CHAPTER 4 NUTATION

The standard nutation series is the IAU 1980 Theory of Nutation (Seidelmann, 1982; Wahr, 1981). The constants defining this theory are given in Table 4.1. The Wahr model is based on geophysical model 1066A of Gilbert and Dziewonski (1975) and therefore includes the effects of a solid inner core and a liquid outer core and a "distribution of elastic parameters inferred from a large set of seismological data." Wahr's work is based on a modification of a rigid Earth theory published by Kinoshita (1977).

VLBI and LLR observations have shown that there are deficiencies in the IAU 1976 Precession and in the IAU 1980 Theory of Nutation. However, these models are kept as part of the IERS Standards and the observed differences with respect to the conventional celestial pole position defined by the models are monitored and reported by the IERS. A preliminary evaluation of the correction to the IAU models has been published by W. E. Carter and T. Herring in the Annual Report of the BIH for 1987, p. D-105. A FORTRAN function for computing the corresponding effect on Ψ and ϵ is available from the Central Bureau on request.

FUNDAMENTAL ARGUMENTS

The fundamental arguments of the nutation series, referred to the epoch JD 2 451 545.0 = 2000 January 1.5 are given by the expressions:

l = Mean Anomaly of the Moon
$= 134^\circ\ 57'\ 46\overset{''}{.}733 + (1325^r + 198^\circ\ 52'\ 02\overset{''}{.}633)\ T + 31\overset{''}{.}310\ T^2 + 0\overset{''}{.}064\ T^3$

l' = Mean Anomaly of the Sun
$= 357^\circ\ 31'\ 39\overset{''}{.}804 + (99^r + 359^\circ\ 03'\ 01\overset{''}{.}224)\ T - 0\overset{''}{.}577\ T^2 - 0\overset{''}{.}012\ T^3$

F = L - Ω where L = Mean Longitude of the Moon
$= 93^\circ\ 16'\ 18\overset{''}{.}877 + (1342^r + 82^\circ\ 01'\ 03\overset{''}{.}137)\ T - 13\overset{''}{.}257\ T^2 + 0\overset{''}{.}011\ T^3$

D = Mean Elongation of the Moon from the Sun
$= 297^\circ\ 51'\ 01\overset{''}{.}307 + (1236^r + 307^\circ\ 06'\ 41\overset{''}{.}328)\ T - 6\overset{''}{.}891\ T^2 + 0\overset{''}{.}019\ T^3$

Ω = Mean Longitude of the Ascending Node of the Moon
$= 125^\circ\ 02'\ 40\overset{''}{.}280 - (5^r + 134^\circ\ 08'\ 10\overset{''}{.}539)\ T + 7\overset{''}{.}455\ T^2 + 0\overset{''}{.}008\ T^3$

where T is measured in Julian Centuries of 36525 days of 86400 seconds of Dynamical Time since J2000.0.

Table 4.1. Series for nutation in longitude $\Delta\Psi$ and obliquity $\Delta\epsilon$, referred to the mean equator and equinox of date, with T measured in Julian centuries from epoch J2000.0.

ARGUMENT					PERIOD	LONGITUDE		OBLIQUITY	
l	l'	F	D	Ω	(days)	(0.0001")		(0.0001")	
0	0	0	0	1	6798.4	-171996	-174.2T	92025	8.9T
0	0	2	-2	2	182.6	-13187	-1.6T	5736	-3.1T
0	0	2	0	2	13.7	-2274	-0.2T	977	-0.5T
0	0	0	0	2	3399.2	2062	0.2T	-895	0.5T
0	1	0	0	0	365.2	1426	-3.4T	54	-0.1T
1	0	0	0	0	27.6	712	0.1T	-7	0.0T
0	1	2	-2	2	121.7	-517	1.2T	224	-0.6T
0	0	2	0	1	13.6	-386	-0.4T	200	0.0T
1	0	2	0	2	9.1	-301	0.0T	129	-0.1T
0	-1	2	-2	2	365.3	217	-0.5T	-95	0.3T
1	0	0	-2	0	31.8	-158	0.0T	-1	0.0T
0	0	2	-2	1	177.8	129	0.1T	-70	0.0T
-1	0	2	0	2	27.1	123	0.0T	-53	0.0T
1	0	0	0	1	27.7	63	0.1T	-33	0.0T
0	0	0	2	0	14.8	63	0.0T	-2	0.0T
-1	0	2	2	2	9.6	-59	0.0T	26	0.0T
-1	0	0	0	1	27.4	-58	-0.1T	32	0.0T
1	0	2	0	1	9.1	-51	0.0T	27	0.0T
2	0	0	-2	0	205.9	48	0.0T	1	0.0T
-2	0	2	0	1	1305.5	46	0.0T	-24	0.0T
0	0	2	2	2	7.1	-38	0.0T	16	0.0T
2	0	2	0	2	6.9	-31	0.0T	13	0.0T
2	0	0	0	0	13.8	29	0.0T	-1	0.0T
1	0	2	-2	2	23.9	29	0.0T	-12	0.0T
0	0	2	0	0	13.6	26	0.0T	-1	0.0T
0	0	2	-2	0	173.3	-22	0.0T	0	0.0T
-1	0	2	0	1	27.0	21	0.0T	-10	0.0T
0	2	0	0	0	182.6	17	-0.1T	0	0.0T
0	2	2	-2	2	91.3	-16	0.1T	7	0.0T
-1	0	0	2	1	32.0	16	0.0T	-8	0.0T
0	1	0	0	1	386.0	-15	0.0T	9	0.0T
1	0	0	-2	1	31.7	-13	0.0T	7	0.0T
0	-1	0	0	1	346.6	-12	0.0T	6	0.0T
2	0	-2	0	0	1095.2	11	0.0T	0	0.0T
-1	0	2	2	1	9.5	-10	0.0T	5	0.0T
1	0	2	2	2	5.6	-8	0.0T	3	0.0T
0	-1	2	0	2	14.2	-7	0.0T	3	0.0T
0	0	2	2	1	7.1	-7	0.0T	3	0.0T
1	1	0	-2	0	34.8	-7	0.0T	0	0.0T
0	1	2	0	2	13.2	7	0.0T	-3	0.0T
-2	0	0	2	1	199.8	-6	0.0T	3	0.0T
0	0	0	2	1	14.8	-6	0.0T	3	0.0T
2	0	2	-2	2	12.8	6	0.0T	-3	0.0T
1	0	0	2	0	9.6	6	0.0T	0	0.0T

Table 4.1 (continued)

ARGUMENT					PERIOD	LONGITUDE		OBLIQUITY	
l	l'	F	D	Ω	(days)	(0.0001")		(0.0001")	
1	0	2	-2	1	23.9	6	0.0T	-3	0.0T
0	0	0	-2	1	14.7	-5	0.0T	3	0.0T
0	-1	2	-2	1	346.6	-5	0.0T	3	0.0T
2	0	2	0	1	6.9	-5	0.0T	3	0.0T
1	-1	0	0	0	29.8	5	0.0T	0	0.0T
1	0	0	-1	0	411.8	-4	0.0T	0	0.0T
0	0	0	1	0	29.5	-4	0.0T	0	0.0T
0	1	0	-2	0	15.4	-4	0.0T	0	0.0T
1	0	-2	0	0	26.9	4	0.0T	0	0.0T
2	0	0	-2	1	212.3	4	0.0T	-2	0.0T
0	1	2	-2	1	119.6	4	0.0T	-2	0.0T
1	1	0	0	0	25.6	-3	0.0T	0	0.0T
1	-1	0	-1	0	3232.9	-3	0.0T	0	0.0T
-1	-1	2	2	2	9.8	-3	0.0T	1	0.0T
0	-1	2	2	2	7.2	-3	0.0T	1	0.0T
1	-1	2	0	2	9.4	-3	0.0T	1	0.0T
3	0	2	0	2	5.5	-3	0.0T	1	0.0T
-2	0	2	0	2	1615.7	-3	0.0T	1	0.0T
1	0	2	0	0	9.1	3	0.0T	0	0.0T
-1	0	2	4	2	5.8	-2	0.0T	1	0.0T
1	0	0	0	2	27.8	-2	0.0T	1	0.0T
-1	0	2	-2	1	32.6	-2	0.0T	1	0.0T
0	-2	2	-2	1	6786.3	-2	0.0T	1	0.0T
-2	0	0	0	1	13.7	-2	0.0T	1	0.0T
2	0	0	0	1	13.8	2	0.0T	-1	0.0T
3	0	0	0	0	9.2	2	0.0T	0	0.0T
1	1	2	0	2	8.9	2	0.0T	-1	0.0T
0	0	2	1	2	9.3	2	0.0T	-1	0.0T
1	0	0	2	1	9.6	-1	0.0T	0	0.0T
1	0	2	2	1	5.6	-1	0.0T	1	0.0T
1	1	0	-2	1	34.7	-1	0.0T	0	0.0T
0	1	0	2	0	14.2	-1	0.0T	0	0.0T
0	1	2	-2	0	117.5	-1	0.0T	0	0.0T
0	1	-2	2	0	329.8	-1	0.0T	0	0.0T
1	0	-2	2	0	32.8	-1	0.0T	0	0.0T
1	0	-2	-2	0	9.5	-1	0.0T	0	0.0T
1	0	2	-2	0	32.8	-1	0.0T	0	0.0T
1	0	0	-4	0	10.1	-1	0.0T	0	0.0T
2	0	0	-4	0	15.9	-1	0.0T	0	0.0T
0	0	2	4	2	4.8	-1	0.0T	0	0.0T
0	0	2	-1	2	25.4	-1	0.0T	0	0.0T
-2	0	2	4	2	7.3	-1	0.0T	1	0.0T
2	0	2	2	2	4.7	-1	0.0T	0	0.0T
0	-1	2	0	1	14.2	-1	0.0T	0	0.0T
0	0	-2	0	1	13.6	-1	0.0T	0	0.0T
0	0	4	-2	2	12.7	1	0.0T	0	0.0T
0	1	0	0	2	409.2	1	0.0T	0	0.0T

Table 4.1 (continued)

ARGUMENT					PERIOD	LONGITUDE		OBLIQUITY	
l	l'	F	D	Ω	(days)	(0.0001")		(0.0001")	
1	1	2	-2	2	22.5	1	0.0T	-1	0.0T
3	0	2	-2	2	8.7	1	0.0T	0	0.0T
-2	0	2	2	2	14.6	1	0.0T	-1	0.0T
-1	0	0	0	2	27.3	1	0.0T	-1	0.0T
0	0	-2	2	1	169.0	1	0.0T	0	0.0T
0	1	2	0	1	13.1	1	0.0T	0	0.0T
-1	0	4	0	2	9.1	1	0.0T	0	0.0T
2	1	0	-2	0	131.7	1	0.0T	0	0.0T
2	0	0	2	0	7.1	1	0.0T	0	0.0T
2	0	2	-2	1	12.8	1	0.0T	-1	0.0T
2	0	-2	0	1	943.2	1	0.0T	0	0.0T
1	-1	0	-2	0	29.3	1	0.0T	0	0.0T
-1	0	0	1	1	388.3	1	0.0T	0	0.0T
-1	-1	0	2	1	35.0	1	0.0T	0	0.0T
0	1	0	1	0	27.3	1	0.0T	0	0.0T

ϵ_{J2000} = 23° 26' 21".448
sin ϵ_{J2000} = 0.39777716

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