According To Dynamical Time Period, Calculate The Diurnal And Direct Motion Of Celestial Sphere’s Objects

Aravinda Ravibhanu Sumanarathna

Research Division of Eco Astronomy Sri Lanka [South Asian Astrobiology & Palaeobiology Research Unit
Space Science Application Division, Arthur C Clarke Institute for Modern Technologies - Moratuwa]
Faculty of Natural Science, Open University of Sri Lanka - Colombo
ecoastronomysrilanka@gmail.com

Abstract: Amateur observational astronomy is the unlimited hobby of learning about the universe and observing as the base of astronomy. It can be divided into five major types of amateur observing: observing with your unaided eyes [naked eye] without optical aids, observing with binoculars, observing with telescopes, observing with cameras that use film and electronic technologies, and Astronomy spectroscopy. Each kind of observing is based on learning how to use different types of observing equipment. Sky is a natural laboratory for every amateur astronomer in the world, but the sky that our students can observe is not impressive. In the 21st century, images are of outstanding importance, and the appearance of the sky is awful. From many cities, it is not possible to look at the sky, but when we find a space between the buildings to see the sky, the light pollution reduces the full numbers of visible stars to a few. How ever, if we could go through the barriers of observation astronomy, it becomes as part of our life. Then we can look at the sky to rediscover the stories of our ancestors & promote positive feelings towards astronomy and towards science in general. Thus amateur astronomers can help people to discover and taste the adventure of a new knowledge by means of simple observations using the naked eye, binoculars, amateur telescopes or public observatories & impress upon humanity the beauty of natural phenomena. Also, you can be step forward for keep something so wonderful.

Introduction

Amateur observation as observing with your naked eye is the first stage of entering the observation astronomy. The coordinate system which corresponds to above observation is relative to the observer & it’s easy to build up compatibility data base of CSO. Thus this practical research activity observer could able to simply calculation of motion of CSO which are tend to exhibit apparent magnitude as more than +5 [Refer the discussion] due to the dynamical time period. This method is more accurate for stars, planets & their satellites.

The following observations were obtained,

- The time taken for the CSO to be observed, till it sets at the horizon.
- The time took for CSO to be observed appears at the horizon.
- The time taken for the CSO to be observed till it appears at the horizon on the next day.
- The time taken for the CSO to set at the horizon and appear on the horizon on the next day.

Method

- Select the suitable sexton for the experiment. (It should have 1/4 of a circle from 0° - 90°)
- To measure the intensity of the Object,
  1. Make sure there is a venire scale attached to the main scale
  2. A tripod for the sexton, so that sexton can be placed horizontally on the ground.
- Identify the celestial objects.
- Measure the angle to the celestial sphere at different periods or at equal time intervals.
- Use the data observed to make calculation at the appropriate time intervals. Use the calculated value to calculate the celestial objects motions in angles per minutes.

Measurement & Calculation

- Observation Start time as tstart
- Observation Start Latitude as xStart
- Observation close time as tend
- Observation close Latitude as xend
- Periods for calculated as d

\[ t_{start}=t_{1}, x_{start}=x_{1}, t_{end}=t_{5}, x_{end}=x_{5} \]

<table>
<thead>
<tr>
<th>Observation</th>
<th>Latitude</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>O1</td>
<td>X1</td>
<td>T1</td>
</tr>
<tr>
<td>O2</td>
<td>X2</td>
<td>T2</td>
</tr>
<tr>
<td>O3</td>
<td>X3</td>
<td>T3</td>
</tr>
<tr>
<td>O4</td>
<td>X4</td>
<td>T4</td>
</tr>
<tr>
<td>O5</td>
<td>X5</td>
<td>T5</td>
</tr>
<tr>
<td>O.EX</td>
<td>X.EX</td>
<td>T.EX</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chart No:01</th>
<th>Data Index &amp; Measurement</th>
</tr>
</thead>
</table>

Fig: 01: Terrestrial Latitudes & Longitudes system
Chart No: 02 | Data Index & Measurement

Total time average for complete one latitude:

\[
\frac{tA/xA + tB/xB + tC/xC + tD/xD}{d} = C/d
\]

1° = C/d

- The time taken for the CSO to be Start of observed, till it sets at the horizon = TOA₁

\[\text{TOA}_1 = t_{\text{start}} + [C/d]_A[X_{EA_1}]\]

- The time taken for the CSO to be Start of observed, till it appears at the horizon.

\[\text{TOB} = t_{\text{start}} - [C/d], [x_{\text{start}}/60]\]

- The time taken for the CSO to set at the horizon and appear on the horizon on the next day.

\[\text{TOC}_1 = t_{\text{start}} - [C/d], [X_{EB}/60]\]

- The time taken for the CSO to be observed, till it appears at the horizon on the next day.

\[\text{TOC}_2 = \text{TOA}_1 + [C/d]_C[x_{EC}/60]\]

DISCUSSION

All calculation of this research activity is relative to location of observer according to terrestrial coordinate system.

<table>
<thead>
<tr>
<th>Time period</th>
<th>Latitude period</th>
<th>Time taken to absolute latitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>t₂ - t₁ = τ₁</td>
<td>X₂ - x₁ = x₁</td>
<td>tA/xA</td>
</tr>
<tr>
<td>t₃ - t₂ = τ₂</td>
<td>X₃ - x₂ = x₂</td>
<td>tB/xB</td>
</tr>
<tr>
<td>t₄ - t₃ = τ₃</td>
<td>X₄ - x₃ = x₃</td>
<td>tC/xC</td>
</tr>
<tr>
<td>t₅ - t₄ = τ₄</td>
<td>X₅ - x₄ = x₄</td>
<td>tD/xD</td>
</tr>
</tbody>
</table>

\[X[\text{end}-\text{start}] = X_{EA_1} - A_{A_2}\]

\[\text{TOA}_1 = \text{TOA}_2\]

A - C = x_{EA_1} - [180° - x_{\text{start}}]

B - C = x_{EA_1} = [180° - x_{\text{End}}]

According to TOA₁ and TOA₂ observation data

\[X_{\text{end}} - X_{\text{start}} = P | X_{EA_1} - X_{EA_2} = P\]

\[X_{\text{end}} - X_{\text{start}} = X_{EA_1} - X_{EA_2}\]
1. Any semi-grate circle terminate by P and Q is a meridian 2. Latitude is measured from equator 3. Longitude is measured from principal meridian 4. The longitude line passing through Greenwich is called the Principal meridian

For the highest accurate result, maximum measurement has to be taken for each calculation. You can apply this calculation on any celestial sphere's objects that are going to rising or setting.

Apparent Magnitude

The apparent brightness of a star observed from the Earth is called the apparent magnitude. The apparent magnitude is a measure of the star's flux received by us. Here are some example apparent magnitudes: Sun = -26.7, Moon = -12.6, Venus = -4.4, Sirius = -1.4, Vega = 0.00, faintest naked eye star = +6.5, brightest quasar = +12.8, faintest object = +30 to +31
Calculating refraction

Bennett (1982) developed a simple empirical formula for calculating refraction from the apparent altitude, using the algorithm of Garfinkel (1967) as the reference; if \( h_a \) is the apparent altitude in degrees, refraction \( R \) in arc minutes is given by

\[
R = \cot \left( h_a + \frac{7.31}{h_a + 4.4} \right);
\]

The formula is accurate to within 0.07° for the altitude range 0°–90° (Meeus 1991, 102). Sæmundsson (1986) developed a formula for determining refraction from true altitude; if \( h \) is the true altitude in degrees, refraction \( R \) in arc minutes is given by

\[
R = 1.02 \cot \left( h + \frac{10.3}{h + 5.11} \right);
\]

The formula is consistent with Bennett's to within 0.1°. Both formulas assume an atmospheric pressure of 101.0 kPa and a temperature of 10 °C; for different pressure \( P \) and temperature \( T \), refraction calculated from these formulas is multiplied by

\[
\frac{P}{101} \cdot \frac{283}{273 + T}
\]

(Meeus 1991, 103). Refraction increases approximately 1% for every 0.9 kPa increase in pressure, and decreases approximately 1% for every 0.9 kPa decreases in pressure. Similarly, refraction increases approximately 1% for every 3 °C decrease in temperature, and decreases approximately 1% for every 3 °C increase in temperature.

Acknowledgement

I express my gratitude to Mr. Saraj Gunaseakara & Mr. Janaka Adassuriya who research scientists at the Space science application division of Arthur C Clarke Institute for Modern Technologies _ Moratuwa _ Sri Lanka. Also I appreciate help given by Dr. Kamal Abeyawardana, Mr. Gabriel dominics & Miss Damitha Jayasundara as members of faculty of natural science _OUSL_Colombo. Finally my sincere thanks go to Miss Ioana Adina Hristea (Faculty of physics-university of Bucharest_Romania).

Reference

