Celestial Calculations: A Gentle Introduction to Computational Astronomy

Consolidated Errata

December 31, 2020

Thanks to all who have contributed to this errata list, especially John Pinto whose attention to detail is greatly appreciated. Just when you think you've found the last mistake...!

The author can be contacted at jllmitpress@gmail.com should additional errors be found in the book requiring this errata list to be updated.

Chapter 1: Introduction

- **Page 6, section 1.2, note 3 near bottom of page**

  The second sentence in note 3 should read "This will be explained more fully in Chapter 4, section 4.1."

Chapter 3: Time Conversions

- **Page 46, section 3.8, step 5**

  The second sentence in step 5 should read "If the result of step 4 is greater than or equal to 24, subtract 24^h."

- **Page 47, section 3.9, step 4**

  The second sentence in step 4 should read "If the result of step 3 is greater than or equal to 24, subtract 24^h."

  Also, the parenthetical note in step 4 is incorrect. It should read

  > "Note that adding 24^h means that the resulting LCT is for the *previous* day while subtracting 24^h means that the resulting LCT is for the *next* day."

- **Page 47, section 3.10**

  The following note should be inserted before the first paragraph.

  > "Note: The time conversion method presented in this section is accurate to approximately a tenth of a second."

- **Page 48, section 3.10, step 10**

  The second sentence in step 10 should read "If the GST from the previous step is greater than or equal to 24, subtract 24^h."

- **Page 48, section 3.11**

  The following note should be inserted before the first paragraph.

  > "Note: The time conversion method presented in this section is accurate to approximately a tenth of a second."

- **Page 49, section 3.11, step 8**

  The second sentence in step 8 should read "If the result of step 7 is greater than or equal to 24, subtract 24^h."

- **Page 49, section 3.12, step 4**

  The second sentence in step 4 should read "If LST is greater than or equal to 24, subtract 24^h."

- **Page 50, section 3.13, step 4**

  The second sentence in step 4 should read "If GST is greater than or equal to 24, subtract 24^h."

- **Page 51, section 3.14, first paragraph**

  The parenthetical in the second sentence of the paragraph should read "... (or their equivalent DMS forms)" instead of "HMS forms."

Chapter 4: Orbits and Coordinate Systems

- **Page 77, section 4.5.4, first full sentence**

  The sentence "An alternative but equivalent equation for relating the true anomaly, mean anomaly, and eccentricity is ..." should read "An alternative but equivalent equation for relating the true anomaly, eccentric anomaly, and eccentricity is ..."

- **Page 85, section 4.6, second paragraph**

  The sentence "Right ascension is analogous to longitude ..." should note that right ascension is "... how far *east* an object is away from the First Point of Aries, ..."

- **Page 89, section 4.7, step 1**

  This step should read

  1. Convert the altitude h to decimal format.

  (Ans: $h = 40.0°$.)

- **Page 91, section 4.7, step 11**

  Step 11 of the example should read

  11. Convert A and h to DMS format.

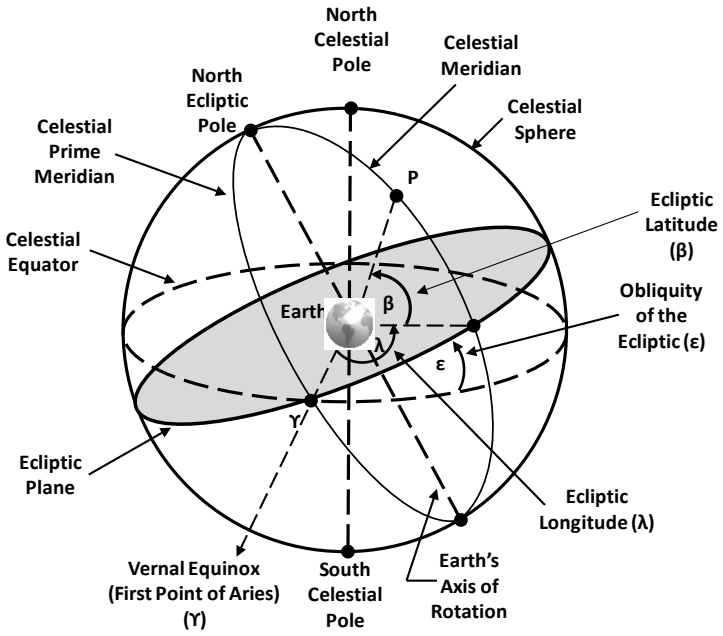
  (Ans: $A = 80°31'31''$, $h = -20°34'40''$.)

- **Page 91, section 4.8**

  The last sentence on the page ("The ecliptic longitude is in the range $[0°, 360°]$ and measured along the ecliptic toward the First Point of Aries.") should be changed to "The ecliptic longitude is in the range $[0°, 360°]$ and is measured eastward along the ecliptic away from the First Point of Aries, which is in the same direction that the Sun moves along the ecliptic."

- **Page 92, figure 4.16**

  Figure 4.16 incorrectly labels the Earth's Celestial Pole, Ecliptic Pole, and Axis of Rotation. The corrected figure is shown below:



Corrected Figure 4.16 for page 92

- **Page 94, section 4.8**

  Step 2 at the top of the page should read "This is the number of Julian centuries since 1/1.5/2000" rather than "... since 1/0.5/2000 ..."

  Additionally, note that the function *computeEclipticObliquity* in the program for chapter 4 contains a line of code that reads

  JD = dateToJD(1, 0.0, iEpoch)

  where the first parameter in the call to *dateToJD* is the month, the second parameter is the day, and the last parameter is the year for the time at which the epoch begins. Epoch J2000.0 begins January 1, 2000 at 1200 UT, so the day parameter in the call to *dateToJD* should be 1.5 instead of 0.0. The function *computeEclipticObliquity* should be modified to ask the user for the day at which the epoch begins rather than always assuming 0.0 (i.e., 12am UT, which is 0^h, on day 0).

  Failure to correctly consider the fractional part of a day in computing the obliquity of the ecliptic is also repeated in the *calcEclipticObliquity* function in the *AstCoord* module of the *AstUtils* library. *calcEclipticObliquity* should be modified to accept a full date (month, day, year) rather than always assuming an epoch starts at January 0.0. The programs for chapters 4 and 6 reference the *calcEclipticObliquity* function in the *AstUtils* library, so that code must be modified as well.

  For the purposes of this book, the error introduced by assuming a January 0.0 start date for an epoch is generally negligible.

- **Page 94, section 4.8, equation 4.8.5**

  The "+" sign in the equation should be a "-" sign. That is, equation 4.8.5 should be

  $$\sin\beta = \sin\delta\cos\varepsilon - \cos\delta\sin\varepsilon\sin\alpha$$

  The book's programs that use this equation are implemented correctly.

- **Page 94, section 4.8, equation 4.8.6**

  The "-" sign in the equation should be a "+" sign. That is, equation 4.8.6 should be

  $$\tan\lambda = \frac{\sin\alpha\cos\varepsilon + \tan\delta\sin\varepsilon}{\cos\alpha}$$

  The book's programs that use this equation are implemented correctly.

- **Page 94, section 4.8, last paragraph, 2nd sentence**

  The sentence "They are identical when δ is interchanged with β and α is interchanged with λ" should read "They are identical when the + sign is interchanged with the – sign, δ is interchanged with β, and α is interchanged with λ"

- **Page 96, section 4.8, step 5**

  The plus sign in the equation to compute T should be a minus sign. The value computed ($T = 0.020943$) in this step is correct.

- **Page 96, section 4.8, step 7**

  The minus sign in the equation to compute y should be a plus sign. The value computed ($y = -0.080188$) in this step is correct.

- **Page 98, section 4.9, equation 4.9.2**

  This equation should be

  $$\alpha = \tan^{-1}\left[\frac{\cos b\cos(l - N_0)}{\sin b\cos\delta_0 - \cos b\sin\delta_0\sin(l - N_0)}\right] + \alpha_0$$

  The book's programs that use this equation are implemented correctly.

- **Page 98, section 4.9, equation 4.9.4**

  This equation should be

  $$l = \tan^{-1}\left[\frac{\sin\delta - \sin b\sin\delta_0}{\cos\delta\sin(\alpha - \alpha_0)\cos\delta_0}\right] + N_0$$

  The book's programs that use this equation are implemented correctly.

- **Page 99, section 4.9, step 2**

  This step should read

  2. Convert l_{1950} to decimal format.

  (Ans: $l = 180.0°$.)

- **Page 99, section 4.9, step 3**

  This step should state that $\delta_0 = 27.4°$ is the declination of the Galactic North Pole rather than the right ascension.

- **Page 99, section 4.9, step 8**

  This step should state that α_0 (instead of N_0) must be added to get the right ascension in degrees. The computed value of $\alpha_{deg} = 513.180867°$ in this example is correct.

- **Page 103, section 4.10, 3rd paragraph**

  The sentence "This algorithm does not work for declinations that are near $\pm 90°$." should be added immediately after the sentence in this paragraph that begins with "However, we will present an algorithm only for precession ..."

- **Page 104, section 4.10, equation 4.10.2**

  The sentence fragment following equation 4.10.2 should read "where D is the difference in years between the new epoch and the reference epoch."

Chapter 5: Stars in the Nighttime Sky

- **Page 111, section 5.1, last paragraph, 3rd sentence**

  The sentence "Because there are 365.2564 sidereal days in a sidereal year ... at a rate of $0.985609°$ per day" should read "Because there are 365.2564 mean solar days in a sidereal year ... at a rate of $0.985609°$ per mean solar day."

- **Page 111, section 5.1, last paragraph, 4th sentence**

  The sentence "So, if N days have elapsed ..." should read "So, if N mean solar days have elapsed ..."

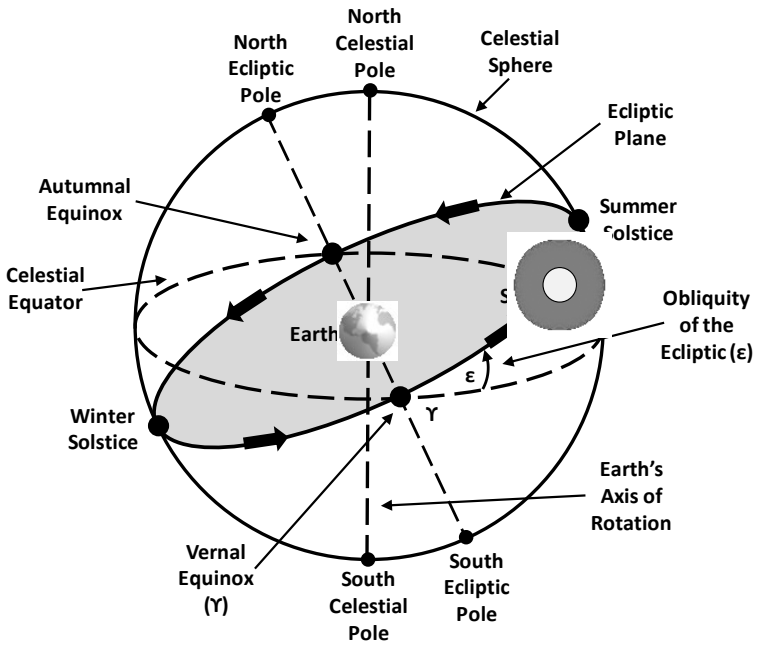
- **Page 112, section 5.1, first paragraph, 1st sentence**

  The sentence "The date at which ... using Julian day numbers to calculate elapsed days ..." should read "The date at which ... using Julian day numbers to calculate elapsed mean solar days ..."

Chapter 6: The Sun

- **Page 141, figure 6.5**

  Figure 6.5 incorrectly labels the Earth's Axis of Rotation; the arrow should be pointing to the North/South Celestial Pole. The corrected figure is shown below:



Corrected Figure 6.5 for page 141

- **Page 148, section 6.6**

  Step 2 in the example of computing the equation of time calculates the obliquity of the ecliptic. In computing the equation of time, the program for chapter 6 assumes a starting time for the year of January 1 at noon UT. The call to *calcEclipticObliquity* in the function *calcEqOfTime* could be modified to ask the user for a start time, or assume some other start time such as January 1 at 12am UT. However, doing so will not significantly change the resulting equation of time that gets calculated. For additional information regarding epoch start times, refer to the errata for Chapter 4, page 94, section 4.8 above for calculating the obliquity of the ecliptic.

- **Page 149, 1st paragraph**

  The paragraph just before section 6.7 begins should read "For this example, $-0^h03^m19^s$ must be added to the "sundial" time to get the corresponding "wristwatch" time."