NEW METHOD FOR MEASURING PHOTOGRAPHIC BINARIES

R. Pannunzio, Astronomical Observatory of Torino M. Scardia, Astronomical Observatory of Brera

ABSTRACT: Preliminary results of a new photographic technique applied to visual double stars are given. This technique consists in the determination of the ϱ , θ and Δ m from measurements made on two pairs of trails left by the components of a binary on a photographic plate, obtained through an adequate movement of the telescope in R.A. and declination.

1. INTRODUCTION

A new photographic technique applied to the visual double stars, that consists in the determination of the angular separation ϱ and the position angle θ from the measures taken on two pairs of photographic trails (fig. 1), obtained by the slow motions of the telescope, has been carried out at the Astronomical Observatory of Torino with the collaboration of the Observatory of Brera (Pannunzio and Scardia, 1980).

The telescope used in this research is the 41 inch astrometric reflector (f= 9943mm, scale value 20.744"/mm) of the Observatory of Torino (Armanelli et al., 1978).

2. TECHNIQUE OF OBSERVATION AND REDUCTION METHOD

The technique of observation can be summarized as follows:

- to operate on the slow motions of the telescope in order to obtain trails on photographic plates Kodak IIa-O (16x16 cm) as shown in figure 1, and not longer than 5 cm (in this way the effect of coma is avoided),
- to obtain a trail oriented East-West stopping the telescope drive.

16 multiple exposures on the same plate have been taken in order to compare the new method with the usual one.

All the plates were measured with a two-coordinates measuring machi ne of the Observatory of Torino and with a microdensitometer PDS 1010 of the Observatory of Naples.

With the measuring machine the X-Y coordinates of several points of each trail were measured in order to obtain the fundamental angles $lpha_{ extsf{1}}.$ $\alpha_{\rm o}, \alpha_{\rm o}$ with respect the instrumental axis as shown in the fig. 1.

With the PDS the trails have been measured by means of a rectangular slit (5x200 microns) which scanned 250 sections on each pair moving perpendicularly as shown in the fig. 2.

Each single scanning, made with steps of few microns in X-scale, gave a densitometric profile of the section.

This profile can be represented analyticallyby the following gauss sian function:

$$D_{i} = \sum_{j=1}^{2} A_{j} e^{-H_{j}^{2}(X_{i} - \overline{X}_{j})^{2}} + D_{s.b.}$$
 (i=1,n n= numb. of steps for each transverse section)

A least-squares solution applied to the recorded density gives the separation between the two trails in that section $(\overline{X}_2 - \overline{X}_1)$.

Repeating this procedure for all sections it is possible to find the mean separation \bar{Q}_1 , \bar{Q}_2 of the pairs of trails.

A generalized Carnot's formula applied to the value $\bar{\varrho}_1, \bar{\varrho}_2, \alpha_o$ above computed, gives the true mean angular separation $ar{Q}$ (fig. 1):

$$\overline{Q} = \sqrt{\frac{\overline{Q}_1^2 + \overline{Q}_2^2 - 2 \cdot \overline{Q}_1 \cdot \overline{Q}_2 \cdot \cos \alpha_0}{\sin^2 \alpha_0}}$$

The position angle heta is computed from an algebraic combination of the angles α_2 , α_3 , β as shown in the figure 1.

3. RESULTS

28 plates of four different double stars have been taken with this new method and with the usual one.

Table I summarizes the obtained results; the columns give: column 1: ADS number of the double star

- 2: plate number
- 3: date of observation
- 4: time of observation in U.T.
- 5: Q and \mathcal{E}_Q obtained with the trails method
- 6: Θ and $\mathcal{E}_{\Theta}^{\xi}$ " " " " " " 7: Q and \mathcal{E}_{Q} obtained with the multiple exposures method

column 8: Θ and ϵ_{Θ} obtained with the multiple exposures method. This new method gives also the difference of magnitude of the components, obtained provisionally by means of the curve of calibration of the plates Kodak IIa-O.

The results are:

```
ADS 1500 \Delta m = 0.44 +/- 0.01 (9 plates)
ADS 3274 \Delta m = 0.73 +/- 0.02 (10 plates)
```

All the previous results have been carried out with the computer Digital PDP 11/34 and PDP 11/10 of the Observatories of Brera and Torino.

4. CONCLUSION

From the analysis of the data we can deduce that the internal accuracy in ϱ and θ obtained with this new method is increased by a factor four, with respect the usual method of the multiple exposures.

The external accuracy in ϱ is always greater with this new method, particularly for double stars not too close.

On the other hand the external accuracy in the position angle is of the same order for both methods.

The main sources of systematic and accidental errors can be:

- different seeing conditions in different nights,
- differential refraction for each star depending from their colour.
- photographic effects for very close binaries,
- non adequate reduction method.

Taking into account the previous points, this new method can be optimized with improvements concerning the technique of observation and the reduction method.

REFERENCES

Armanelli L., Delgrosso A. and Pannunzio R.: 1978, Astron. and Astrophys. Suppl. Series 31, 121

Pannunzio R. and Scardia M.: 1980, Report of the Astron. Observ. of Merate N. 3/80

TABLE I

ADS 9979 2 4-SEP-80 20:00 6.630 ± 0.013 23.2.94 ± 0.00 6.617 ± 0.009 222.85 ± 0.04 6.617 ± 0.025 232.55 ± 0.04 6.617 ± 0.025 232.55 ± 0.04 6.617 ± 0.025 232.55 ± 0.04 6.617 ± 0.025 232.55 ± 0.04 6.617 ± 0.025 232.55 ± 0.04 6.617 ± 0.025 232.55 ± 0.04 6.617 ± 0.025 232.55 ± 0.04 6.617 ± 0.025 232.55 ± 0.04 6.617 ± 0.025 232.55 ± 0.04 6.617 ± 0.025 232.55 ± 0.04 6.37 ± 0.025 232.55 ± 0.04 6.37 ± 0.025 232.55 ± 0.04 6.37 ± 0.025 232.55 ± 0.04 6.37 ± 0.02 3 ± 0.27 ± 0.025 232.55 ± 0.04 6.37 ± 0.025 232.55 ± 0.04 6.37 ± 0.025 232.55 ± 0.03 ± 0.23 ± 0.027 ± 0.03 ± 0.027 ± 0.02 ± 0.03 ± 0.027 ± 0.06 ± 0.027 ± 0.02 ± 0	Г			
1 1 2 3 4 4 5 5 6 6 6 6 6 7 7 7 7 7 8 9 9 9 9 9 9 9 9 9 9 9 9 1 1 17-JUL-80 20:00		6.00		2.
1 1 7—JUL—80 20:00	∞			ļ į
1 17—JUL—80 20:00 6.630 ± 0.013 232.94 ± 0.10 6.617 ± 0.019 2 3 15—SEP—80 20:30 6.646 ± 0.006 232.44 ± 0.09 6.577 ± 0.033 2 15—SEP—80 20:30 6.646 ± 0.000 159.75 ± 0.09 6.577 ± 0.033 2 15—SEP—80 20:33 3.529 ± 0.000 159.75 ± 0.06 3.546 ± 0.019 1 1 2 2—0CT—80 22:35 3.529 ± 0.003 160.25 ± 0.06 3.546 ± 0.019 1 1 2 2—0CT—80 22:35 3.529 ± 0.003 160.25 ± 0.06 3.546 ± 0.019 1 1 2 2—0CT—80 22:39 3.480 ± 0.003 160.25 ± 0.06 3.546 ± 0.019 1 1 2 2—0CT—80 22:39 3.480 ± 0.003 160.25 ± 0.06 3.540 ± 0.019 1 1 2 2—0CT—80 22:30 3.481 ± 0.003 160.25 ± 0.06 3.540 ± 0.019 1 1 2 2—0CT—80 22:30 3.487 ± 0.005 159.98 ± 0.11 3.589 ± 0.016 1 3 470 ± 0.005 159.01 ± 0.12 3.596 ± 0.019 1 1 2 2—0CT—80 22:30 3.477 ± 0.005 159.98 ± 0.11 3.589 ± 0.016 1 3 470 ± 0.005 159.01 ± 0.12 3.596 ± 0.016 1 1 4 17—DEC—80 22:30		0 20	$\nabla \omega \circ \circ \circ 4 + 2 \circ - \omega \omega \nabla \circ 4 \circ \circ$	9.
1 1 7 JUL-80 20:00		mmm		205
1 1 7 JUL-80 20:00 6.630 ± 0.013 232.94 ± 0.10 6.601 ± 0.0 6.617 ± 0.0 6.601 ± 0.0 6.617 ± 0.0 6.0 6.617 ± 0.0 6.0 6.617 ± 0.0 6.0 6.617 ± 0.0 6.0 6.617 ± 0.0 6.0 6.617 ± 0.0 6.0 6.617 ± 0.0 6.0 6.617 ± 0.0 6.0 6.617 ± 0.0 6.0 6.617 ± 0.0 6.0 6.0 6.617 ± 0.0 6.0 6.0 6.0 6.0 6.0 6.0 6.0 6.0 6.0		1 - 0 m	\mathcal{L}	1001
1 1 7 - Jul80 20:00 6.630 ± 0.013 232.94 ± 0.10 6.601 6.601 3.542 ± 0.006 232.44 ± 0.09 6.577 6.205 0.203 6.645 ± 0.006 232.94 ± 0.09 6.577 6.205 0.203 0.203 0.203 159.87 ± 0.06 3.584 6.207 -80 22:35 3.529 ± 0.003 159.87 ± 0.06 3.584 6.28 - 0.77 -80 22:35 3.484 ± 0.003 150.50 ± 0.07 3.596 1.28 0.203 0.203 0.203 160.25 ± 0.06 3.584 1.28 0.007 -80 22:30 3.484 ± 0.003 160.25 ± 0.06 3.584 1.28 0.007 -80 22:30 3.484 ± 0.003 160.25 ± 0.06 3.584 1.28 0.007 -80 22:30 3.487 ± 0.005 159.98 ± 0.13 3.529 1.39 0.007 -80 22:30 3.427 ± 0.005 159.98 ± 0.13 3.529 1.39 0.007 -80 22:30 3.445 ± 0.005 159.98 ± 0.13 3.529 1.39 0.007 150.01 ± 0.12 3.596 1.39 0.007 -80 22:30 22:30 3.445 ± 0.005 159.98 ± 0.13 3.529 1.39 0.007 150.01 ± 0.12 3.596 1.39 0.007 150.01 ± 0.12 3.596 1.39 0.007 150.01 ± 0.12 3.596 1.39 0.007 150.01 ± 0.12 3.596 1.39 0.007 150.01 ± 0.12 3.596 1.39 0.007 150.01 ± 0.12 3.596 1.39 0.007 150.01 ± 0.007 150.01 ± 0.12 3.596 1.39 0.007 150.01 ± 0.007 150.0		/ 0 0 0		
1 1 77—JUL—80 20:00 6.630 ± 0.013 232.94 ± 0.10 6.60 6.60 3 15-SEP—80 20:00 6.646 ± 0.006 232.44 ± 0.09 6.577 6.20 6.507 3.524 ± 0.005 232.94 ± 0.09 6.577 3.59 6.267—80 22:35 3.529 ± 0.003 159.87 ± 0.06 3.58 6.28 - 0.07—80 22:35 3.484 ± 0.003 160.25 ± 0.06 3.58 7.28 - 0.07—80 22:30 3.484 ± 0.003 160.25 ± 0.06 3.58 7.28 - 0.07—80 22:30 3.484 ± 0.003 160.25 ± 0.00 3.58 7.28 - 0.07—80 22:30 3.484 ± 0.003 160.25 ± 0.01 3.59 7.29 10 9-DEC-80 22:30 3.427 ± 0.005 159.98 ± 0.13 3.52 7.29 10 9-DEC-80 22:30 3.445 ± 0.005 150.01 ± 0.12 3.59 11 9-DEC-80 22:30 3.445 ± 0.005 150.01 ± 0.12 3.59 11 9-DEC-80 22:30 3.445 ± 0.005 150.01 ± 0.12 3.59 11 7.28 - 0.07—80 23:15 10.33 ± 0.007 309.10 ± 0.05 10.31 3.59 11 3.00 11 2.29 - 0.005 150.01 ± 0.01 3.59 10.31 2.20 9-DEC-80 23:15 10.33 ± 0.007 309.10 ± 0.00 10.29 10.29 10.31 2.20 9-DEC-80 22:35 10.33 ± 0.007 308.57 ± 0.00 10.33 2.20 9-DEC-80 22:35 10.33 ± 0.007 308.57 ± 0.00 10.33 2.20 9-DEC-80 22:35 10.33 ± 0.007 308.57 ± 0.00 10.33 2.20 9-DEC-80 22:35 10.33 ± 0.007 308.57 ± 0.00 10.33 2.20 10.33 2.20 10.33 2.20 10.33 2.20 10.33 2.20 22:35 10.33 7 ± 0.005 308.57 ± 0.00 10.33 2.20 10.33 2.20 10.33 2.20 22:35 10.33 7 ± 0.005 308.57 ± 0.00 10.33 2.20 10.33 2.20 22:35 10.33 7 ± 0.005 308.57 ± 0.00 10.33 2.20 22:35 10.33 7 ± 0.005 308.62 ± 0.00 10.33 2.20 22:35 10.33 7 ± 0.005 308.57 ± 0.00 10.33 2.20 22:35 10.33 7 ± 0.005 308.57 ± 0.00 10.33 2.20 22:35 10.33 7 ± 0.005 308.57 ± 0.00 10.33 2.20 22:35 10.33 7 ± 0.005 308.57 ± 0.005 308.57 ± 0.005 308.57 ± 0.005 308.57 ± 0.005 308.57 ± 0.005 308.57 ± 0.005 308.57 ± 0.005 308.57 ± 0.005 308.57 ± 0.005 308.50 ± 0.	7	+ + +		
1 17—JUL—80 20:00	ļ	100	48948539959555555	0
1 17—JUL—80 20:00 6.630 ± 0.013 232.94 ± 0.10 6.646 ± 0.006 232.44 ± 0.09 2 15.5 m² 8 15.5 m² 8 20:00 6.646 ± 0.006 232.44 ± 0.09 2 15.5 m² 8 27-00T—80 22:35 3.524 ± 0.002 159.87 ± 0.06 2 28-00T—80 22:35 3.529 ± 0.003 160.25 ± 0.06 8 30-00T—80 22:30 3.484 ± 0.003 160.25 ± 0.06 8 30-00T—80 22:30 3.484 ± 0.003 160.25 ± 0.06 8 30-00T—80 22:30 3.484 ± 0.003 160.25 ± 0.06 11 9.00 11 9-0 m² 8 30-00T—80 22:30 3.484 ± 0.005 159.98 ± 0.13 13 9-0 m² 8 20:30 22:30 3.484 ± 0.005 159.98 ± 0.13 13 9-0 m² 8 20:30 3.427 ± 0.005 159.98 ± 0.13 13 9-0 m² 8 21:25 3.449 ± 0.005 159.98 ± 0.13 14 17-0 m² 8 20:31 5 10.333 ± 0.007 309.10 ± 0.05 160.25 ± 0.19 17 28-0 m² 8 22:30 22:30 3.449 ± 0.005 180.32 ± 0.005		· • • •		4.
1 17-JUL-80 20:00 6.630 ± 0.013 232.94 ± 0.1 3 15-SEP-80 20:00 6.646 ± 0.006 232.44 ± 0.0 3 15-SEP-80 20:30 6.646 ± 0.006 232.44 ± 0.0 3 15-SEP-80 20:30 6.646 ± 0.006 232.94 ± 0.0 5 28-OCT-80 22:35 3.529 ± 0.003 159.87 ± 0.0 7 28-OCT-80 22:35 3.484 ± 0.003 160.25 ± 0.0 8 30-OCT-80 22:50 3.484 ± 0.003 160.25 ± 0.0 9 30-OCT-80 22:50 3.484 ± 0.003 160.25 ± 0.0 11 9-DEC-80 20:30 3.412 ± 0.005 159.98 ± 0.1 12 9-DEC-80 20:30 3.412 ± 0.005 159.98 ± 0.1 13 9-DEC-80 20:30 3.412 ± 0.005 159.98 ± 0.1 14 17-DEC-80 20:30 3.412 ± 0.005 159.98 ± 0.1 15 17-DEC-80 20:45 3.445 ± 0.005 159.98 ± 0.1 16 17-DEC-80 20:45 3.445 ± 0.005 159.98 ± 0.1 17 28-OCT-80 20:30 3.412 ± 0.005 150.25 ± 0.1 18 30-OCT-80 20:30 10.333 ± 0.007 309.10 ± 0.0 19 30-OCT-80 20:30 10.325 ± 0.005 308.34 ± 0.0 22 9-DEC-80 20:30 10.325 ± 0.005 308.35 ± 0.0 23 9-DEC-80 20:30 10.325 ± 0.005 308.32 ± 0.0 24 17-DEC-80 20:30 10.325 ± 0.005 308.35 ± 0.0 25 17-DEC-80 20:30 10.325 ± 0.005 308.85 ± 0.0 26 17-DEC-80 20:20 10.337 ± 0.005 308.85 ± 0.0 26 17-DEC-80 20:20 10.327 ± 0.005 308.85 ± 0.0 26 17-DEC-80 20:20 10.327 ± 0.005 308.85 ± 0.0 26 17-DEC-80 20:20 10.327 ± 0.005 308.85 ± 0.0 26 17-DEC-80 20:20 10.327 ± 0.005 308.85 ± 0.0 26 17-DEC-80 20:20 10.327 ± 0.005 308.85 ± 0.0 26 17-DEC-80 20:20 10.327 ± 0.005 308.85 ± 0.0 26 17-DEC-80 20:20 10.327 ± 0.005 308.85 ± 0.0 27 17-DEC-80 20:20 10.327 ± 0.005 308.85 ± 0.0 28 27 17-DEC-80 20:20 10.327 ± 0.005 308.85 ± 0.0 29 20 20 20 20 20 20 20 20 20 20 20 20 20	-	0 6	00 L 0	5
1 17-Jull-80 20:00 6.630 ± 0.013 232.94 ± 4 4 - 25EP-80 20:00 6.646 ± 0.006 232.44 ± 4 1 - 0CT-80 22:35 3.529 ± 0.003 159.87 ± 4 1 - 0CT-80 22:35 3.529 ± 0.003 159.87 ± 6 28-0CT-80 22:35 3.480 ± 0.003 160.25 ± 6 28-0CT-80 22:30 3.480 ± 0.003 160.25 ± 1 2 8-0CT-80 22:30 3.480 ± 0.003 160.25 ± 1 2 9-DEC-80 22:30 3.487 ± 0.005 159.98 ± 1 9-DEC-80 20:30 3.427 ± 0.005 159.98 ± 1 9-DEC-80 20:10 3.445 ± 0.005 159.01 ± 1 9-DEC-80 20:10 3.445 ± 0.005 159.01 ± 1 1 9-DEC-80 20:10 3.445 ± 0.005 159.01 ± 1 1 1 2-DEC-80 20:10 3.445 ± 0.005 158.51 ± 1 1 1 2-DEC-80 20:10 3.445 ± 0.005 158.51 ± 1 1 1 2-DEC-80 20:10 3.449 ± 0.005 160.25 ± 1 1 1 2-DEC-80 20:10 3.449 ± 0.005 160.25 ± 1 1 1 2-DEC-80 20:10 3.449 ± 0.005 188.3 ± 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		0		
1 17—JUL-80 20:00 6.630 ± 0.013 232.9 4 1—0CT-80 20:30 6.646 ± 0.006 232.4 4 1—0CT-80 22:35 3.529 ± 0.003 159.8 3.0-CT-80 22:35 3.529 ± 0.003 159.8 3.0-CT-80 22:35 3.529 ± 0.003 159.8 3.0-CT-80 22:35 3.484 ± 0.003 160.5 17 28—0CT-80 22:30 3.484 ± 0.005 159.0 17 28—0CT-80 22:30 3.484 ± 0.005 159.9 11 9—DEC-80 20:30 3.445 ± 0.005 159.9 11 9—DEC-80 21:30 3.449 ± 0.005 159.9 11 9—DEC-80 21:25 3.449 ± 0.005 308.4 11 3.0-CT-80 22:35 10.331 ± 0.005 308.4 11 3.0-CT-80 22:35 10.332 ± 0.004 308.3 22 47 10.337 ± 0.005 308.3 22 47 10.307 ± 0.005 308.3 22 47 10.307 ± 0.005 308.3 22 47 10.307 ± 0.005 308.3 22 47 10.307 ± 0.005 308.3 22 47 10.307 ± 0.005 308.3 22 47 10.307 ± 0.005 308.3 22 47 10.307 ± 0.005 308.3 22 47 10.307 ± 0.005 308.3 22 47 10.307 ± 0.005 308.3 22 47 10.307 ± 0.005 308.3 22 47 10.307 ± 0.005 308.3 22 47 10.307 ± 0.005 308.3 22 47 10.307 ± 0.005 308.3 22 47 10.207 ± 0.005 308.	9			
1 17—JUL—80 20:00 6.630 ± 0.013 232. 4—SEP—80 20:30 6.646 ± 0.006 233. 5 27—0CT—80 22:35 3.524 ± 0.002 159. 6 28—0CT—80 22:35 3.524 ± 0.002 159. 6 28—0CT—80 22:35 3.484 ± 0.003 160. 9 20:00 22:30 3.484 ± 0.003 160. 17 28—0CT—80 22:50 3.484 ± 0.003 160. 18 30—0CT—80 22:50 3.484 ± 0.003 160. 19 9—DEC—80 22:50 3.484 ± 0.003 160. 10 9—DEC—80 22:50 3.484 ± 0.003 180. 10 3.445 ± 0.00			F. Ø R. 9 9 0 0 0 R R 9 1 + 4 W 4 R W R Ø Ø Ø	89
1 17—JUL—80 20:00 6.630 ± 0.013 2 4—SEP—80 20:00 6.646 ± 0.006 3 15—SEP—80 20:30 6.646 ± 0.006 3 15—SEP—80 20:30 6.646 ± 0.006 3 15—SEP—80 20:30 22:35 3.529 ± 0.002 2 2 10 3 1.003 3.640 ± 0.003 3.0007—80 22:35 3.484 ± 0.003 3.0007—80 22:30 3.484 ± 0.003 3.0007—80 22:30 3.484 ± 0.003 3.0007—80 22:50 3.484 ± 0.003 3.0007—80 22:50 3.484 ± 0.003 3.0007—80 22:50 3.484 ± 0.003 3.0007—80 22:50 3.484 ± 0.003 3.0007—80 22:50 3.484 ± 0.003 3.0007—80 22:50 3.489 ± 0.003 3.0007—80 22:50 3.499 ± 0.003 3.499 ± 0.00		1 00		07
1 2 3 4 5 5	-	 		
1 2 3 4 55 9979 2 4-SEP-80 20:00 6.630 ± 0. 3 15-SEP-80 20:30 6.646 ± 0. 3 15-SEP-80 20:30 6.646 ± 0. 3 15-SEP-80 20:30 6.646 ± 0. 5 27-00T-80 22:35 3.529 ± 0. 7 28-00T-80 22:35 3.484 ± 0. 8 30-00T-80 22:30 3.487 ± 0. 11 9-DEC-80 20:30 3.419 ± 0. 12 9-DEC-80 20:45 3.470 ± 0. 13 9-DEC-80 21:10 3.449 ± 0. 14 17-DEC-80 21:25 3.449 ± 0. 15 17-DEC-80 21:25 3.449 ± 0. 16 17-DEC-80 21:25 3.449 ± 0. 17 28-00T-80 22:30 3.419 ± 0. 18 30-00T-80 22:30 3.419 ± 0. 20 9-DEC-80 22:30 3.419 ± 0. 21 30-00T-80 22:30 10.335 ± 0. 22 9-DEC-80 22:30 10.326 ± 0. 23 9-DEC-80 22:30 10.326 ± 0. 24 17-DEC-80 22:25 10.326 ± 0. 25 17-DEC-80 22:25 10.327 ± 0. 26 17-DEC-80 22:25 10.327 ± 0. 27 17-DEC-80 22:25 10.327 ± 0. 28 27 17-DEC-80 22:25 10.327 ± 0. 29 20 20 20 20 20 20 20 20 20 20 20 20 20	i !	01		00
1 2 3 4				
1 2 3 4 1 17-JUL-80 20:00 9979 2 4-SEP-80 20:00 4 1-0CT-80 20:30 6.66 5 27-0CT-80 22:35 3.55 6 28-0CT-80 22:35 3.55 7 28-0CT-80 22:30 3.48 8 30-0CT-80 22:30 3.48 11 9-DEC-80 20:30 3.49 12 9-DEC-80 20:30 3.49 13 9-DEC-80 20:30 3.49 14 17-DEC-80 20:30 3.49 15 17-DEC-80 20:30 3.49 16 17-DEC-80 20:45 3.49 17 28-0CT-80 20:45 3.49 18 30-0CT-80 20:45 3.49 19 30-0CT-80 22:50 10.3 20 9-DEC-80 22:00 10.3 22 9-DEC-80 22:25 10.3 23 9-DEC-80 22:25 10.3 24 17-DEC-80 22:25 10.3 25 17-DEC-80 22:25 10.3 26 17-DEC-80 22:25 10.3 27 17-DEC-80 22:25 10.3 28 20 17-DEC-80 22:25 10.3 29 20 20:40 4.7	5	1	4004 FOROSO MERUAGEFAT	-0
1		99	CC44 444444 Immumumumumu	.7
1 17—JUL—80 20:00 9979 2 4—SEP—80 20:00 3 15—SEP—80 20:00 3 15—SEP—80 20:30 4 1—0СТ—80 22:36 6 28—0СТ—80 22:36 7 28—0СТ—80 22:36 8 30—0СТ—80 22:36 9 30—0СТ—80 22:36 11 9—DEC—80 20:31 13 9—DEC—80 21:12 14 17—DEC—80 21:31 15 17—DEC—80 23:31 16 17—DEC—80 23:31 17 28—0СТ—80 23:31 18 30—0СТ—80 23:31 19 30—0СТ—80 23:31 20 9—DEC—80 23:31 22 9—DEC—80 23:32 24 17—DEC—80 23:32 25 17—DEC—80 23:32 26 17—DEC—80 22:22 27 17—DEC—80 22:32 28 17—DEC—80 22:32 28 17—DEC—80 22:32 29—DEC—80 22:32 26 17—DEC—80 22:32 27 17—DEC—80 22:32 28 17—DEC—80 22:32 28 17—DEC—80 22:32	İ		immmm mmmmm loooooooo	
1 17—JUL—80 20 9979 2 4—SEP—80 20 3 15—SEP—80 20 3 15—SEP—80 20 4 1—0CT—80 24 5 27—0CT—80 22 7 28—0CT—80 22 8 30—0CT—80 22 9 30—0CT—80 22 11 9—DEC—80 20 12 9—DEC—80 20 13 9—DEC—80 20 14 17—DEC—80 21 14 17—DEC—80 21 15 17—DEC—80 23 16 17—DEC—80 23 17 28—0CT—80 23 18 30—0CT—80 23 19 30—0CT—80 23 20 9—DEC—80 22 20 9—DEC—80 22 21 9—DEC—80 22 22 9—DEC—80 22 23 9—DEC—80 22 24 17—DEC—80 22 25 17—DEC—80 22 26 17—DEC—80 22 27 17—DEC—80 22 28 17—DEC—80 22 28 20—DEC—80 22 29—DEC—80 22 20 20—DEC—80 22 20 20—DEC—80 22 21 17—DEC—80 22 22 20—DEC—80 22 23 3—DEC—80 22 24 17—DEC—80 22 25 17—DEC—80 22 26 17—DEC—80 22 27 17—DEC—80 22 28 27 17—DEC—80 22 28 27 17—DEC—80 22 29 20—DEC—80 22 20 20—DEC—80 22 20 20—DEC—80 22 20 20—DEC—80 22 20 20—DEC—80 22 20 20—DEC—80 22 20 20—DEC—80 22 21 20—DEC—80 22 22 20—DEC—80 22 23 3—DEC—80 22 24 17—DEC—80 22 25 27—DEC—80 22 26 27—DEC—80 22 27—DEC—80 22 28 27—DEC—80 22 28 27—DEC—80 22 29—DEC—80 22 20 20—DEC—80 22 20 20—DE		100 m	wwwwwww4-w4001w0w40000	1 4 2
1 17—JULY 9979 2 4—SEP 3 15—SEP 3 15—SEP 4 1—0CT 7 28—0CT 7 28—0CT 11 9—DEC 11 9—DEC 11 9—DEC 12 9—DEC 13 9—DEC 14 17—DEC 15 0 9—DEC 16 17—DEC 24 17—DEC 24 17—DEC 25 17—DEC 26 17—DEC 26 17—DEC 27 17—DEC 28 9—DEC 29—DEC 29—DEC 29—DEC 20 9—DEC 21 17—DEC 21 17—DEC 22 20—DEC 23 20—DEC 24 17—DEC 25 17—DEC 26 17—DEC 26 17—DEC 27 17—DEC	4	i 0 0 0	42222200 	22
1 17—JULY 9979 2 4—SEP- 3 15—SEP- 3 15—SEP- 4 1—0CT- 5 27—0CT- 6 28—0CT- 7 28—0CT- 9 30—0CT- 11 9—DEC 12 9—DEC 13 9—DEC 14 17—DEC 15 17—DEC 16 17—DEC 17 28—0CT- 18 30—0CT- 18 30—0CT- 19 30—0CT- 10 30—0CT- 11 28—0CT- 12 9—DEC 13 9—DEC 14 17—DEC 22 9—DEC 24 17—DEC 24 17—DEC 25 17—DEC 26 17—DEC		80		9 9 9 9
1 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	3	1 TO		日 日 日 日 日 日 日 日 日 日 日 日 日 日 日 日 日 日 日
1		1 2 2 2		
32.74 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2				
	2	ļ		2 2
		1 0	i O I D	4068
AI A	-	į	!	!!!
		AD,	AI	AI

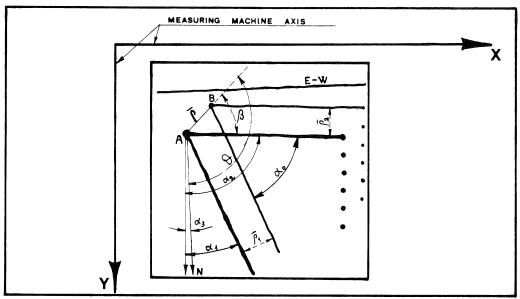


Fig. 1

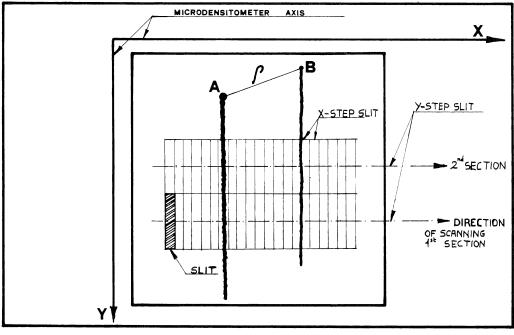


Fig. 2