NUTATION TERMS DERIVED FROM THE Z- AND THE τ-TERM OF THE IPMS SYSTEM

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Abstract. The non-polar common terms, z and τ, of the IPMS system are analyzed for determining amplitudes of some terms of the forced nutation. The method of analysis and the results obtained are described briefly. Comparison is made with theoretical and other observational results. A fuller account of this work will be published elsewhere.

1. Introduction

It is well known that some terms of the existing nutation table (Woolard, 1953) based on the rigid Earth model require corrections of observable amounts according to the liquid core theory (e.g. Jeffreys and Vicente, 1975a,b; Molodensky, 1961). Amplitudes of the principal, semi-annual and annual nutation terms are evaluated from the monthly mean non-polar common terms of the IPMS, that is, z in latitude (Kimura, 1902) for 1962-1976 and τ in longitude (Yokoyama, 1976) for 1967-1976, respectively, and these are compared with the theoretical values.

In order to derive z and τ in a uniform system, various corrections are applied to the data of each station, taking into account, in particular, revisions of the star places.

2. Meanings of z and τ

With the aid of an approximation $a_i = L' \pm 180°$, the monthly mean values of z and τ can be written in the following form, for the nutation terms mentioned above:

$$z = a \sin \Omega \cos L' + (A + b \cos \Omega) \sin L' - c \sin(2L' - 101°) \quad , \qquad (1)$$

$$\tau = a \sin \Omega \sin L' + (A - b \cos \Omega) \cos L' + c \cos(2L' - 101°) \quad . \qquad (2)$$

E. P. Fedorov, M. L. Smith and P. L. Bender (eds.), Nutation and the Earth's Rotation, 35–40.

Here, a_i, L' and Ω are the mean right ascension of the stars observed during a month for each station, the mean longitude of the Sun, and the longitude of the ascending mode of the Moon at the monthly common epoch of the IPMS, respectively. a, b, A and c are the observed corrections to the tabular values of the longitude component of the principal nutation, the nutation constant, the prograde mode of the semi-annual nutation, and the retrograde mode of the annual nutation, respectively.

The retrograde mode of the semi-annual nutation (1/3-annual) and the prograde mode of the annual nutation (constant) are not taken into account due to the smallness of their magnitudes.

3. Results of Analysis

Harmonic coefficients of the annual and semi-annual components of both z and τ are determined year by year, in order to see whether there is an Ω-dependent variation or not.

Figure 1 shows variation of the annual coefficients related to a sin Ω of equations (1) and (2). A clear Ω-dependent variation in z and parallel variation of τ suggest a need for considerable correction to the longitude component of the principal nutation.

Figure 2 shows the variation of the annual coefficients related to both A and b cos Ω of equations (1) and (2). Since there is no perceptible Ω-dependent variation, the correction to the nutation constant appears to be very small. The constant levels in both z and τ probably represent the correction to be added to the semi-annual nutation.

Furthermore, as shown in Table 1, a stable semi-annual variation has been detected in z, but not in τ. In consideration of the agreement in both amplitude and phase with the theoretical values, this semi-annual variation might be an observational confirmation of the dynamical effect of the liquid core upon the annual nutation.

The final results of analysis are:

	Principal nutation		Semi-annual nutation	Other than nutation	Annual nutation
z ;	$0''.016\sin\Omega\cos L'$	$-0''.001\cos\Omega\sin L'$	$-0''.023\sin L'$	$-0''.008\cos L'$	$-0''.006\sin(2L'-90°)$
p.e.	± 2	± 1	± 1	± 1	± 9
τ ;	$0''.016\sin\Omega\sin L'$	$-0''.001\cos\Omega\cos L'$	$-0''.018\cos L'$	$+0''.015\sin L'$	----
p.e.	± 2	± 2	± 2	± 2	

Even after correcting for the catalog errors, there still remain annual components in both z and τ which cannot be explained by the nutation.

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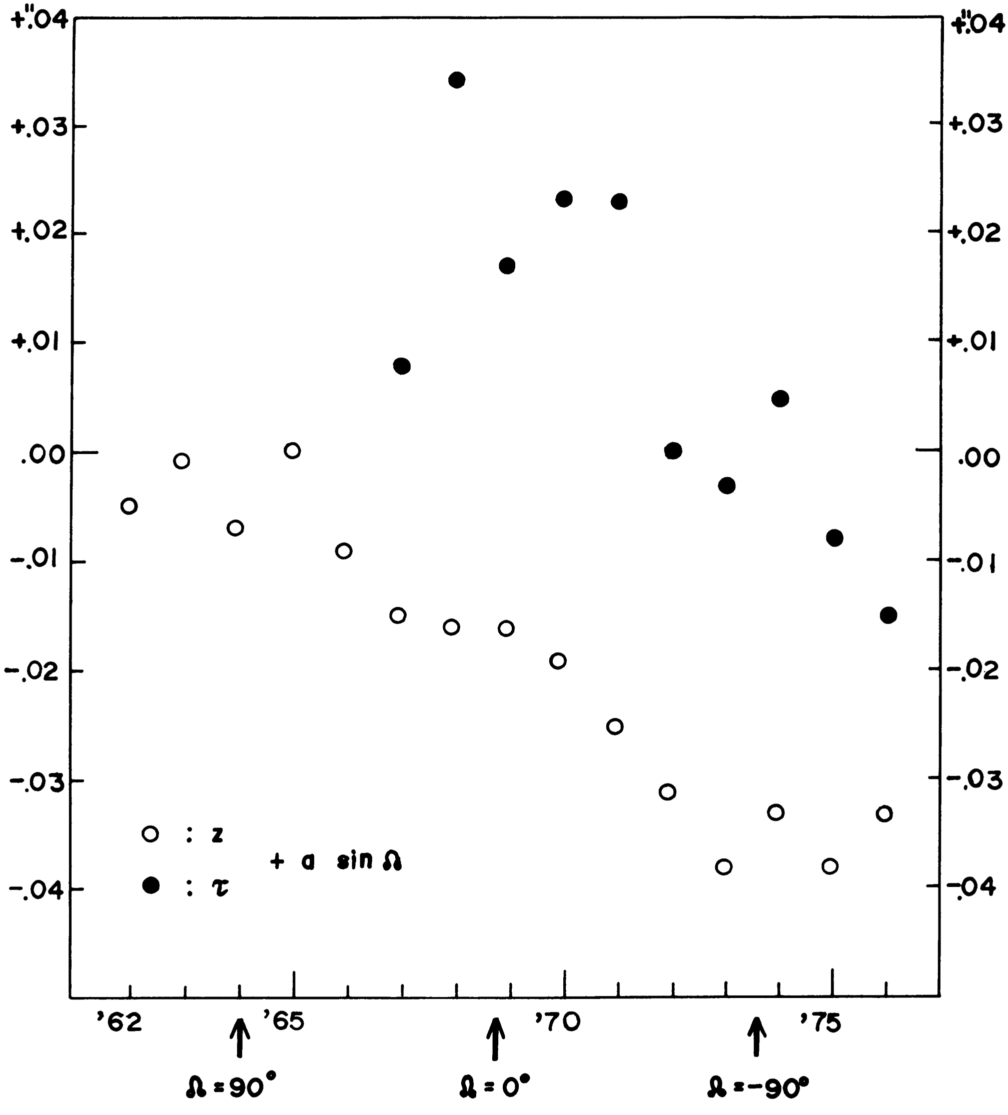

Figure 1. Variation of the annual coefficients related to the longitude component of the principal nutation.

Summarized in Table 2 are the observed and theoretical amplitudes of the nutation terms of present interest. Since no correction for the Oppolzer terms was applied to the observed data, our results give the nutation of the mean figure axis of the mantle. For direct comparison with our results, the theoretical amplitudes in Table 2 are deduced on the basis of the nutation of the figure axis of the rigid Earth instea of the rotation axis. For that purpose, we adopt Kinoshita's (1977)

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nutation theory based on the nutation constant of 9"2277, in which the correction to the luni-solar precession, +1"10 per century, and the geodesic precession, +1"915 per century, were taken into account.

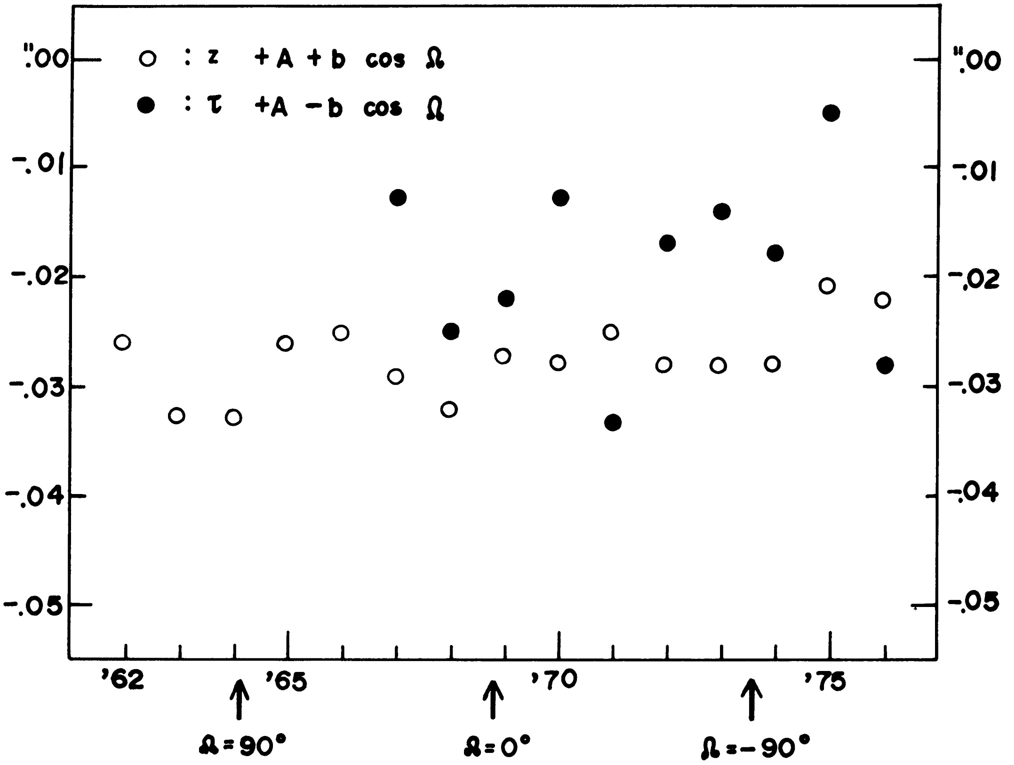

Figure 2. Variation of the annual coefficients related to the nutation constant and the semi-annual nutation.

Table 1. Semi-annual component of z for each year

	sin 2L'	cos 2L'		sin 2L'	cos 2L'		sin 2L'	cos 2L'
1962	"003	"009	1967	-"001	"010	1972	"000	"006
1963	0	6	1968	- 1	4	1973	2	7
1964	2	8	1969	- 1	8	1974	1	2
1965	0	9	1970	- 3	8	1975	3	3
1966	- 1	6	1971	- 3	9	1976	0	2

Observed, 1962-1976: -"006 sin(2L' - 90°)

Theory: -"006~-"007 sin(2L' - 101°)

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Table 2. Comparison between observation and theory for the nutation amplitudes

Theory	Principal long.	Principal obliq.	Semi-annual prograde mode	Annual retrograde mode
Jeffreys, Vicente (1957a)	6".838	9".202	".550	
Jeffreys, Vicente (1957b)	6.861	9.219	.515	
Molodensky I (1961)	6.836	9.200	.550	".031
Molodensky II (1961)	6.841	9.203	.548	.031
Pedersen (1967)	6.839	9.202	.549	
Kakuta (1970)	6.813	9.181	.557	
Sasao, Okamoto, Sakai (1977)	6.839	9.202	.549	.032
Sasao, Okubo, Saito (1977)				
Wang	6.837	9.201	.550	.031
Bullen and Haddon	6.839	9.202	.549	.030
Gutenberg and Bullen-A	6.840	9.203	.548	.031
Observation				
Present results IPMS *z*	6.842	9.209	.553	.031
IPMS τ	6.842	9.211	.548	
Feissel, Guinot (1977) BIH *z*	6.844	9.211		
w	6.837	9.207		
Kimura (1940) ILS *z*	phase deviation		.549	.034, .032
Fedorov (1963) ILS pair	6.8437	9.1980		
Taradij (1969) ILS pair	6.8476	9.1970		
Wako (1970) ILS *z* a			.5436	
b			.5502	
Yokoyama (1974) ILS *z*	6.836	9.203		
Yokoyama (1975) Paris Astrolabe time	6.838	9.212		
lat.	6.831	9.212		
Billaud (1975)				
$\Delta\alpha_\alpha$ of Paris Astrolabe	6.819			
IAU	6,8584	9.2100	.5299	.0250
Kinoshita (1976)	6.8709	9.2267	.53105	.0250

4. Concluding Remarks

Table 2 shows that the present results generally agree well with the theoretical and other observational ones, except for the nutation constant. Observed values of the nutation constant determined in the ILS system seem to have a systematic difference from those based on the IPMS and the BIH data.

Our result for the annual nutation should be regarded with some reservations, because we cannot confirm by our method of analysis whether

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it actually has the argument (L'+α) or not. However, it is at least certain that there exists a stable semi-annual variation in z.

In consideration of the errors of the solution, we could conclude nothing definitive about the observation of the phase lead, in particular, of the principal and annual nutations due to the dissipative core-mantle coupling (Sasao, Okamoto and Sakai, 1977; Sasao, Okubo and Saito, 1977).

Such information will be obtained in detail after completion of the recalculation of the past ILS observations, and it will make a more detailed comparison with the theories possible.

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