2. Device Independent Graphics in MIDAS

After a long search for a simple yet effective device independent graphics system, the Astronet Graphics Library has been chosen to be implemented into the MIDAS system. This library has its origins within the Astronet project in Italy and met most of the criteria for the functionality of such a product. In particular, it is not proprietary as many commercial packages such as GKS are and does not require a license if used by academic or research organizations. The AGL library has the necessary subset of the GKS functionality for the MIDAS applications and is an efficient implementation of this functionality. Also it is supported by a strong group within the Astronet project that will insure its continued viability and adaptability in the future. It is anticipated that a release of the MIDAS system in the spring of 1986 will be adapted to the AGL library and will provide drivers for many of the standard graphics devices. In particular, better support of the almost Tektronix compatible family of graphics terminals is anticipated. A definitive list will be provided in a future "MIDAS Memo".

3. Device Independent Image Display Software

After the ST-ECF meeting in Paris in May, it became quite evident that there is a strong desire on the part of many users that some sort of device independent interfaces for image displays be developed along the lines of the device independent graphics standards. These interfaces would allow various image displays to be used with the MIDAS software or with any software that implements these interfaces. This is a more difficult problem than the graphics question since there are as yet no standards such as GKS available to serve as a model. Progress is nevertheless being made. A preliminary draft has been drawn up in collaboration with the STARLINK project in the UK and it is hoped that this set of interfaces will be mature enough for discussion by a wider audience in early 1986. Of course, the time scale for implementing these interfaces into MIDAS and providing support for various other display devices besides RAMTEK and DeAnza is still to be defined. Suggestions are more than welcome at this time and should be directed to Klaus Banse.

4. ESO Archives

The development of archiving of ESO data is proceeding in parallel with the Developments for the Space Telescope "Data Management Facility", and will share in principle the same hardware and most of the same software so that an integrated archiving system will exist.

On the hardware side, ESO is sharing 50 % of a data base computer known as "Intelligent Database Machine". This device implements hardware that permits fast searching of relations between various data. Also, an optical disk has been acquired for the permanent storage of data. Both these devices are in the process of being installed and tested in Garching and are not yet available for public access.

On the software side, programs and procedures are being developed in close collaboration with the ST-ECF and the Space Telescope Science Institute. This software will provide the necessary tools to determine what observations have been made and to retrieve data from the permanent storage. More on these developments will be available in future columns.

Spectrophotometry of Globular Cluster Stars with the CASPEC System; A Comparison with Results from Other Spectrographs

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I. What is the Aim of Abundance Determination in Globular Cluster Stars?

The globular cluster stars, as well as the field halo stars, are among the oldest observable objects of our Galaxy and even of the Universe. The abundance of metals in their atmosphere is small; it is the signature of still older objects which synthesized these metals out of the primordial material (essentially made of hydrogen and helium). The analysis of globular cluster stars provides a unique opportunity to understand the early history of our Galaxy.

During the last ten years, as échelle spectrographs were available at the Kitt Peak and Cerro Tololo 4 m telescopes, numerous globular cluster stars were analysed in detail (see for example the review paper of Pilachowski et al. 1983). Interesting information was gathered but a number of problems appeared.

In particular, it seems that although field halo stars and globular clusters were formed simultaneously (Carney 1979) there are some differences in the chemical composition of globular cluster stars and of the field halo stars. For example, it has been noted that in globular cluster stars the strength of the CN and the CH bands varies from star to star and in some clusters sodium and aluminium appear enhanced in "CN strong" stars.

It has been suggested (Iben and Renzini, 1984) that this phenomenon could be due to the crowding of the stars in a cluster: this crowding would lead to an accretion of the ejecta of intermediate AGB stars onto main sequence dwarfs (at the beginning of the evolution of the globular cluster). These ejecta

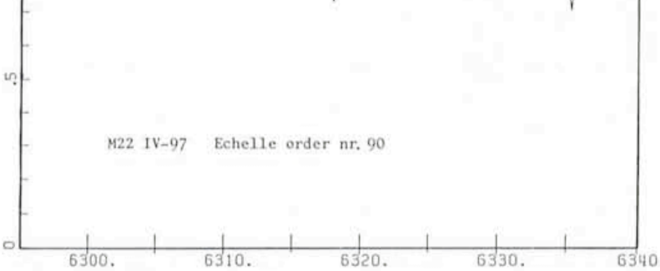

Fig. 1: *An example of a part of an echelle order.*

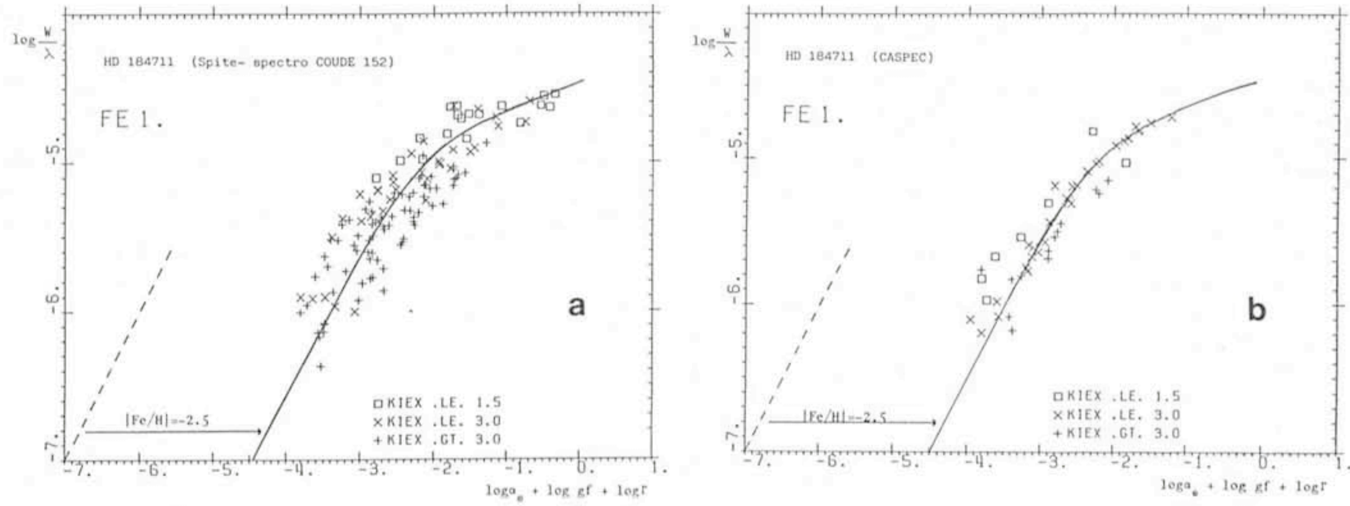

Fig. 2: *Curves of growth of HD 184711: (a) from photographic spectra (1.52 m telescope, coudé spectrograph); (b) from CASPEC spectra.*

could be enriched in carbon, nitrogen, sodium and aluminium according to Iben (1975).

A good way to test this explanation is to compare with high precision the relative abundances of the elements in the atmospheres of the globular cluster stars and of the halo field stars.

It is clear that the abundance anomalies that are expected in globular cluster stars are rather small (a factor of 2 or 3) and, therefore, their measurement requires a high accuracy in the determination of the abundances, especially when the element is represented by only a few lines and when these lines are weak.

II. The CASPEC Spectrograph and the Precision of the Data

First, we wondered whether the resolution of the CASPEC spectrograph was sufficient to study the abundance anomalies in globular cluster stars.

A first run of three nights was allocated at the 3.6 m telescope in June 1984. The weather is not always good in June but in spite of high winds, clouds and bad seeing we could obtain at least the spectra of one supergiant star in M22 and of one in ω Cen, as well as the spectrum of a typical halo field giant, HD 184711, as a reference star.

The 31.6 l/mm echelle and the 300 l/mm cross disperser gratings were used, which give a dispersion of 6 Å/mm and a resolution of 20,000. The ADU of the star spectra was about 1,000. Flat-field exposures were taken after each object exposure, using the quartz lamp. The reduction of the data was partly carried out at the ESO Garching facilities where the help of D. Ponz was greatly appreciated, and partly with our own programs on the VAX computer at Meudon; we checked that both reduction packages give the same results. An example of the tracing of the spectra is given in figure 1.

III. Comparison with a Star Previously Observed with Another Spectrograph: HD 184711

We first compared the results of the CASPEC with those of the 1.5 m coudé spectrograph. Some years ago, indeed, we obtained spectra of the field halo giant HD 184711 with this spectrograph (Spite and Spite 1979). The resolution of these spectra was approximately the same as the one of the CASPEC spectra but the range of wavelength was different (λ4300–6200 for the coudé spectra and λ6000–6900 for the CASPEC spectra). Thus the easiest way to compare the precision of the abundance determination was to compare the observed curves of growth built from the same model atmosphere with both sets of data. These curves of growth are

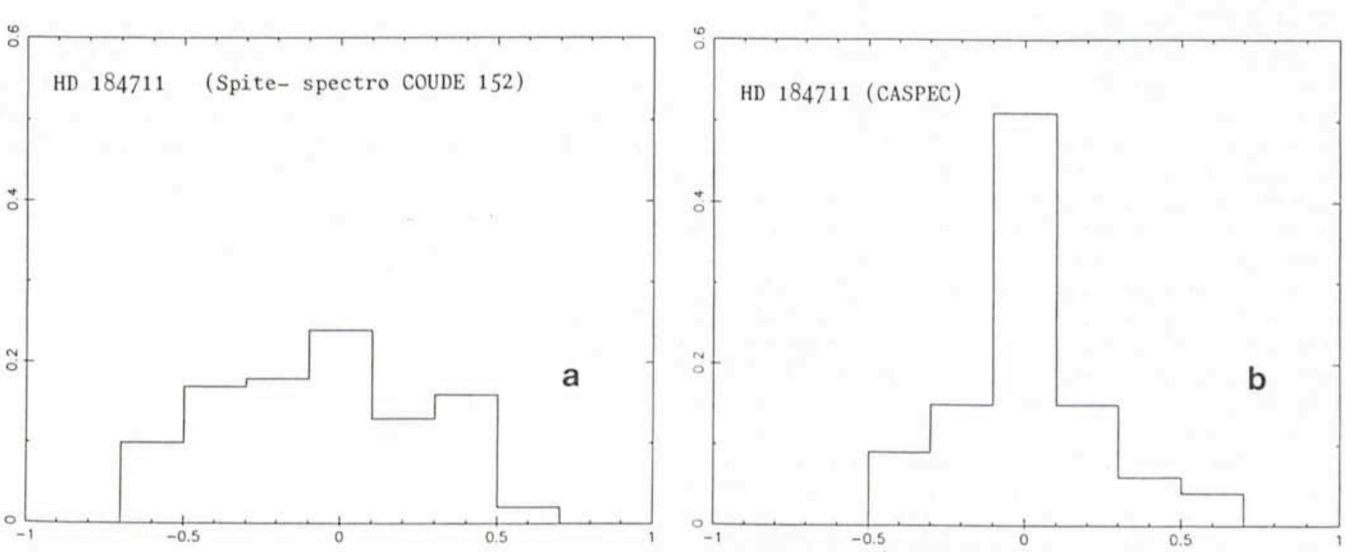

Fig. 3: *Histogram of the dispersion of FeI measurements around the curve of growth: (a) from photographic spectra (1.52 m telescope coudé spectrograph); (b) from CASPEC spectra.*

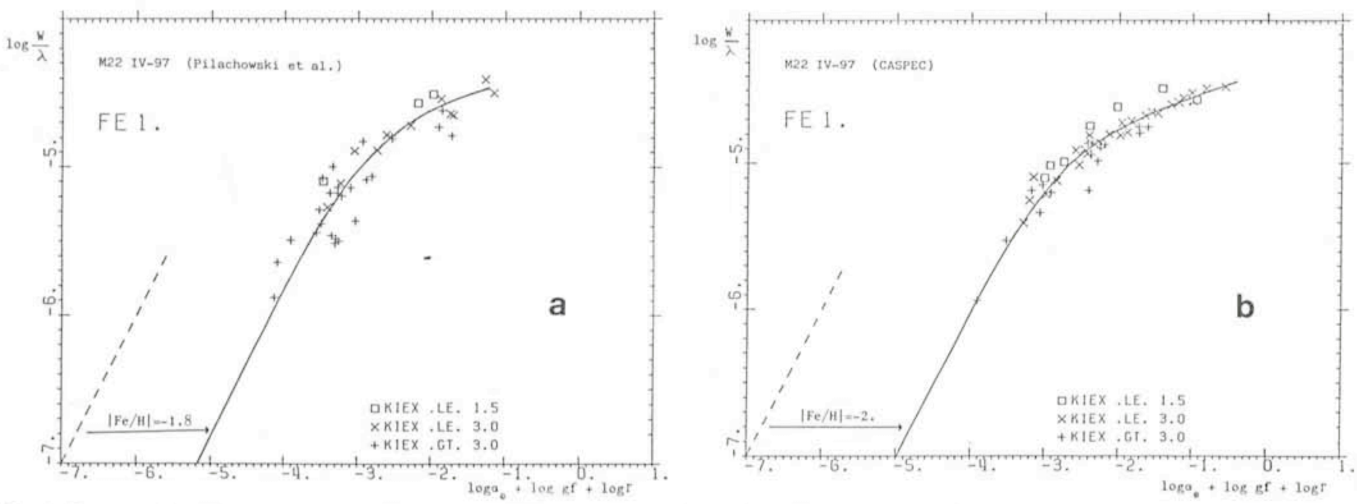

Fig. 4: *Curves of growth of M22 IV97 from echelle spectra: (a) at Kitt Peak (Pilachowski et al. 1982); (b) at ESO (CASPEC).*

displayed in figures 2a and 2b. The ordinate is log W/λ where W is the equivalent width of the line, and the abscissa is X = $\log\alpha_0 + \log gf + \log\Gamma$ where α_0 is the abundance of the element in the solar atmosphere, gf the oscillator strength of the line and Γ a parameter depending on the model and on the line (Cayrel and Jugaku 1963) computed line by line from the model of the star. The abundance of an element relative to the Sun ([Fe/H] for example) is then simply represented by the distance between the linear part of the curve of growth and the fiducial line logW/λ = X (fig. 2).

It can be seen, at first, that the mean abundance [Fe/H] = −2.5 is the same in figures 2a and 2b. But the standard deviation is smaller when the CASPEC data are used. This is striking in figure 3 where the histograms of the deviations of the abundances measured line by line, from the 1.5 m coudé photographic spectra and from the CASPEC spectra, are compared.

IV. Observation of a Star Already Observed at Kitt Peak: M22–IV97

This star is one of the brightest in M22. It has already been analysed by Pilachowski et al. (1982) using 6 Å/mm KPNO spectra in the range λ5300–6300 Å. We obtained a spectrum of this star in the range λ6000–6900 Å. The theoretical and observed curves of growth for the KPNO and the CASPEC data are drawn in figures 3a and 3b, and the histograms of the abundances computed line by line in figures 4a and 4b. Again the quality of the CASPEC data seems excellent.

Moreover, part of the abundance spread along the curve of growth is probably real. It can be seen indeed, in figure 3b, that the Fe abundance deduced from the low excitation potential lines (open squares) is higher than the abundance deduced from the high excitation potential lines (crosses). This phenomenon points towards a possible error on the temperature of the model or more probably a non-LTE effect in the atmosphere, leading to an over-population of the lower levels of the atom. To avoid this effect as far as possible, it is generally recommended not to use the low excitation potential lines in an abundance determination.

V. The Chemical Composition of M22–IV97 and ω Cen 65

Therefore, although the CASPEC echelle spectrograph arrived late at ESO we are convinced that many interesting works can be done with this excellent instrument, in particular about the chemical composition of the old galactic objects like the globular cluster stars (see also D'Odorico et al. 1985).

In Table 1 we present our preliminary abundance determinations in the atmospheres of the stars M22–IV97 and ω Cen 65.

The atmospheres of the stars have been simulated by models interpolated in the grid of the Gustafsson's models (Gustafsson et al. 1975) extended toward lower gravities and temperatures (Gustafsson 1977). Line transition probabilities were determined from a line by line analysis of the solar spectrum (Delbouille et al. 1973). For this work the Holweger solar model has been used (Holweger, Müller 1974). The damping constants of the lines were taken by adding 0.78 dex to the Van der Waals constant computed from the hydrogenic approximation of Unsöld (Aller, 1963).

The two stars are rather similar (the mean abundance of the elements is about 1/100 of solar abundance). Differences appear for Na, Al and Ba. Some recent theories can account for such anomalies.

The gravities of the stars have been computed by admitting that the star masses were about 0.8 $M_\odot$. It is clear that in this case the ionization equilibrium cannot be satisfied: the iron abundance is different when the neutral or the ionized lines are used. On the other hand, we are also able to confirm an H_α

TABLE 1
Abundance of the elements relative to the Sun

	M22 IV–97	ω Cen 65
Stellar parameters: θ_{eff}, log g, [M/H] v_t	1.26, 0.9, −1.9 2 km/s	1.26, 0.3, −1.8 2 km/s
Element	log $(A_*/A_\odot)$	log $(A_*/A_\odot)$
O I	−1.9	−1.8
Na I	−1.9	−2.3
Al I	−1.5	−1.1
Si I	–	−1.2
Ca I	−1.6	−1.5
Sc II	−1.7	−1.9
V I	−1.9	−1.9
Ti I	−1.6	−1.7
Ti II	−1.4	−1.4
Cr I	−2.3	−2.1
Fe I	−2.0	−1.9
Fe II	−1.4	−1.5
Ni I	−1.9	−1.9
Ba II	−1.3	−1.9

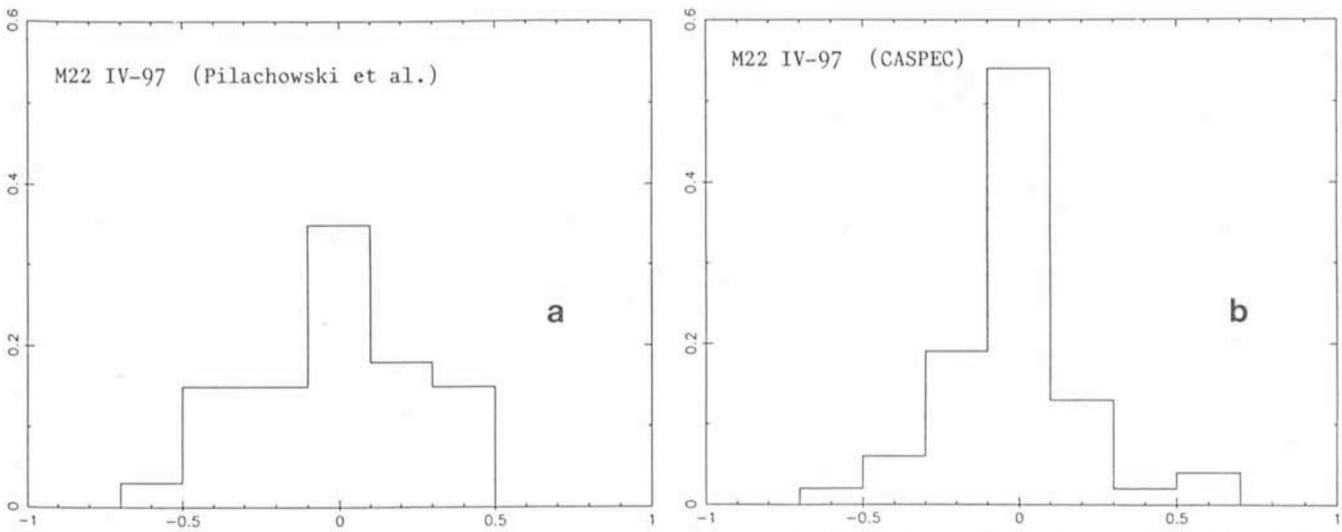

Fig. 5: *Histogram of the dispersion of FeI measurements of the star M22 IV97: (a) at Kitt Peak (Pilachowski et al. 1982); (b) at ESO (CASPEC).*

emission in these globular cluster stars and in the active star HD 184711 (Spite et al. 1981; Gratton et al. 1984).

In addition, we recently obtained some other excellent spectra of stars in ω Cen, NGC 6582, and in the Magellanic Clouds (field stars and globular cluster stars). All these spectra are now under reduction and seem very promising.

We are very grateful to Dr. D'Odorico for advising us about the optimal use of CASPEC and CCD for our program.

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High Resolution Monitoring of the Emission Lines in SS 433

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Introduction to SS 433

During the last few years the star 433 of the Stephenson Sanduleak catalogue of emission-line objects has become one of the most intensively observed sources in the Galaxy. It is believed to be an X-ray binary whose compact component is either a neutron star or a black hole. Attention was drawn to SS 433 in 1978 by Clark and Murdin (1978), who pointed out that independently discovered X-ray and radio sources were probably associated with SS 433. The object is situated at the center of a supernova remnant detected at radio wavelength (W 50) and showing Wolf-Rayet like winds.

It was in 1979 through a study of its optical spectrum by Bruce Margon that SS 433 entered the astronomical hall of fame. The spectrum is dominated by Hα emission lines although HeI, HeII and CIII/NIII are also present, as well as stellar and IS absorption lines. The remarkable discovery was that the Hα lines were split in three components. Two of them oscillate with opposite phase over a huge radial velocity range (–30,000 to +50,000 km/s) with a 164-day period. Shortly after Margon's discovery, Andy Fabian and Martin Rees suggested that these moving "satellite" lines arise in two oppositely directed jets and the kinematic "precessing jet" model developed in detail by Abell and Margon has had remarkable success in explaining observations of SS 433. Precession of the (v = 0.26 c) jets was invoked to explain the 164-day period (see e.g., Margon, 1984). Beautiful confirmation of this precessing jet model was provided by radio measurements by several groups which showed that SS 433 is resolved on various scales from less than 3 milliarcseconds up to 2 arcseconds, is jet-like and has a changing corkscrew structure which varies in good agreement with predictions of the model