I. Objectives

1. Determine your latitude by observing the meridian passage of a star of known declination.
2. Define coordinate system terms.
3. Explain how declination could be calculated from a star's altitude and the observer's latitude.

II. Introduction

In this lab you will calculate your latitude by observing the meridian transit of a star of known declination. A star reaches its greatest altitude when it crosses the meridian.

III. Theory and Calculations

We need to use a little algebra and geometry, the celestial sphere, and a good observation to determine our latitude. See the diagram below.

1. Recall that there are 180^o in half a circle and 90^o in a quarter of a circle.

2. The North Celestial Pole, or NCP, has an altitude that is the same as our latitude, φ.

3. The zenith, Z, is directly overhead, 90^o from the horizon in every direction.

4. The angle between the northern horizon, N, and the zenith, Z is $90^o = \varphi + (90^o - \varphi)$.

5. The angle between the North Celestial Pole, NCP and the Celestial Equator, CE, is also $90^o = \varphi + (90^o - \varphi)$.

6. So the angle between the Celestial Equator, CE and the southern horizon, S, has to be $180^o - \varphi - (90^o - \varphi) - \varphi = 180^o - \varphi - 90^o + \varphi - \varphi = 180^o - 90^o - \varphi + \varphi - \varphi = 90^o - \varphi$

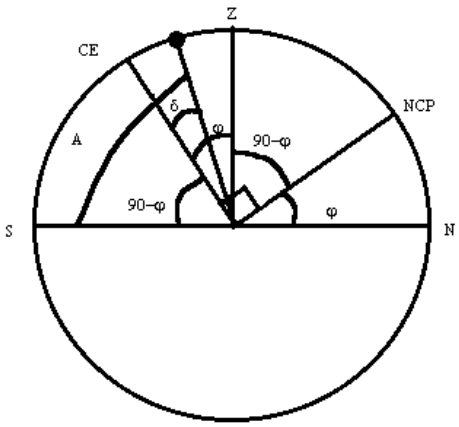
7. Recall that *d* is the declination of the star, its angular distance above the Celestial Equator, CE.

8. A is the altitude of the star, its angular distance from the southern horizon, S.

9. The altitude of the star is $A = 90^o - \varphi + d$.

10. Adding φ to both sides of the formula in step 9, $\varphi + A = 90^o + d$.

11. Subtracting A from both sides of the formula in step 10, $\varphi = 90^o + d - A$.


Z
CE
NCP
δ
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N

IV. Prelab Definitions

1. latitude

2. longitude

3. zenith

4. meridian transit

5. right ascension

6. declination

7. hour circle

8. altitude

9. azimuth

10. North Celestial Pole

11. celestial equator

V. Prelab Questions

1. What is the altitude A of Polaris, the North Star at the North Pole, where the latitude is 90^0? Hint: imagine standing on the North Pole. Where would you see Polaris?

2. What is the altitude A of Polaris at the equator, where the latitude is 0^0? Hint: imagine standing on the equator. Where would you see Polaris?

3. What is the altitude A of Polaris at 45^0N latitude, halfway between the equator and the North Pole?

4. How are a northern hemispere observer's latitude and the altitude of Polaris related?

5. What is the latitude at your location?

VI. Lab Procedure

1. Using the Star List or a star chart, identify a bright star that will cross the meridian between the southern horizon, S and the zenith, Z during the time you make your observation.

   the star's declination, d =

2. Using a compass, establish north-south and east-west lines. Make your observation facing due south.

3. When the star crosses your meridian estimate its altitude using one of your calibrated angular measuring devices.

   the star's altitude A =

4. Compute your latitude using the formula from step 11 of the Theory and Calculations section, above. $\varphi = 90^{o} + d - A$.

   calculated latitude φ =

5. Your location's true latitude =

VII. Lab Discussion

1. Is the calculated latitude the same as the true latitude? Other than mathematical errors what are the possible sources of error in your measurements? Why?

2. If you know the true latitude and the altitude of the star, but not its declination, explain how could you calculate its declination.

3. Explain how longitude and right ascension are related.

4. Explain how latitude and declination are related.

5. Why is it important to have an understanding of latitude and longitude?