ALMANAC CATALOGUE OF ZODIACAL STARS

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649193295

Almanac catalogue of zodiacal stars by Nautical Almanac Office

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NAUTICAL ALMANAC OFFICE

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Trieste

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OF

ZODIACAL STARS.

PRINTED FOR THE USE OF

THE AMERICAN EPHEMERIS AND NAUTICAL ALMANAC.

BUREAU OF NAVIGATION,
WASHINGTON.
1864.

University Press:
Welch, Bigelow, and Company,
Cambridge.

PREFACE.

THE Almanac Catalogue of Zodiacal Stars has been prepared and published under the direction of the Bureau of Navigation, Navy Department.

The selection and arrangement of the stars was made by MR. JOHN DOWNES, Assistant Nautical Almanac.

The Catalogue contains all the stars, to the $6\frac{1}{2}$ magnitude inclusive, which, from their positions, are liable to be occulted by the moon: stars of the smaller magnitudes belonging to important clusters are also included. It embraces a zone extending to eight degrees of latitude on each side of the ecliptic; and consequently contains many stars which do not come within the limits of occultation, but which, from their proximity to the moon's path, may be required for moon-culminations.

A large proportion of the stars belonging to clusters have been selected from authorities which do not give the constants of reduction to apparent places. The constants, in these cases, have been computed by the formula given in the Introduction.

These computations, as well as the reductions to a common epoch, have been made in the Nautical Almanac Office, by MR. G. W. HILL, under the direction of the Superintendent, who has conducted the work through the press.

Nautical Almanac Office,
Cambridge, Mass., Feb. 11, 1864.

ZODIACAL STARS.

INTRODUCTION.

The present catalogue has been prepared with a view to facilitating the computer's labor in some of the departments of the American Ephemeris and Nautical Almanac Office; especially in the preparation of the lists of occultations, and in the selection of stars proper to be observed in connection with the moon's transit. Another object has been to furnish a catalogue which, from its size and cheapness, will be more accessible to computers than the larger and more expensive catalogues, which are rarely to be met with excepting in the libraries connected with scientific associations. Of these, the catalogue in most general use in this country is that of the British Association, — a heavy quarto, which comes to us at a price which many computers cannot well afford to pay. The present catalogue, which will answer every purpose equally well with the more costly works in the reduction of occultations and moon-culminations, forms a handy little pamphlet which can be freely circulated among computers at a very trifling expense. Another advantage of the small cost and size of the work is, that new editions can be issued at short intervals, with such corrections of the stars' places as may be derived from new observations.

The places of the stars have been derived from the following authorities. Wherever they are found in the Greenwich *Twelve-Year Catalogue*, their mean right ascensions and declinations have been reduced to the epoch 1850 from that work. As this catalogue consists of two distinct catalogues, giving for the same star, in most cases, different places, as deduced from an unequal number of observations, weights proportionate to the number of observations in each were allowed in combining the results. Whenever, as was frequently the case, one of the coördinates was wanting, its place was supplied from the *British Association Catalogue*, which was the one used next in order of preference. With the exception of the places derived from the *Twelve-Year Catalogue*, and those of the smaller stars grouped in clusters, most of the places were taken from this (*The British Association Catalogue*), as were also the precessions, secular variations, and proper motions used in reducing the places from the *Twelve-Year Catalogue*. In some cases, however, where the stars' places were given only approximately, or where they rest only on the authority of Lacaille, the places have been determined from *Oeltzen's Argelander's Southern Zones*.

The stars of the Pleiades group, not found in the *Twelve-Year Catalogue*, have been reduced from Bessel's places, given in the *Astronomische Untersuchungen*, Band I. All the stars quoted by the numbers of Rumker and Lalande, and the hour and number of Weisse, are reduced from these respective authorities. Wherever the precessions and secular variations have not been given, they have been computed for this work. All stars, to the $6\frac{1}{2}$ magnitude, and situated within eight degrees of the ecliptic, are supposed to be given in this catalogue. In general, stars smaller than those of the $6\frac{1}{2}$ magnitude are not given. It is only where they are grouped in clusters, as in the Pleiades, Hyades, and a few smaller groups,

that the smaller stars are included. In these cases they are given to the 9th or 10th magnitude. In some instances, the more interesting multiple stars are also given to the smaller magnitudes.

Mean Places of the Stars.

The mean right ascensions and declinations of the stars are given in this catalogue for the epoch 1850. For any other time, these coördinates may be computed by means of the annual variations which are given for each star. These variations are composed of the annual precessions and proper motions. In most catalogues the precession and proper motion are treated separately in the reductions. As the precessions are themselves variable quantities, they will sometimes require correction for the secular variation, which is the variation of precession in one hundred years. The combined precession and proper motion being affected by the same variation, and nearly in the same degree (the only difference being the very slight change which takes place in the proper motion), the annual variations will require the same corrections.

Denoting by t_0, the epoch of the catalogue,
t, the time for which the mean place is required,
v, the annual variation in right ascension,
Δp, its secular variation,
v', the annual variation in declination,
$\Delta p'$, its secular variation,

then $t - t_0$ will be the interval for which the whole variation must be computed, and that value of the annual variation must be employed which corresponds to the middle of this interval. Or, denoting by v_0 the annual variation for the epoch t_0, we must take

$$v = v_0 + \frac{t - t_0}{100} \frac{\Delta p}{200} (t - t_0)$$

$$v' = v'_0 + \frac{t - t_0}{100} \frac{\Delta p'}{200} (t - t_0).$$

Then, denoting by

α_0 the mean right ascension at the epoch t_0,
α " " " " time t,
δ_0 " declination at the epoch t_0,
δ " " " time t,

we shall have

$$\alpha = \alpha_0 + v \ (t - t_0)$$
$$\delta = \delta_0 + v' \ (t - t_0).$$

EXAMPLE. Let the mean right ascension and declination of 32 Tauri, star No. 174, be required for the beginning of the year 1864.

Taking α_0, δ_0, v_0, v_0', Δp, $\Delta p'$ from the catalogue, we have

		α_0	3 h 48 m 0.77 s			δ_0	+ 22° 2′ 32.0″
		v_0	− 3.531			v'	+ 10.78
		Δp	+ 0.0145			Δp	− 0.431
1864 − 1850,	$t - t_0$		+ 14.		$t - t_0$		+ 14.
$\Delta p\ (t - t_0) \div 200$,	(1)		+ 0.001	$\Delta p'\ (t - t_0) \div 200$,	(1)′		− 0.03
$v_0 + (1)$	v		+ 3.532	$v'_0 + (1)'$,	v'		+ 10.75
	$v\ (t - t_0)$		+ 49.45		$v'\ (t - t_0)$		+ 2 30.5
$\alpha_0 + v\ (t - t_0)$	α	3 48 50.22		$\delta_0 + v\ (t - t_0)$,	δ	+ 22 5 2.5	

Apparent Places of the Stars.

When a star's mean place has been computed for the beginning of the year, the apparent place for any time, τ, within the year can be computed by the method which BESSEL has given in his *Tabulæ Regiomontanæ*, from the logarithms of the constants a, b, c, d, a', b', c', d', given for each star in the catalogue, and the logarithms of A, B, C, D, given in the *Nautical Almanac* for every day in the year.

Let α' be the apparent right ascension, δ' the apparent declination, μ the proper motion in right ascension, μ' the proper motion in declination, and τ the fraction of the year corresponding to a given date, and we shall have

$$\left.\begin{aligned} x &= A\,a + B\,b + C\,c + D\,d + \tfrac{1}{15}E + \tau\,\mu \\ x' &= A\,a' + B\,b' + C\,c' + D\,d' + \tau\,\mu' \end{aligned}\right\} \text{(A)}$$

for which the logarithms of A, B, C, D, and the residual E, must be taken for the given date. The value of $\frac{1}{15}E$ can never exceed 0".0084, and can seldom be required. Then

$$\begin{aligned} \alpha' &= \alpha + x \\ \delta' &= \delta + x' \end{aligned}$$

In consequence of an interchange of letters which has been made in the notation of BESSEL's formulæ by the late English astronomer BAILY, it will be necessary, in order that the computer may not be misled, to give the formulæ for computing A, B, C, D, a, b, c, d, a', b', c', d'. The arrangement of the letters is according to BESSEL's notation.

$A = \tau - 0.34236 \sin \Omega + 0.00440 \sin 2\,\Omega - 0.02519 \sin 2\,\odot + 0.00294 \sin (\odot + 82^\circ\ 34')$.

$B = -9''.2235 \cos \Omega + 0''.0896 \cos 2\,\Omega - 0''.5508 \cos 2\,\odot - 0''.0093 \cos (\odot + 280^\circ\ 21')$.

$C = -20''.4451 \cos \omega \cos \odot$.

$D = -20''.4451 \sin \odot$.

$E = -0''.0483 \sin \Omega + 0''.0015 \sin 2\,\Omega - 0''.0035 \sin 2\,\odot$.

$a = 3^s.07201 + 1^s.33701 \sin \alpha \tan \delta$.

$b = \frac{1}{15} \cos \alpha \tan \delta$.

$c = \frac{1}{15} \cos \alpha \sec \delta$.

$d = \frac{1}{15} \sin \alpha \sec \delta$.

$a' = 20''.0551 \cos \alpha$.

$b' = -\sin \alpha$.

$c' = \tan \omega \cos \delta - \sin \alpha \sin \delta$.

$d' = \cos \alpha \sin \delta$.

μ = the annual proper motion in right ascension.

μ' = the annual proper motion in declination.

τ = the time reckoned from the moment when the sun's mean longitude was 280°, as expressed in fractional parts of a tropical year.

$\odot$ = the sun's true longitude.

Ω = the longitude of the moon's ascending node.

ω = the obliquity of the ecliptic.

α = the star's mean right ascension for the beginning of the year.

δ = the star's mean declination for the beginning of the year.

α' = the star's apparent right ascension at the time τ.

δ' = the star's apparent declination at the time τ.