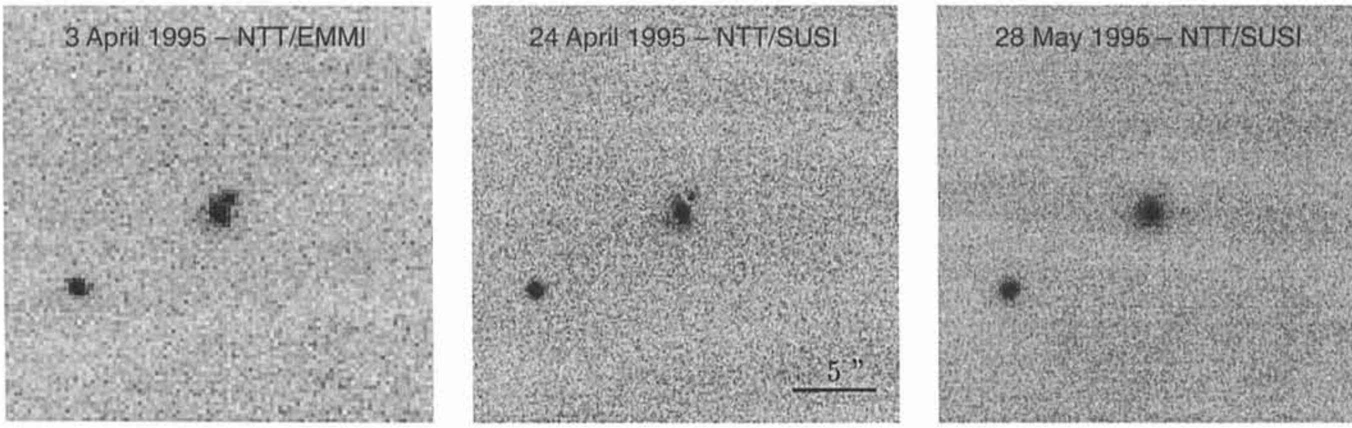

A sequence of images of SN 1995K taken with the NTT. The first image (left) shows the supernova near maximum light. Three weeks later the object has faded considerably (middle) and is not detected two months after discovery. The stretch of the images is comparable to show the brightness decline of the supernova. The seeing measured from stars in the images was 0.8, 0.5 and 0.7 arcseconds from left to right.

and to obtain a spectrum of both the supernova and its galaxy.

The galaxy spectrum shows emission lines of Hα, [N II], weak [O III], and Hβ lines corresponding to a Sbc galaxy spectrum at a redshift of 0.478. An additional spectrum obtained at CTIO one month later confirms this conclusion.

An essential ingredient for the use of a high-redshift supernova as a distance indicator is its classification. The current classification scheme of supernovae is based on spectra around the maximum brightness of the event. For a meaningful and secure distance determination it is of paramount importance to classify the supernova by obtaining a spectrum. Since a supernova at a redshift of 0.4 reaches a peak brightness of $m_R \approx 22.3$–23.3 (depending on q_0) this is not a simple task.

The spectrum of SN 1995K is heavily contaminated by the galaxy (the supernova is located only 1.1 arcseconds from the galaxy nucleus). Nevertheless, it appears consistent with a regular SN Ia at maximum. The defining absorption line of [Si II] near 6100 Å can be seen near 9000 Å in our spectrum, a region severely affected by night sky lines.

Preliminary photometry indicates a peak magnitude of about 22.7 in R which explains some of the difficulties in obtaining a decent spectrum. The light curve of SN 1995K has been established through observations at the NTT, the 3.6-m and the Danish 1.5-m at ESO, and the 2.5-m DuPont telescope on Las Campanas. Whenever possible, we observed SN 1995K through special filters which correspond to B and V filters redshifted to 0.45. This technique makes uncertainties due to K-corrections (due to the redshifts) minimal. Since the regular R filter is almost identical to B redshifted to 0.47, we have included observations using this filter as well. The decline rate should be easily measurable from our photometry, and the possibility to measure a reliable distance is promising. Only modern image-processing techniques allow us to extract accurate magnitudes from an object which is deeply embedded in its host galaxy like SN 1995K. The available SUSI images (see Figure) obtained under very good seeing conditions will play an important role as templates for the extraction of the supernova magnitudes.

SN 1995K is the most distant star observed to date. It is among the half dozen supernovae at $z > 0.3$ known so far (Nørgaard-Nielsen et al., 1989, Perlmutter et al., 1994, 1995). The discovery of this supernova is proof that our programme is working. We were predicting one or two supernovae for our trial period. The next step is the establishment of reference images for the second half of the year (October/November) with the CTIO telescope and a continuation of the search early next year. With an improved version of the search software and several lessons learned from the pilot project we are well-prepared for more distant supernovae to be discovered.

For a reliable measurement of q_0 we will need more supernovae. We estimate that about 20 supernovae with accurate peak magnitudes are needed to put significant constraints on the deceleration of the Universe. Combining our results with similar projects under way at the Lawrence Berkeley Laboratory we should be able to reach this goal in the next few years. One of the main obstacles right now is the availability of good spectroscopic data. More photons would greatly enhance our ability to take spectra of these objects.

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The Magellanic Catalogue of Stars – MACS

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Introduction

The Magellanic Clouds harbour a vast number of objects of interest for the observer. In many cases it is, however, difficult to find accurate coordinates for stars in crowded fields of the Clouds. A first step to solve this problem was made by Périé et al. (1991), who published a catalogue of almost 1000 stars in the direction of the Magellanic Clouds with typical *V* magnitudes between 9 and 11. The positions are based on ESO Schmidt plates and have a positional accuracy of 0.5″. This catalogue can be used as reference catalogue to obtain star positions on, e.g., astrographic plates.

In order to have enough reference stars for CCDs, however, a much higher surface density of stars is needed. De Boer (1993) presented plans for such a catalogue. The first version of it is now available. The **Ma**gellanic **C**atalogue of **S**tars (MACS) is based on scans of ESO Schmidt plates and contains about 244,000 stars covering large areas around the LMC and the SMC. The limiting magnitude is $B \leq 16^{\rm m}.5$ and the positional accuracy is better than 0.3″ for 99% of the stars. The stars of this catalogue were screened interactively to ascertain that they are undisturbed by close neighbours.

Plate Material, Measurement, and Selection

The MACS is based on plates taken with the ESO Schmidt telescope between November 1988 and January 1989 (a few plates taken in 1991 were also used). The exposure time was 60 minutes in the blue passband IIa-O + GG 385. The limiting magnitude is $B \approx 20^{\rm m}.5$. The plate centres are the same as in the ESO/SRC survey. The plates were intended as a repetition of the ESO Quick Blue Survey with the aim of deriving absolute proper motions of the LMC and the SMC, measured with respect to background galaxies (Tucholke and Hiesgen, 1991). We used 21 plates of 12 fields, so that most fields were covered by two plates. The MACS in its present version covers an area of about 200 and 120 square degrees for the LMC and the SMC, respectively (Figs. 1a, b).

The Schmidt plates were digitized with the PDS 2020 GM^{plus} microdensitometers of the Astronomical Institute of Münster University. A fully automatic programme (Horstmann, 1992) was used for the detection of objects. For the MACS, the parameters of this programme were chosen to yield a limiting magnitude of about $B = 16^{\rm m}.3$. This limit was checked using CCD photometry from the literature. Since published photometry is not available for all fields, we had to rely on the homogeneity of the plate material. From comparison of the internal magnitudes in plate overlap regions we found that the limiting magnitudes scatter by $\pm 0^{\rm m}.2$.

A very time-consuming step is the *interactive screening* of all detected objects. The aim of the selection is to provide the catalogue user with reference stars which are apparently *undisturbed* by neighbouring stars on the Schmidt plates. We excluded stars having close neighbours with separations of about 2″ to 11″. Galaxies and artifacts were removed from the data base during this viewing. The efficiency of the screening against double stars varied somewhat with crowding conditions: in very crowded

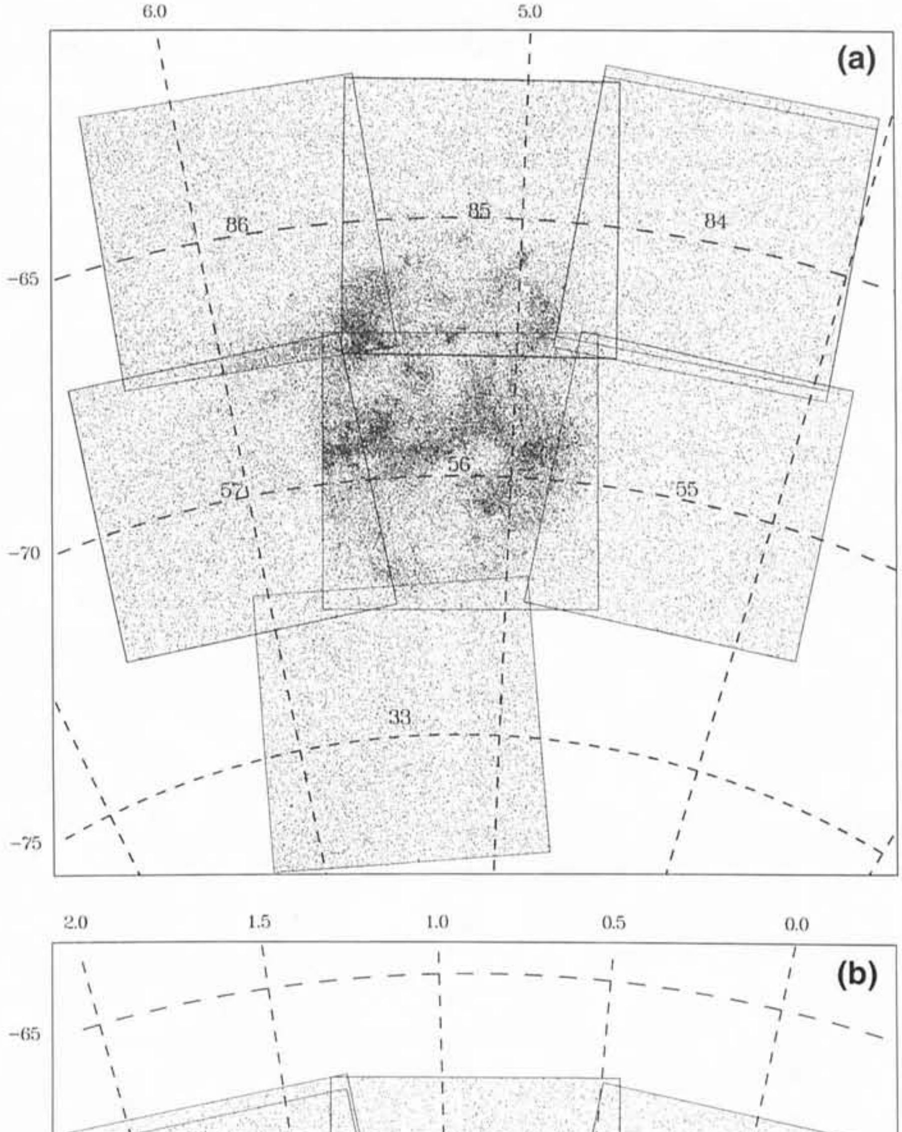

Figure 1: (a) Sky distribution of 175,779 MACS catalogue stars towards the LMC. Also given are numbers identifying the ESO/SERC atlas fields, the outlines of the plates used, and a J2000.0 co-ordinate grid. The largest concentrations of catalogue stars are found near active star-forming regions, while the bar contributes relatively few stars brighter than $B \approx 16^{\rm m}.3$.
(b) 67,782 catalogue stars in the direction of the SMC. The outer wing is not yet included in the catalogue. Note the concentrations around the galactic globular clusters 47 Tuc and NGC 362.

fields small perturbations were tolerated in order to keep a sufficient number of stars. Note that discarded stars might be undisturbed by their neighbours on CCD frames due to a more favourable scale. What matters here, however, is reliable photographic reference positions. The screening is a major improvement relative to catalogues compiled in a non-interactive way like the Guide Star Catalog or the ROE/NRL Catalogue. The second author inspected ≈ 529,000 objects selected by the search programme, 422,000 of which passed this procedure.

Astrometry and Positional Accuracy

The computation of right ascensions and declinations (α, δ) from the plate coordinates used between 160 and 220 reference stars fainter than $9^{m}_{\cdot}0$ from the PPM South Catalogue (Bastian et al., 1991). Positions from Schmidt plates, obtained by transforming plate to celestial coordinates using low-order polynomials, frequently show systematic patterns when compared to independent catalogues (Taff et al., 1990). This effect is probably caused by the bending of the plates to the curved focal plane during exposure. Our case is no exception. Since all plates were exposed, developed and scanned in a similar way, we combined the residuals from all 21 plates into a two-dimensional array as a function of x and y. We found a clear systematic pattern (Tucholke et al., 1995) and subtracted it from the measured (x, y)-co-ordinates. This reduces the mean residuals to 0.18″ in both co-ordinates. Although individual plates do not strictly adhere to this systematic pattern, an individual correction for each plate is not feasible, since the number of PPM stars per plate is still too low to allow a sufficient spatial resolution.

A first check on the accuracy of the MACS is provided by the comparison of the two plates available for most of the fields. Comparison of (α, δ) yields an r.m.s. scatter between 0.12″ and 0.19″ per co-ordinate. Typical amplitudes of systematic differences are 1–3 μm, corresponding to 0.07″ . . . 0.20″. Internal magnitudes agree within $0^{m}_{\cdot}11$ . . . $0^{m}_{\cdot}19$ after correction for the different limiting magnitudes.

The regions of overlap between neighbouring plates (see Figs. 1) yield an extreme test of the positional accuracy. R.m.s. differences are 0.34″ . . . 0.42″; thus the accuracy on one plate is 0.24″ . . . 0.30″. The scatter of the internal magnitudes about the mean difference ranges from $0^{m}_{\cdot}12$ to $0^{m}_{\cdot}18$.

The Catalogue

In the present version, the MACS contains data for 175,779 and 67,782 stars in the direction of the LMC and SMC, respectively. The surface density of stars in non-crowded regions is 0.15 stars/□′. This is just sufficient to yield for a modern CCD covering 25□′ on the average the minimum number of 4 reference stars.

TABLE 1. SOME LINES FROM THE PRELIMINARY MACS FOR STARS IN THE FIELDS OF NGC 330 (SMC) AND SN 1987A (LMC).

Name	α_{2000}	δ_{2000}	N	Mag.	Flags Pos	Flags Mag	Flags Bochum
⋮	⋮	⋮					
MACS J0056–724#003	0 56 03.321	–72 29 07.80	1	16.56	0	0	0
MACS J0056–724#005	0 56 06.837	–72 28 35.25	1	17.81	0	0	0
MACS J0056–724#006	0 56 07.449	–72 29 28.38	2	18.19	0	0	0
MACS J0056–725#005	0 56 13.847	–72 30 00.32	2	17.49	0	0	0
MACS J0056–724#010	0 56 24.076	–72 29 14.48	2	17.04	0	0	0
⋮	⋮	⋮					
MACS J0535–692#022	5 35 30.401	–69 16 18.13	1	19.33	0	0	0
MACS J0535–692#024	5 35 32.625	–69 15 48.53	4	19.14	0	0	0
MACS J0535–692#025	5 35 34.493	–69 17 13.58	1	99.00	0	1	0
MACS J0535–693#024	5 35 34.828	–69 19 19.53	1	19.98	0	0	0
MACS J0535–692#027	5 35 36.136	–69 16 08.96	4	17.98	0	0	0
⋮	⋮	⋮					

Note: The name of the object consists of the acronym MACS (for Magellanic Catalogue of Stars, but one can also read it as Magellanic Cloud Star), the letter J denoting the equinox J2000.0 to which the position refers, a position code for the upper right (NW) corner of the box with size $1^{m} \times 6'$, and the #nnn giving the running number of the star inside that box. This format is in agreement with the Rules and Regulations for Nomenclature as defined by IAU Commission 5.

A name was assigned to each star following the suggestion of de Boer (1993), giving its truncated position and a running number within an (α, δ)-box of $1^{m} \times 6'$. This format allows to add further stars inside the box to the catalogue without upsetting the numbering system. Table 1 shows the data for some stars in the vicinity of SN 1987A (LMC) and the young globular cluster NGC 330 (SMC).

The star positions are given for the equinox J2000.0 and the epoch 1991.0, compiled from up to 8 plates. As a typical accuracy (within the PPM system) we take 0.27″ from the r.m.s. scatter in the overlap regions. Less than 1% of the stars carry a flag that the internal positional error is larger than 0.5″. Instrumental magnitudes are given in a blue passband. They are corrected to a common, arbitrary zero point for the LMC and the SMC, respectively, and should be useful at least for identification. Just 0.6% of the stars had to be flagged as having an above-average plate-to-plate scatter of internal magnitudes, either from bad photometry or due to variability.

Proper motions could not be derived, since the plates were taken at more or less the same epoch. This limits the usefulness of the catalogue as an astrometric reference. However, in crowded fields one can hope that the majority of stars are MC members with a common proper motion, thereby minimising this problem. In the future, we plan to add proper motions to our catalogue (a few plates from the ESO Quick Blue Survey have already been scanned).

First attempts in using the MACS as a reference catalogue for CCDs in very crowded fields revealed large difficulties in the identification process, since for our catalogue many stars had been discarded due to disturbing neighbours. This problem can be alleviated by distributing a zoomed-down version of the original scans, with the catalogue stars marked.

The MACS has up to now been cross-identified only with the catalogue of Périé et al. (1991), showing r.m.s. differences as expected from the internal errors. An identification with the Guide Star Catalog will follow. An important cross-identification, to be done before the first official release, will relate the MACS to the data base currently being compiled at the Astronomisches Institut Bochum containing astrophysical information on thousands of (relatively bright) stars in the direction of the LMC.

A detailed description of the creation and content of the MACS will be given in a forthcoming paper (Tucholke et al., 1995). Colleagues interested in a preliminary version of the catalogue should contact us under the e-mail address `tucholke@astro.uni-bonn.de`.

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