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REPLY TO LUYTEN'S CRITICISM OF THE LICK AUTOMATIC MEASURING ENGINE

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FOREWORD

Donald E. Osterbrock

The paper entitled "Proper Motion Survey with the Forty-Eight Inch Schmidt Telescope LIII. Proper Motions for 3040 Stars in the Hyades," written, published and circulated by William J. Luyten, University of Minnesota, contains a vitriolic personal attack on a young Lick Observatory staff member, Robert B. Hanson, as well as an attack on the scientific results from the Lick Proper Motion Survey. Dr. Luyten did not send a copy of this paper to Dr. Hanson nor to anyone else at Lick Observatory for comments in advance of publication, nor did he send a copy of the paper to Lick Observatory when it was published. We first became aware of the existence of Dr. Luyten's paper when an astronomer from another institution, visiting Lick Observatory, told us about it and then, at my request, sent us a copy. After receiving it, I wrote to Dr. Luyten, requesting him to make space available to us for a scientific reply in the series that he controls. In a long and intemperate letter he refused to do so.

I very much regret that this departure from the usual scientific amenities has denied us the opportunity to reply in the normal way in the same series, and has raised the problem of how to respond to an attack that has appeared in a privately controlled publication, not subject to the impersonal refereeing procedure nearly universal among scientific journals.

We have sought counsel widely on whether or not to respond, and have received a wide spectrum of advice. One point of view is that since Dr. Hanson is only the latest in a series of astronomers, including R. A Lyttleton, O. J. Eggen, J. L. Greenstein, J. H. Oort, Z. Kopal, W. F. van Altena, H. L. Giclas, D. E. Weistrop, and probably others, who have incurred Dr. Luyten's displeasure and have been excoriated in print, we should realize that little responsible astronomical attention will be given to another diatribe from this source. A second opinion is that Dr. Luyten's paper should be ignored altogether, on the ground that vilification delivered in its style deserves no rational or reasoned response. We ourselves feel there is a more charitable reason not to reply; we all have a sincere admiration for Dr. Luyten's large and very real contributions to astronomy in the past, and we feel that to call wide attention to such a petty and querulous attack cannot help but diminish his image as a major scientist.

Nevertheless, we have decided for several reasons to issue a reply to the criticisms put forward by Dr. Luyten in his paper. Most importantly, we believe that a young astronomer near the beginning of his career cannot be allowed to stand alone and undefended before this attack of a well known figure such as Dr. Luyten. Furthermore, to the extent that Dr. Luyten has raised legitimate scientific questions, they deserve a considered and impersonal response. Finally, we are concerned that silence on our part might be misinterpreted as an admission that we accept Dr. Luyten's charges as correct. Therefore, for these reasons we have decided to publish the following response, by B. F. Jones, which sets out the facts quite well. Dr. Jones is in charge of the Lick astrometric programs and is thoroughly familiar with the past and present astrometric activities here, as well as with the associated instrumentation. I urge every astronomer who is in any doubt about Dr. Luyten's charges to compare his innuendos and highly selected examples with this measured reply. I believe that the issue will thereby be settled in the mind of any fair and unprejudiced reader. We have no intention of prolonging this regrettable controversy by any further publications.

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REPLY TO LUYTEN'S CRITICISM OF THE LICK AUTOMATIC MEASURING ENGINE

B. F. Jones

I. INTRODUCTION

Luyten (1969, 1975, 1976, 1980) has published several criticisms of work done on the Lick Automatic Measuring Engine (AME). We discuss here in some detail the criticisms published in 1980, showing that while Luyten found a few errors in the work, the substance of his criticism is without foundation and results from either a misreading of the published papers or a faulty statistical analysis. Most of Luyten's criticism is directed at three papers on the Hyades (van Altena 1966, vA I; van Altena 1969, vA II; and Hanson 1975), and at the Lick Pilot Proper Motion Program (Klemola, Vasilevskis, Shane, and Wirtanen 1971).

Van Altena blinked the region of the Hyades using the Lick survey machine in a search for Hyades members in vA I. This work was done before the completion of the AME. The proper motions were measured at the survey machine using a comparator, the least reading of which corresponded to a motion of 1$''$.9 cent^{-1}, and this he took to be his error. Colors and magnitudes were determined from image diameter measurements made on Palomar Sky Survey prints. Later, after completion of the AME, van Altena returned to Lick to measure his plates on the AME, and the proper motions were recomputed using these measures. These results were presented in vA II, where the proper motions showed a marked improvement in accuracy over vA I. However, the colors and magnitudes were largely carried over from vA I.

Hanson (1975) measured five plates to determine absolute proper motions of Hyades stars by referring their motions to external galaxies. Two of his plates were the ones blinked by van Altena. His main purpose was to determine the Hyades distance. For this work he received the Trumpler Award of the Astronomical Society of the Pacific.

The Lick Pilot Proper Motion Program was undertaken mainly to test reduction procedures for the Lick Proper Motion Program now in progress. This program is a survey of the entire sky north of −23°, which will eventually produce the proper motions for several hundred thousand stars. By referring the motions to external galaxies, the proper motions will be on an absolute system.

Most of Luyten's criticisms fall into two categories: (1) individual stars with large errors, in motion or photometry; and (2) comparisons of selected stars in common between two data sets that indicate much larger errors than the authors claim. We will show below in some detail that (1) most of the individual stars cited either are noted as being discrepant by the author or are misidentifications; and (2) in computing differences between different authors, Luyten uses highly selective samples. We will discuss Luyten's criticism of the Hyades data of van Altena and Hanson, the criticism of the Pilot Program, and briefly the other work done with the AME.

II. HYADES PHOTOMETRY

The photometry in vA I and II did not make use of the Lick AME or the Carnegie astrograph plates. Instead, it used image diameter measurements made on Palomar Sky Survey prints. Thus any criticism of van Altena's photometry has no bearing on the accuracy of the AME, or on the astrograph plates. Hanson's photometry did use the AME and astrograph plates. Luyten confuses van Altena's and Hanson's error estimates, stating that van Altena claims his "photometry readings have an accuracy of $\pm 0^m.04$, and that for $7 < V < 14$ his mean errors are $\pm 0^m.26$ for V and $\pm 0^m.23$ for B-V." These quoted errors are, in fact, from Hanson's paper. Van Altena gives an error estimate only for B-V, $\sigma(B-V) = 0.16$, and states that his method breaks down for stars brighter than magnitude 11. Because of lack of standards for faint stars, Hanson says his photometric errors may reach 1^m or more near the plate limit.

Luyten compares all stars in common between Hanson and van Altena, completely ignoring the above limits where good photometry is claimed, and also ignoring misidentifications that were pointed out by Hanson in a note added in proof to his paper. The r.m.s. differences for these stars are $\sigma_V = 0^m.69$, $\sigma_{(B-V)} = 0^m.43$, which are inevitably larger than van Altena's and Hanson's error estimates. In the color and magnitude range in which standards exist, the comparison between Hanson and van Altena is

$$\Delta V = 0^m.06, \qquad \sigma_{\Delta V} = 0^m.37,$$

$$\Delta(B-V) = 0^m.20, \qquad \sigma_{\Delta(B-V)} = 0^m.35 .$$

Upgren (1974) and Weis, Deluca, and Upgren (1979) have determined photoelectric colors and magnitudes for many Hyades stars. For 47 stars observed by them after the publication of vA I, we have the comparison (vA I - photoelectric):

$$\Delta V = 0^m.06, \qquad \sigma_{\Delta V} = 0^m.22,$$

$$\Delta(B-V) = -0^m.07, \qquad \sigma_{\Delta(B-V)} = 0^m.21 .$$

This includes all the stars in common. For 13 stars observed by Weis, Deluca, and Upgren after Hanson's paper appeared, we have the comparison (Hanson - photoelectric):

$$\Delta V = 0^{m}.22, \qquad \sigma_{\Delta V} = 0^{m}.31,$$

$$\Delta(B-V) = 0^{m}.08, \qquad \sigma_{\Delta(B-V)} = 0^{m}.25.$$

Here one star has been rejected because it falls near the edge of Hanson's plate. These dispersions are reasonably close to the errors quoted by both van Altena and Hanson.

Luyten mentions several stars specifically. vA 218, 236, and 474 are all near 19th magnitude. vA 599 is 16th magnitude. Van Altena's measurements on the Palomar Sky Survey prints found all four stars too blue relative to later measurement. All four are much fainter than V = 14, the stated limit of Hanson's good photometry. Luyten correctly notes that H 592 is not in fact vA 739. This star, misidentified by Hanson, seems to be the 12th magnitude star near vA 739 on the vA II finding chart. BD +16°590 is mentioned by Luyten as a case of a large error in photometry, but this was noted by Hanson in his paper, where Hanson states, "Image interference on blue plate with nearby bright star. (B-V) suspect." Similarly, for H616 = Os996, Hanson states, "Near α Tau, all data may be suspect, $m_b \sim 11.9$."

In summary, with regard to Luyten's criticism of the photometry:

1) Luyten ignores the fact that van Altena's photometry used image diameter measurements on Palomar Sky Survey prints and did not use either the Lick AME or the Lick astrograph plates.

2) In making comparisons, Luyten misrepresents van Altena's and Hanson's error estimates and stated range of good photometry.

3) Luyten completely ignores Hanson's notes to his Table III and the notes added in proof.

4) A comparison with subsequent photoelectric photometry shows that at least in the range covered by the standards, both van Altena's and Hanson's photometry are as accurate as they say.

III. HYADES MOTIONS

We next discuss the accuracy of Hanson's and van Altena's proper motions. Again, it must be stressed that the proper motions in vA I were not determined using the Lick AME. Although we are certain that most of Luyten's criticisms of this paper could be effectively answered, we will not discuss them further here since they do not bear on the accuracy of the AME.

Luyten (1971) and Hanson had 176 stars in common fainter than V = 9, which Hanson states is the "bright limit for accurate proper motions." For these 176 stars, the mean differences and dispersions of the proper motions are (Hanson-Luyten):

$$\overline{\Delta\mu_\alpha} = 0''.67 \pm 0''.15 \text{ cent}^{-1}, \quad \sigma_{\Delta\mu_\alpha} = 1''.96 \text{ cent}^{-1},$$

$$\overline{\Delta\mu_\delta} = -0''.06 \pm 0''.12 \text{ cent}^{-1}, \quad \sigma_{\Delta\mu_\delta} = 1''.59 \text{ cent}^{-1}.$$

If we accept Luyten's (1971, 1975) own estimates for his errors as 2''.0 cent^{-1}, then this implies essentially zero error for Hanson. Accepting Hanson's estimate for his own errors as 0''.5 to 0''.7 cent^{-1} would give a Luyten error of 1''.7 cent^{-1}. Thus a direct comparison of Hanson with Luyten confirms Hanson's error estimate. The differences in the mean motions are easily explained by the fact that Hanson's motions are absolute, while Luyten's are relative. Because of reflex solar motion, one would expect a difference in the mean motions of approximately

$$\overline{\Delta\mu_\alpha} = 0''.7 \text{ cent}^{-1},$$

$$\overline{\Delta\mu_\delta} = -0''.2 \text{ cent}^{-1}.$$

The observed values, quoted above, agree with these predicted values to within their errors.

More generally, one can compare the proper motions in Hanson, vA II, Luyten (1971), and Pels, Oort, and Pels-Kluyver (1975). One finds that the r.m.s. differences about the mean difference are what one expects from each author's stated errors. Since one has several such comparisons, one can solve for the individual errors, and in each case these derived errors are close to the errors claimed by the individual investigators. This is shown in Table I.

Luyten seems to be under the impression that Hanson and van Altena worked closely together on the Hyades and used the same plate material. In fact, van Altena was gone for two years before Hanson arrived at Lick and for five years before Hanson began his Hyades study. In remeasuring van Altena's stars, Hanson had only the published finding charts and approximate coordinates to go by. Since many of the very faint van Altena stars are not visible on these charts, some misidentifications were inevitable. These eventually showed up as proper motion and photometric discrepancies. Since van Altena attempted to push the astrograph plate material to its limits, in a few cases he measured random grain clumps. These were not "plate flaws," but part of an attempt to derive from the plates as much information as possible. Since Hanson had plates at three additional epochs, he remeasured these faint objects to test their reality. In several cases, Hanson's attempt to remeasure the object on five

TABLE I

COMPARISON OF HYADES MOTIONS

Source of comparison	Observed dispersion (cent^{-1})	Dispersion calculated from stated errors (cent^{-1})	Number of stars
Hanson-Luyten	1".77	2".1	176
Hanson-vA II	1".32	1".2	141
Hanson-Pels	0".81	0".8	25
Luyten-Pels	1".74	2".1	46

Investigator	Investigator's error estimate (cent^{-1})	Calculated error (cent^{-1})
Hanson	0".6	0".6
vA II	1".0	1".2
Luyten	2".0	1".7
Pels	0".5	0".5

plates led to a large error in the proper motion. Thus the explanation for vA37 = H47, noted as such by Hanson in his paper. Other individual stars mentioned by Luyten are:

VA422 = H402: This is a double, noted as such by Hanson, who states in a note added in proof: "double, AME measured wrong star at epoch 1." Thus this discrepancy was recognized by Hanson.

VA307 = H306: Luyten objects to the large error in μ_δ for this star given by Hanson. The explanation is that probably a wrong grating image was measured at one epoch. Whatever the cause of the large error, the only choice was to print the error as determined, or to suppress the data for this star to avoid embarrassment.

VA451 = H416: Hanson clearly records this misidentification in a note added in proof.

VA670 = H627: The μ values for this star are in agreement. Hanson discusses in his paper why some of his errors are listed as zero. It is simply due to round-off.

In addition, Luyten raises five points, which we shall answer in order.

1) Claim: Hanson's values for the proper motion differ from van Altena's for five stars.

Answer: True, but these are bright stars, and Hanson states that the bright limit for accurate motion is near $V = 9^m$.

2) Claim: For five faint stars originally found by Luyten, Hanson's results disagree with Luyten's.

Answer: Even assuming that all five identifications are correct, no evidence is presented that Hanson's motions are incorrect. They only disagree with Luyten's.

3) Claim: For 25 stars, there is a systematic difference between Hanson's and van Altena's motions.

Answer: There are 377 stars in common. The 25 stars used by Luyten include a large proportion near the plate limit and several noted misidentifications. It is not a representative sample. Van Altena's zero point is ostensibly on the system of N30, but the zero point correction was made using bright stars. We attach little significance to the mean differences (Hanson minus van Altena) of $\Delta\mu_\alpha = +0\overset{''}{.}7$ cent^{-1}, $\Delta\mu_\delta = +0\overset{''}{.}1$ cent^{-1}.

4) Claim: For four stars found by van Altena and remeasured by Hanson, the colors, magnitudes and motions measured on the same machine and using the same plate material give totally incompatible results.

Answer: This is a misstatement of the facts. As pointed out by van Altena in vA I and subsequently pointed out to Luyten privately in 1975, and stressed here, *van Altena used Palomar Sky Survey prints to obtain his colors and magnitudes*. Moreover, these stars are outside the range where Hanson claims good photometry, and some are misidentified as noted by Hanson.

5) Claim: Hanson stated that using five epochs rather than two would result in more accurate proper motions, since spurious motions could be detected, but then Hanson remeasured the same plate flaws that Luyten pointed out.

Answer: Hanson's measurement of additional epochs showed that a few of van Altena's faint stars were in fact random grain clumps; they were not plate flaws, a term used only by Luyten. By thus confirming the discrepancies previously pointed out by Luyten, Hanson did, as he stated, improve the accuracy of the proper motions.

IV. PILOT PROGRAM

Much of Luyten's (1976) criticism of the Pilot Program revolves around Lick Region 29. This region is listed in Klemola *et al.* (1971) with a note that states it is near the zone of avoidance and has only eight galaxies, all near the east edge of the plate. Moreover, the plate constant errors for this region published in Klemola *et al.* (1971) are an order of magnitude larger than most others. That the proper motions for this region are nearly useless was recognized by Klemola and Vasilevskis (1971), who gave it zero weight in their solutions for solar motion and galactic rotation. Since the problem for this region is in the reductions, not in the measurements, the decision was made to publish these motions as is, since the reader had been properly warned about the poor reference frame, and the proper motions could easily be corrected if a reliable reference frame became available. Such a reference frame is expected to become available through the planned attempt to bridge the zone of avoidance.

Luyten criticizes the motions in two other regions, one centered at 11^h12^m, +50°, the other at 12^h00^m, +15°, complaining that the mean motions for stars in these fields are inconsistent with reflex solar motion. We first note the Pilot Program motions for the AGK-3 stars in these regions are in reasonable agreement with the motions in the AGK-3. After correcting the AGK-3 motions for Fricke's correction to precession, the comparison is (in the sense AGK-3 − Lick):

11:12 +50°	$\overline{\Delta\mu_\alpha} = -0''.2 \pm 0''.3$ cent^{-1},	$\sigma_{\Delta\mu\alpha} = 1''.6$ cent^{-1},
	$\overline{\Delta\mu_\delta} = +0''.2 \pm 0''.3$ cent^{-1},	$\sigma_{\Delta\mu\delta} = 1''.5$ cent^{-1},
12:00 +15°	$\overline{\Delta\mu_\alpha} = -0''.5 \pm 0''.3$ cent^{-1},	$\sigma_{\Delta\mu\alpha} = 1''.7$ cent^{-1},
	$\overline{\Delta\mu_\delta} = -0''.4 \pm 0''.4$ cent^{-1},	$\sigma_{\Delta\mu\delta} = 2''.2$ cent^{-1}.

Furthermore, the mean Lick motions <u>are</u> in reasonable agreement with the motion expected for reflex solar motion. We have here recomputed the mean motions for the stars in these two fields, and give the results for several magnitude groupings in Table II. Also given is the approximate amount of solar reflex motion expected, using the secular parallaxes computed at Lick (Klemola and Vasilevskis 1971). These are presumably the worst cases found of over 60 high-weight fields. Even here, the agreement is remarkably good, with the observed values generally within one sigma of the predicted values. Luyten's criticism of these fields remains obscure to us.

We turn next to the mean errors of the Lick motions. A mean error of 0".7 $cent^{-1}$ was derived by Klemola <u>et al.</u> (1971) for the Pilot motions. However, it was also stated that, depending on the weight of the galaxy solution, larger external errors could be expected for low-weight fields. Luyten has determined errors for the Lick motions of 1".8 $cent^{-1}$ by comparison with various catalogues. Since it is not known which catalogues he used and whether he has applied the correction to precession to the catalogue motions, or made adequate correction for known systematic error in several of the catalogues used for comparison, we are uncertain of the correctness of this number. Furthermore, this comparison is made on a highly selected sample, namely the brightest Lick stars, which were largely measured only on the short exposure on the Lick plates. After the publication of the Pilot Program motions, it was found that the proper motions for such bright stars ($B \leq 9$) are affected by a systematic magnitude error. These stars form only a small fraction of the total number measured, but it is these that Luyten used for his comparison.

In a comparison of Lick motions with those of 165 randomly selected AGK-3 stars on high-weight fields, we find a dispersion of total proper motion of $\sigma_{\Delta\mu}$ = 1".65 $cent^{-1}$. In making this comparison, no stars were thrown out because of large discrepancies. Many of the stars used were bright (poor Lick motions) or faint (poor AGK-3 motions). Although the accidental errors of the AGK-3 are near 1".0 $cent^{-1}$, there are regional systematic errors that may reach 1".6 $cent^{-1}$ (de Vegt 1975), and there may be large discontinuities at (AGK-3) plate boundaries. Even accepting the internal AGK-3 errors as valid would imply maximum Lick errors of 1".3 $cent^{-1}$, less than Luyten's claim. Allowance for total errors in the AGK-3 comparison would make the implied Lick mean error smaller than this maximum; it need not be inconsistent with the value 0".7 $cent^{-1}$.

Unfortunately, there is no large set of data with known small systematic and accidental errors with which to compare the Lick data. For the main Lick program now in progress, several lines of evidence suggest errors of 0".7 $cent^{-1}$. Since the epoch difference is now 30% larger, this would imply errors for the Pilot proper motions of about 0".9 $cent^{-1}$. One such comparison is with the proper motions determined by Chiu (1980) in selected areas 51 and 57. For 35 stars in common, the r.m.s. value of the differences is

TABLE II

MOTIONS IN REGIONS 231 AND 707

Region	B Range	N	$\overline{\mu_\alpha}$ (cent^{-1})	Expected Motion Apex 18^h+30 (cent^{-1})	Expected Motion Lick Apex (cent^{-1})	Observed Dispersion $\sigma_{\Delta\mu_\alpha}$ (cent^{-1})
231 11:12 +50	B <10.0	10	-3".85±1".25	-2".6	-2".1	3".95
	10.0≤ B <14.0	44	-0".54±0".43	-1".7	-1".4	2".95
	14.0≤B	46	-0".11±0".30	-0".9	-0".7	2".09
			$\overline{\mu_\delta}$ (cent^{-1})			$\sigma_{\Delta\mu_\delta}$ (cent^{-1})
	B< 10.0	10	-1".21±0".88	-1".3	-1".7	2".78
	10.0 ≤B <14.0	44	-1".01±0".60	-0".9	-0".6	2".03
	14.0≤B	46	-0".67±0".26	-0".4	-0".6	1".80
			$\overline{\mu_\alpha}$ (cent^{-1})			$\sigma_{\Delta\mu_\alpha}$ (cent^{-1})
707 12:00 +15	B< 10.0	11	-1".76±1".21	-2".6	-1".7	3".80
	10.0≤B <14.0	40	-1".62±0".71	-1".7	-1".1	4".46
	14.0≤B	44	-0".77±0".28	-0".9	-0".6	1".90
			$\overline{\mu_\delta}$ (cent^{-1})			$\sigma_{\Delta\mu_\delta}$ (cent^{-1})
	B <10.0	11	-3".02±1".11	-1".4	-2".5	3".66
	10.0≤ B <14.0	40	-1".01±0".60	-0".9	-1".7	3".81
	14.0≤B	44	-0".60±0".20	-0".5	-0".8	1".53

$$\sigma_{\Delta\mu} = 0\rlap{.}''66 \text{ cent}^{-1} ,$$

which we take to be close to the errors of the Lick measures, since the errors of Chiu's motions are very small.

Luyten claims there are eight stars measured in the Pilot Program for which proper motions larger than 20" cent^{-1} are published, but which in fact do not move at all or are nonexistent. Six of these stars are in Region 29, which was discussed above. The other two are Lick mistakes, made because of human error in surveying the stars. The wrong image systems were coded for measurement. One of the stars is AGK-3 +48°13". The other is star 72 in Region 75. This same star is also listed as star 73.

Luyten objects to the fact that when Klemola and Vasilevskis (1971) did solar motion solutions, the apex moved north when high proper motion stars were excluded from the solution. We note here that the errors in the position of the apex were large for all solutions, and in fact the positions are nearly the same within the errors.

V. OTHER WORK DONE WITH THE AME

The Lick AME was installed in Santa Cruz in 1968. It was the first fully automatic measuring engine. Although its technology reflected the early 1960's, it was modified in 1971-1972, and we presently have funds from NSF for a further upgrading. We expect that after the present modifications it will be fully competitive with newer machines.

The main use of the AME has been the measurement of plates for the Lick Proper Motion Survey. However, many other projects have been completed using the machine. Since the same general procedures were used in all of these astrometric measurements, it seems unlikely that the standard of precision for one project (i.e., the Hyades studies criticized by Luyten) would be markedly different from that for all the rest.

A list of more than 40 papers based on measurements with the AME is appended. Work in the following four categories illustrates the types of problems in which the machine has produced valuable results:

1. Klemola (e.g., Klemola et al. 1978) has used the AME for many occultation predictions. These predictions have been of high accuracy, as evidenced by the successful observations of the occultations (Millis and Wasserman 1978; Elliot et al. 1978; Nichelson et al. 1978; and several others in press).

2. The extensive work on cluster membership by Cudworth (1971, 1976a,b), Jones (1973), Jones and van Altena (1970), van Altena and Jones (1970, 1972), and others has been used by a large number of photometric and other observers (Haro 1976; Kilambi 1971; Landolt 1979; McClure,

Forrester, and Gibson 1974; Robinson and Kraft 1974; Stauffer 1980; Upgren 1974; Weis, Deluca, and Upgren 1979; Sagar and Joshi 1978; and numerous others).

3. The parallaxes of stars determined with the aid of the AME (Vasilevskis 1975; Vasilevskis et al. 1975; Klemola et al. 1976) have been compared with U. S. Naval Observatory parallaxes by Harrington et al. (1978) and Strand (1979). The systematic errors were found to be small and the agreement with U. S. Naval Observatory parallaxes was well within the stated errors.

4. The Lick AME and astrograph were used to produce coordinates for the reference stars used by the Jupiter Voyager missions for pointing (Klemola 1978, 1979).

VI. CONCLUSION

The discussion above has shown that the Lick AME has been a productive measuring engine whose precision is as high as claimed. It has fully lived up to the goals set for it. Its worth has been recognized by those who have directly employed it as well as by those who have used results obtained with it. Luyten's reasons for criticizing a small portion of the work done on the AME remain obscure to us. It is to be hoped the criticism is a result of a misunderstanding and as such it will come to rest. In any case, our intention is not to return to the subject.