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New Infrared Photometer and F/35 Chopping Secondary at the 3.6 m Telescope

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An F/35 chopping secondary mirror was installed and tested on the 3.6 m telescope in November 1984 together with a new infrared photometer which incorporates the TV acquisition and guiding system. In future, this system will replace the "F/8" photometer used until now. After a brief description of the chopper and photometer, we report here on the performance achieved during this first test using detector units essentially identical to those used with the old system and described by Moorwood in an earlier *Messenger* article (**27**, 11, 1982).

Chopping Secondary

Fig. 1 is a photograph of the 3.6 m telescope with the chopping secondary installed. As the mirror has a diameter of only 33 cm, it is rather more difficult to see than the normal F/8 secondary! It is attached to a unit, providing for chopping, focussing and rotation, which is supported by the special infrared top ring and spider assembly mounted in place of the usual optical top ring. The mirror is driven by magnetic actuators which are servo-controlled to provide either square wave chopping (for photometry) or a linear sweep on the sky (for speckle interferometry). Immediately behind it, a metal compensating plate having a similar moment of inertia is driven in opposition to the mirror by the same control system. This substantially improves the overall performance by suppressing any vibration of both the position sensor and the support spider. Chopping amplitude, frequency, centre position, angle and the focus are all remotely controlled via an HP terminal in the control room.

For the test, the servo system was adjusted to give a 5 ms rise time (90 % duty cycle at the frequencies around 10 Hz normally used for photometry) and yielded an end position stability of $\simeq$ 0.5 % of the amplitude up to values of 2 arcminutes on the sky.

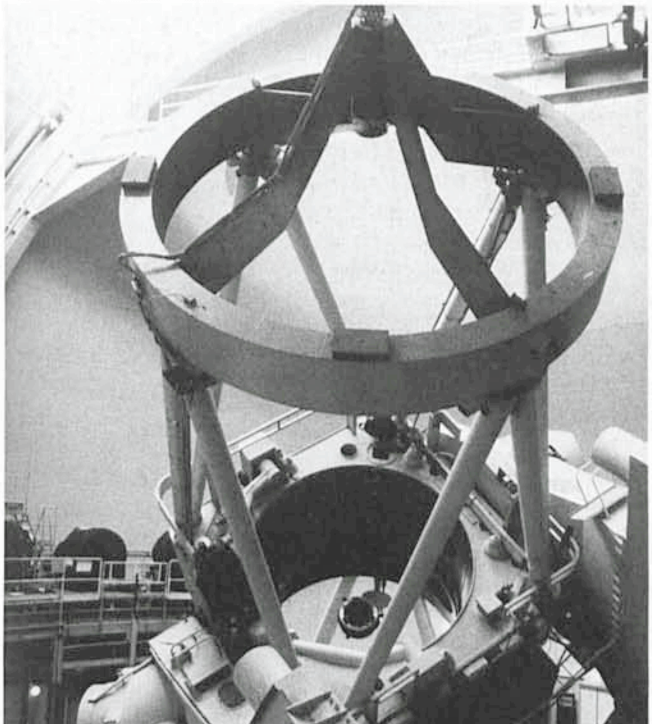


Fig. 1: *F/35 top ring and chopping secondary mounted on the 3.6 m telescope.*

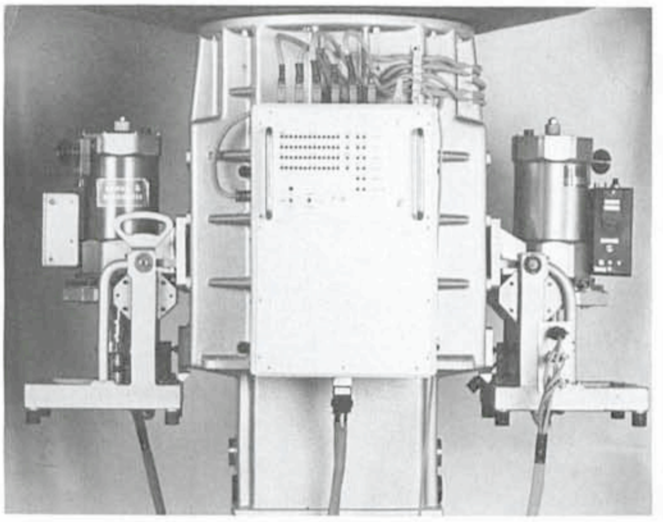
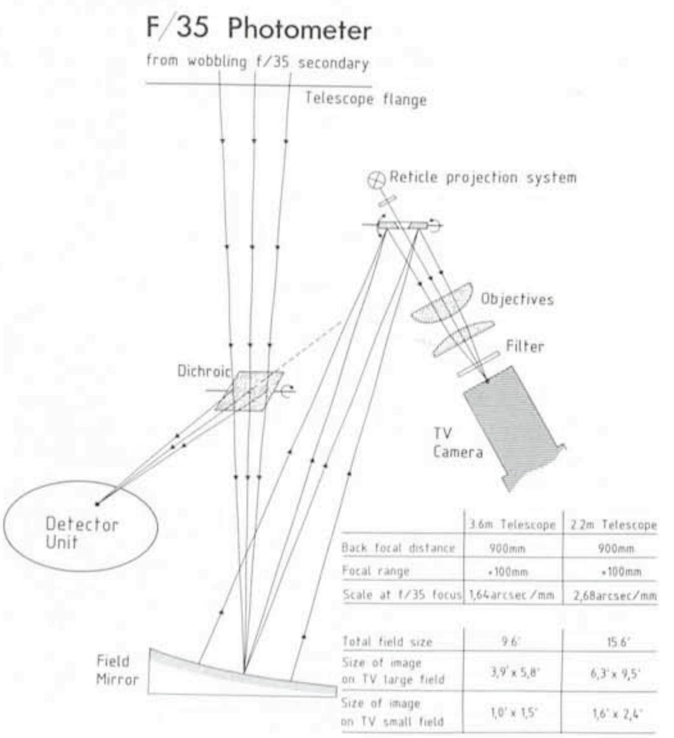


Fig. 2: *The new F/35 photometer.*

Photometer

Fig. 2 is a photograph of the new photometer mount shown supporting InSb and bolometer detector units equipped with standard photometric and CVF filters. The new speckle detector has also been designed to be compatible with this mount. Fig. 3 is a schematic of the optical layout and contains some basic data for the 3.6 m and also the 2.2 m telescope where it is planned to install an identical photometer for use with an F/35 chopping secondary unit to be built by the Max-Planck-Institut für Astronomie in Heidelberg. Although only one is shown, the detector units are in fact fed by separate dichroic mirrors which are supported in such a way that the centre of the field is either occupied by one of the dichroics or is completely unobstructed to allow acquisition of faint objects.



	3.6m Telescope	2.2m Telescope
Back focal distance	900mm	900mm
Focal range	±100mm	±100mm
Scale at f/35 focus	1,64arcsec/mm	2,68arcsec/mm
Total field size	9.6'	15.6'
Size of image on TV large field	3,9' x 5,8'	6,3' x 9,5'
Size of image on TV small field	1,0' x 1,5'	1,6' x 2,4'

Fig. 3: *Optical schematic of the photometer illustrating the principle of the TV acquisition/guiding system.*

The TV camera is fixed and views the field via the field mirror, a small flat mirror located at the pupil image formed by the field mirror and one of two objectives which determine the instantaneous field sizes given in Fig. 3. The large field offers higher sensitivity for acquisition while the small field has a more optimum scale for guiding. For the latter purpose, offset guide stars can be located by scanning the instantaneous fields over the total field by tilting the small flat mirror. To the observer, this is equivalent to a normal X, Y movement of either the camera or a more conventional guide probe. With this mirror at its "centre field" position, the optical cross projected onto the camera is centred on the infrared beam and, to facilitate centring guide stars, its size is matched to the small field and hence shows the extent of the latter within the large field. For acquisition, the observer has the choice of viewing the chopped or a single image (with the chopper stationary in either beam or centred) which can either be direct or through the dichroic. Similarly, the telescope can be guided directly on the object being observed through the dichroic or on an offset guide star. In practice, these choices are determined by the object brightness. During the test, the dark sky limits were $m_v \simeq 19$ (direct), 16.5 (bolometer dichroic) and 14.5 (InSb dichroic) but it is hoped to improve these limits in future by cooling the camera which was not possible on this occasion for technical reasons. Provision for daytime observing has also been made by installing a second, infrared sensitive, TV camera such that it or the normal camera can be selected by simply moving a mechanical slide to which both cameras are permanently attached. Unfortunately, this first test of its performance was somewhat disappointing. At about 45° from the Sun it is possible to see stars down to m_H (1.65 μm) $\simeq 5$. This is better than the normal camera and should help ease the problem of pointing (by checking the telescope pointing on bright stars) but is inadequate for guiding.

As with the chopper, all the photometer functions (except switching between TV cameras) are remotely controlled from the control room.

Performance

Magnitude limits (1σ, 30 min., $\Phi = 7.5''$) determined during the test are summarized in Table 1 together with the improvements gained relative to the old "F/8" system. These are consistent with the increased throughput of the telescope plus photometer ($\simeq 40$ % at 1.2 μm to $\simeq 25$ % at 20 μm) and the reduction in thermal background emission. At 3.8 μm, an effective emissivity of 0.15 was measured for the telescope plus photometer compared with a value of about twice this determined for the old system using the same technique. The wavelength dependence of the sensitivity gain is determined by the relative contributions of the noise from the detector (dominant at J, H), the telescope thermal emission (L, N) and the thermal sky emission (M, Q). Variable noise at N and Q coupled with rapidly varying humidity on the nights available

TABLE 1: *Limiting magnitudes and improvement relative to the F/8 system*

BAND	J	H	K	L	M	N	Q
Centre Wavelength (μm)	1.25	1.65	2.2	3.8	4.8	10.3	18.6
Limiting Magnitude*	20.6	19.8	19	14.7	11.7	8.8	≃4.5
Improvement w.r.t. F/8	0.5	0.4	0.6	0.8	0.3	0.4	≃0.2

* Limits correspond to the 1σ noise measured through a 7.5" diameter diaphragm with a total integration time of 30 min.

for performance tests suggests that the magnitude limits quoted for these bands may have been somewhat degraded by an additional sky noise component.

The new system also offers several other performance advantages which are less directly obvious. No significant chopping offset signals are generated for example and there is thus no baseline drifting due to telescope flexure during long integrations. The possibility of direct guiding through the dichroics avoids the loss of time required to find offset guide stars and the availability of an optically generated reference cross permits accurate optical centring independently of the electronic stability of the TV system. Some observational flexibility has also been gained by virtue of the fact that switching between detectors, changing the chopping amplitude and direction, etc. are now relatively easy operations from the control room.

Tentative Time-table of Council Sessions and Committee Meetings in 1985

May 20	Users Committee
May 21	Scientific Technical Committee
May 22–23	Finance Committee
May 30	Committee of Council, Berlin
May 30–31	Council, Berlin
June 4–5	Observing Programmes Committee, Zürich
November 12	Scientific Technical Committee
November 13–14	Finance Committee
December 11–12	Observing Programmes Committee
December 16	Committee of Council
December 17	Council

All meetings will take place at ESO in Garching unless stated otherwise.

A Word of Thanks

Many ESO staff have been involved in the project at various stages. For their technical support in Garching we would like particularly to thank D. Enard, G. Hess, G. Huster, B. Jensen, J.-L. Lizon, M. Moresmau, W. Nees, J. Paureau and G. Raffi. During the installation and test we were also ably assisted by the La Silla staff and are particularly grateful for the invaluable help given by T. Bohl, P. Bouchet, F. Gutierrez, G. Ihle, J. Roucher and K. Teschner.

AS 338 in Outburst, or How I Found my "Pet Symbiotic"

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Until some months ago, I used to envy those of my colleagues who were always talking and writing with tremendous enthusiasm about *their favourite object.* My recent observations of the symbiotic star AS 338 enable me now to tell an exciting story as well.

Did I Observe the Right Object?

Symbiotic systems contain late-type (bright) giants or Miras and, in addition, a hot radiation source. They are surrounded by gaseous and dusty envelopes. Therefore, their radiation should be polarized due to scattering in the atmospheres of the late-type stars and/or the circumstellar nebulae. In October 1983, I started a multifilter linear polarization survey of 16 symbiotic stars, using the 1.23 m telescope of the German-Spanish Astronomical Centre. Only four stars showed sufficiently large intrinsic polarization that could be separated from the interstellar component. These were such fashionable symbiotics as HM Sge, V1016 Cyg and R Aqr and, last not least, AS 338. The wavelength dependence of the polarization and the position angle of AS 338 as displayed in Fig. 1 show some interesting properties: a pronounced maximum of the polarization in the B-filter and a significant, sharp rotation of the position angle at H_α. In a forthcoming article in *Astronomy and Astrophysics* I shall show in detail that the polarization of AS 338 can be explained by two scattering regions: Mie scattering by solid particles in the extended atmosphere of the M star and Thomson scattering in an asymmetric circumstellar nebula (possibly an accretion disk around a companion star). Encouraged by this result I decided that AS 338 merits a more thorough investigation. Luckily, the low declination of AS 338 allows its observation from the southern hemisphere as well. In July/August 1983, I had observing time at ESO's 1.5 m and 50 cm telescopes for spectroscopic and photometric studies of southern symbiotic stars. During this observing run, I had already secured one IDS spectrum in the range 4500 to 6800 Å and UBVRI photometry of AS 338. Subsequently, I could convince my colleague F. J. Zickgraf of the importance of getting JHKL photometry of AS 338 during his own observing run at the ESO 1 m telescope in April 1984; and J. Bouvier, in July 1984, took another IDS spectrum at the 1.5 m telescope, covering from about 3650 to 8050 Å. The 1983 and 1984 spectrograms are presented in Fig. 2. They show strong emission lines of the Balmer series and He I and numerous weaker emission lines of singly ionized iron. Only a trace of the underlying late-type continuum is visible longward from H_α in the 1984 spectrogram. David Allen's recently published new "Catalogue of Symbiotic Stars" also contains a spectrum of AS 338, dated August 1978 (see Fig. 2). Even a quick look at this spectrogram shows it to be quite different from my own ones: In Allen's spectrogram, the Balmer lines and the He I lines are stronger and, in addition, there are emission lines of higer ionized species such as He II, [O III] and [Fe VII]. The M-type absorption spectrum is prominent with strong TiO bands. My surprise changed into fear when I recalled that, for identifying AS 338, I had not used a finding chart, but the description of its position given by P. Merrill and C. Burwell in 1950 (*Astrophysical Journal*, **112,** 72). Did I really observe the right object? Fortunately, during the observations, I had made a quick freehand drawing of the field around AS 338 as it appeared on the TV guider screen. A comparison of this "finding chart" with the one published now by Allen not only proves that I actually did observe the right object, but, in 1983, the star seemed to be much brighter compared to other field stars than on the POSS print used by Allen.

An Outburst?

The spectral changes and the brightening of AS 338 become explainable if we assume that it has undergone an outburst as sometimes observed in symbiotic stars. The published and new near IR data of AS 338 from 1974, 1980 and