FORTNIGHTLY NUTATION FROM THE ILS DATA

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1. INTRODUCTION

There are two reasons why the study of fortnightly nutation is important. First, it provides an opportunity to investigate some peculiarities of the Earth's structure; second, it permits us to calculate more precisely the apparent locations of stars.

Determination of the parameters of the fortnightly lunar wave is always impeded by other variations with similar periods that are present in the observations. The appearance of a series of semi-monthly terms is caused by the following factors. When reductions of star positions to apparent places are performed with incorrect values of the fortnight nutation coefficients, then the observational data will contain periodic errors with the argument $\alpha-2L$ (α is the right ascension of the star, L is the mean Moon's longitude). At present the nutation coefficients obtained by Woolard (1953) for a rigid Earth model are used: $n = 0''.0884$ in obliquity and $m \sin \varepsilon = 0''.2037 \sin \varepsilon$ in longitude. Errors due to incorrect nutation coefficients cannot be separated from "dynamic latitude variations" with the same argument that are caused by the motion of the Earth's rotation pole relative to the pole of its figure under the influence of external perturbations.

These "variations" have mainly been studied theoretically for different models of the Earth's structure (Oppolzer, 1880; Woolard, 1953; Fedorov, 1963; Kakuta, 1970; Atkinson, 1973; McClure, 1973). For a perfectly rigid Earth Woolard (1953) gave

$$\Delta\phi = -0''.0062 \sin(\alpha-2L) \quad .$$

Experimental confirmation of their existence has been found in several investigations (Fedorov, 1963; O'Hora, 1973; McCarthy, 1976).

One more type of latitude variation with the argument $\alpha-2L$ is caused by the effect of the O_1 term of the diurnal tide on the position of a vertical line. The equation

E. P. Fedorov, M. L. Smith and P. L. Bender (eds.), Nutation and the Earth's Rotation, 41–46.

$$\Delta\phi = 0''.0074 \cos 2\phi \sin(\alpha-2L)$$

is used to correct the observational data.

The period of the semi-monthly lunar term with the argument $\alpha-2L$ depends essentially on the program of observations. For the group program of the ILS, which is carried out during a fixed mean day period, $T = 14^d19$. Finally, M_2 and M_f -- the terms of semi-diurnal and semi-monthly tides -- correspondingly affect the results of latitude observations. Their periods are $14^d.77$ and $13^d.66$ respectively.

2. OBSERVATIONAL DATA

Series of latitude observations that were carried out over twenty years (1935.0-1955.0) at three ILS stations (Mizusawa, Japan; Carloforte, Italy; Ukiah, USA) have been used as initial data to obtain the lunar term with the $\alpha-2L$ argument. The series of observations were divided into three cycles: 1935.0-1941.0; 1941.0-1949.0; 1949.9-1955.0 in order to exclude the influence of some differences in the technique of reduction of instantaneous latitudes. The analysis was performed on deviations from the smoothed curve of mean daily values that were obtained using only complete observations of evening and morning groups during the night. 64114 instantaneous latitudes were used, consisting of 14512 from Mizusawa, 18874 from Carloforte, and 30728 from Ukiah. Variations with periods less than 20 days were excluded during the analytic smoothing.

3. RESULTS

Every cycle of observations was analyzed separately in two steps. The first step consisted of refining the system of declinations and proper motions of stellar group centers, i.e., constant and linear terms were determined and were removed from the observations using the equations

$$\Delta\phi_{ij} = x_i + y_i t_{ij} \quad , \quad (i = 1,2,\ldots,12) \quad .$$

The second step included computing a periodogram by least-squares analysis of the values

$$\Delta\phi_{ij} - (x_i + y_i t_{ij}) \quad .$$

In the end, an amplitude spectrum was obtained for the periods $13^h500 - 15^h000$ with $\Delta t = 0^d.01$.

Corrections for the effect of tidal terms O_1, M_2, M_f were not accounted for in the instantaneous latitudes. Some of the analysis results are given in Figs. 1, 2, and 3. Mean weighted value of parameters of the

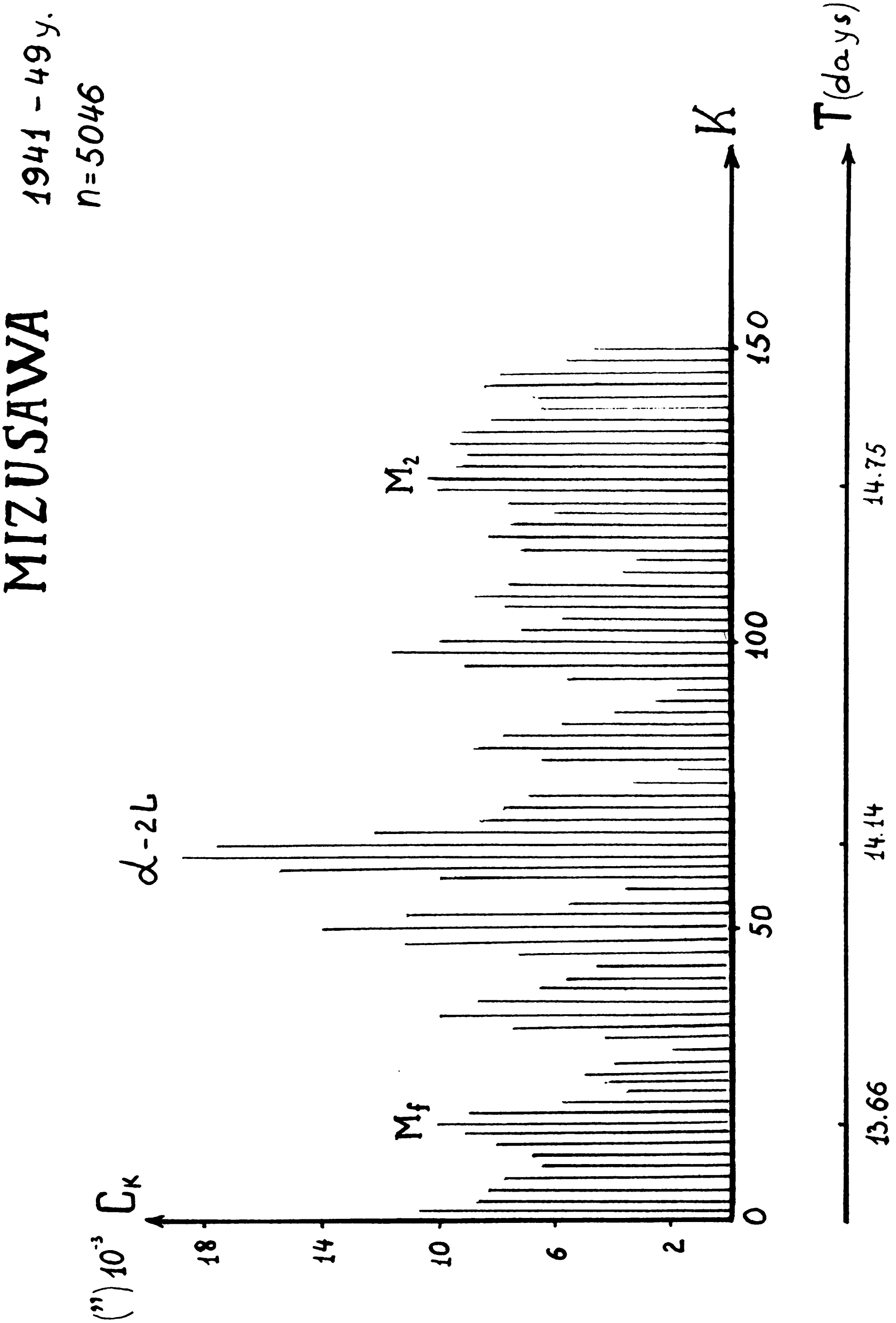

Figure 1

https://doi.org/10.1017/S007418090003179X Published online by Cambridge University Press

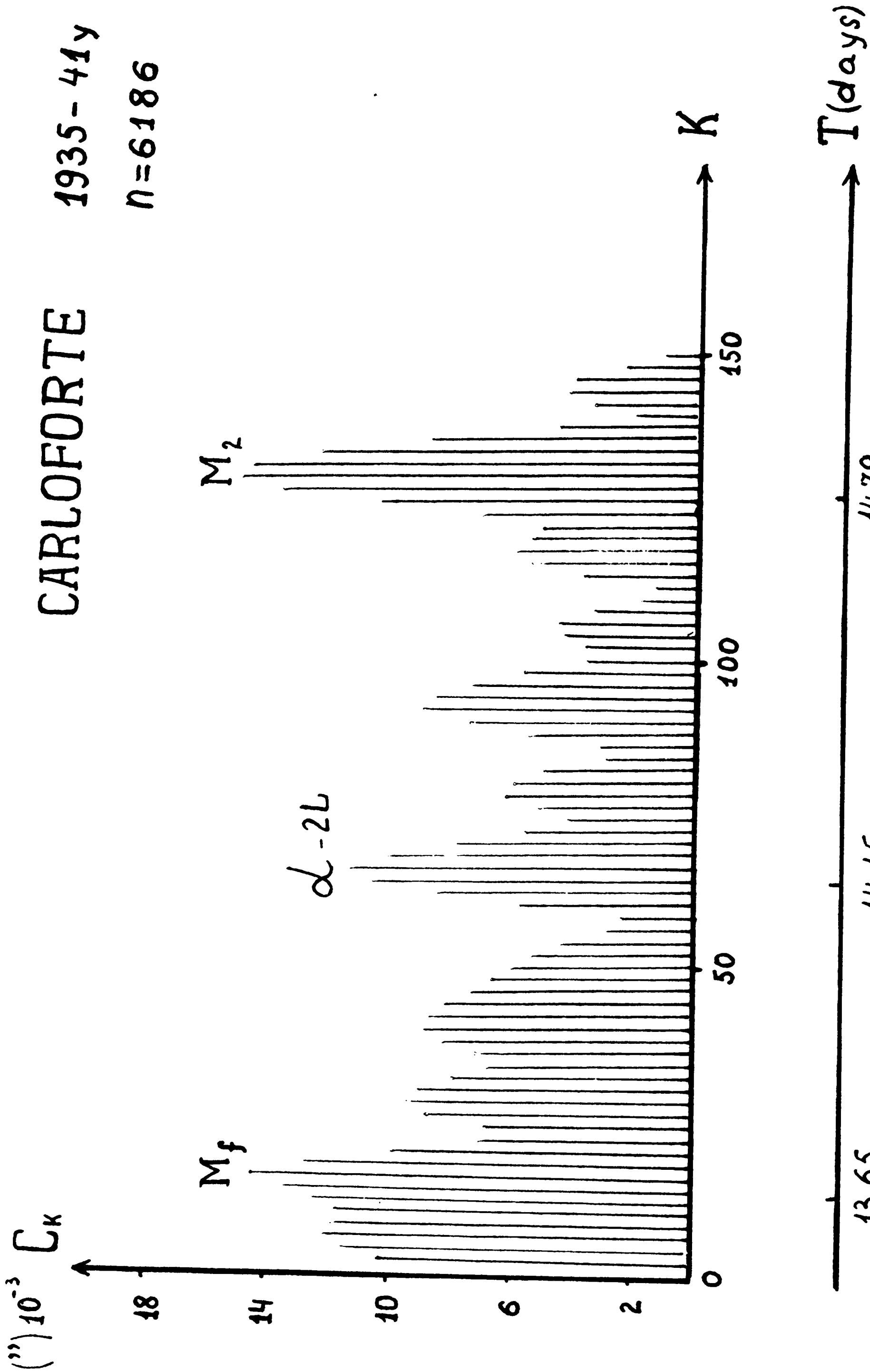
CARLOFORTE
1935-41y
n=6186
M2
α-2L
Mf
(") 10-3 Ck
18
14
10
6
2
0
50
100
150
K
13.65
14.15
14.79
T(days)

Figure 2

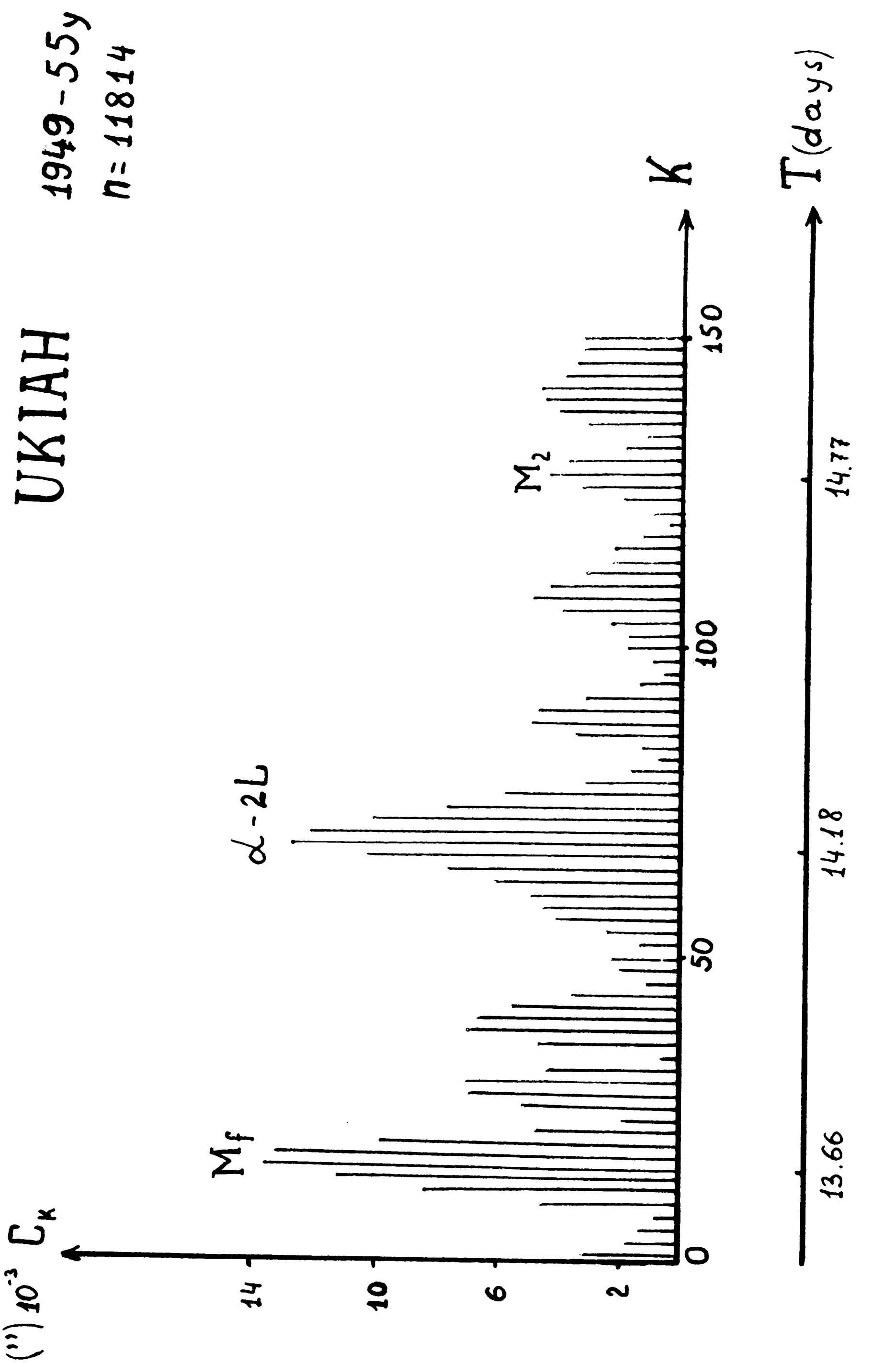
UKIAH
1949-55y
n=11814
('') 10^-3 C_k
14
10
6
2
0
50
100
150
K
M_f
α-2L
M_2
13.66
14.18
14.77
T(days)

Figure 3

terms containing the α−2L argument obtained from the observations at the latitude stations in Carloforte, Mizusawa, Ukiah during 1935.0 - 1955.0 are as follows:

$$-0\overset{''}{.}0085 \sin(\alpha - 2L - 10\overset{\circ}{.}1)$$
$$\pm 17 \qquad \pm 13\overset{\circ}{.}2 \quad .$$

These result are in agreement with those obtained by Fedorov (1963) and O'Hora (1973).

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