THE RELATIVE POSITION OF THE MOON TO THE SUN AT THE 1970 MARCH 7 ECLIPSE

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Received 21 October 1975

Abstract

The reduction of the contact time observation for the 1970 Mexico solar eclipse is revised employing the solar ephemeris in the IAU 1964 system, the lunar ephemeris $J=2$ and a refined geocentric position of the telescope, all of which have become available after the first report was presented. Assuming ET—AT to be $32.^{s}0$, the observed positions minus ephemerides become

$\Delta\ (L_{☾}-L_{\odot})=-0.''12\pm0.''02$ (m.e.),

$\Delta\ (\beta_{☾}-\beta_{\odot})=+0.''19\pm0.''07$ (〃).

1. Introduction

At the solar eclipse on March 7, 1970, a contact time observation was made by means of spectrocinematography at Puerto Escondido, Oaxaca in Mexico. The description on the observation, the data processing and the preliminary reduction were already reported in this series of the reports by the present authers (Mori, T. and Kubo, Y., 1971). After that time, the new ephemerides of the sun and the moon have become available and the geocentric position of the observation site was established. In the present paper, the preliminary reduction is revised on the basis of these new data.

2. Preparation of the ephemerides and the other related quantities

This revision is made using the following ephemerides and quantities.

(i) Sun

Dr. Furukawa of Tokyo Astronomical Observatory computed the ephemeris of the sun in the IAU 1964 system directly from the Newcomb's theory. The apparent places and true distances before and after the eclipse are:

ET 0^{h}	α_{app}	δ_{app}	r
Mar. 7	$23^{h}08^{m}28.^{s}178$	$-5°31'22.''51$	0.9923 9038
8	23 12 10.465	−5 8 2.36	0.9926 4935

(ii) Moon

The astronomical Division of the Department compiled the lunar ephemeris $J=2$, which is entirely identical with that given in the AE after 1973. The apparent places and parallaxes are:

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ET	α_{app}	δ_{app}	π
Mar. 7, 17^h	$23^h\ 8^m54.^s936$	$-5°\ 1'44.''05$	$60'40.''4577$
18	23 11 7.044	−4 44 8.36	60 39.4811

(iii) Telescope site

The geocentric position of the telescope was established by means of doppler observation of satellites NNSS by the courtesy of U.S. Army, Top. Comm. in 1971. The result in the NAD system has been reported to be:

$\varphi = 15°52'12.''72N,$

$\lambda = 262°55'48.''08E,$

$H = 142.0\text{m}.$

This result is deduced to the geocentric coordinate system, NWL 8 D, through the following translation:

$\varDelta U = -23\text{ m},\ \varDelta V = +159\text{ m}$ and $\varDelta W = +185\text{ m}$ (NWL 8 D−NAD),

where $(U,\ V,\ W)$ is a right hand sysrem; W is parallel to the rotation axis of the earth, positive to the north, and U lies in the Greenwich Meridian, positive to Greenwich. Then the geocentric geodetic coordinates are deduced through the IAU 1964 geodetic parameters:

$\varphi = 15°52'15.''84N,$

$\lambda = 262\ 55\ 46.66E,$

$H = 71.9\text{m}.$

For this geodetic system, the following vertical deflection $(\xi,\ \eta)$ and geoidal height $(\varDelta H)$ at this site are found:

$\xi \equiv \varphi_a - \varphi_g = -22.''7 \pm 0.''3$ (m. e.),

$\eta \equiv (\lambda_a - \lambda_g)\cos\varphi = -12.''2 \pm 0.''5$ (〃),

$\varDelta H \equiv H - h_0 = -21\text{m} \pm 1\text{m}$ (〃).

The sense of λ is positive to the east and h_0 is orthometric height.

(iv) Miscellaneous quantities

The following quantities have been adopted in the present reduction.

ET−AT (BIH) $= 32.^s0$

AT (BIH)−UTC $=$ 8.17 (on 7. Mar. 1970)

UTI−UTC $= -0.02$ (〃)

$\bar{r}_\odot = 15'59.''63$ (Auwers, 1891)

$k \equiv R_{☾}/R_\odot = 0.2725026$

$\Pi = \Pi_W + 0°17$ (observed),

where Π is axis angle and Π_W is Watts' angle. The other symbols are of the ordinary use and then self-explaining.

3. Local prediction

The above data lead to the topocentric places, their derivative to ET and the radii of the moon and the sun at the time $7^d17^h27^m15.^s566$ UTC:

$\alpha_\odot = 23^h11^m10.^s158,\quad \dot{\alpha}_\odot = +0.^s003/s,\quad \alpha_{☾} = 23^h11^m08.^s969,\quad \dot{\alpha}_{☾} = +0.^s037/s,$

$\delta_\odot = -5°14'27.''14,\quad \dot{\delta}_\odot = +0.''02/s,\quad \delta_{☾} = -5°15'2.''63,\quad \dot{\delta}_{☾} = +0.''30/s,$

$r_\odot = 16'6.''84 \qquad r_{☾} = 16'47.''66.$

Whence,

$$\delta_{☾}-\delta_{\odot}=-35.''49,$$
$$(\alpha_{☾}-\alpha_{\odot})\cos\delta_{\odot}=-17.\ 76,$$
$$r_{☾}-r_{\odot}=\ \ 40.\ 82.$$

4. Observation minus calculation

Combining the observed values presented in the first report with the calculated ones in the present paper, we obtain:

$$\Delta(\delta_{☾}-\delta_{\odot})=+0.''13\pm0.''05\ \text{(m. e.)},$$
$$\Delta(\alpha_{☾}-\alpha_{\odot})\cos\delta_{\odot}=-0.\ 18\pm0.\ 05\ (\ \ //\ \ ),$$
$$\Delta(r_{☾}-r_{\odot})=-0.\ 32\pm0.\ 02\ (\ \ //\ \ ),$$

or, in the ecliptic coordinate system,

$$\Delta(L_{☾}-L_{\odot})=-0.''12\pm0.''02\ \text{(m. e.)},$$
$$\Delta(\beta_{☾}-\beta_{\odot})=+0.\ 19\pm0.\ 07\ (\ \ //\ \ ),$$

where the mean errors are taken from the alternative solutions in the first report.

Acknowledgement

The authers wish to thank US Army, Top. Comm. and Prof. Poveda of National University of Mexico for the positioning of the observation site. They are also indebted Dr. Furukawa to his solar ephemeris.

References

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