Determining Latitude of a Place using Trigonometry

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Abstract— Astronomy is a natural science that studies celestial objects and phenomena. It applies mathematics, physics, and chemistry, in an effort to explain the origin of those objects and phenomena and their evolution. It is one of the oldest of the natural sciences. The early civilizations in recorded history, such as the babylonoans, greek, Indians, Egyptians, Nubians, Iranians, Chinese, maya and many ancient indigenous peoples of the Americas performed methodical observations of the night sky. Historically astronomy has included disciplines as diverse as astrometry celestial navigation observational astronomy and the making of calendres. Latitude is a geographic coordinate that specifies the north south position of a point on the earth's surface. A circumpo alar star is a star as viewed from given latitude on earth that never sets below the horizon due to its apparent proximity to one of the celestial poles. In this paper we would propose how circumpolar star on meridian serves as in finding latitude of places and how this concept plays an vital roles in astronomy.

Key words: Astronomy, Circumpolar Star, Meridian Altitude, Latitude

I. INTRODUCTION

A. *Latitude of Place*

Earth's surface. Latitude is an angle (defined below) which ranges from 0° at the Equator to 90° (North or South) at the poles. Lines of constant latitude, or parallels, run east–west as circles parallel to the equator. Latitude is used together with longitude to specify the precise location of features on the surface of the Earth.

B. *Zenith Distance*

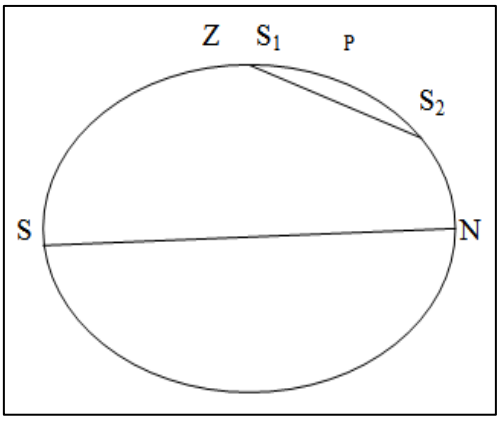
Zenith distance the angular of a celestial object from the zenith measured by the arc of a vertical circle intercepted between the object and the zenith the complement of the altitude. The angular distance from the zenith of a point on the celestial sphere to the sphere, measured along a great circle that is perpendicular to the horizon. The complement of the altitude.

$$\text{Zenith distance} = 90^{O}\text{-Altitude.}$$

C. *Circumpolar Star*

A circumpolar star is a star, as viewed from a given latitude on Earth, that never sets below the horizon due to its apparent proximity to one of the celestial poles. Circumpolar stars are therefore visible from said location toward the nearest pole for the entire night on every night of the year (and would be continuously visible throughout the day too, were they not overwhelmed by the Sun's glare). All circumpolar stars lie within a relative circumpolar circle, whose radius equals the observer's latitude. This was in fact the original meaning of "Arctic Circle", before the current geographical meaning.

Meridian observations of a circumpolar star:



Let S_1, S_2 the true positions of a circumpolar star at its lower and upper transists. Let a_1 and a_2 be the altitudes of S_1 and S_2 (after allowing corrections for dip, refractions)

$$S_1n = a_1$$
$$S_2n = a_2$$

Latitude of the place ø = Pn

$$S_1n + S_2n = Pn - PS_1 + Pn + PS_2$$
$$= 2.Pn$$
$$= 2ø$$
$$a_1 + a_2 = 2ø$$
$$ø = \frac{a_1+a_2}{2}$$

1) If the meridian altitude of a circumpolar star are 20°and 30° and the corresponding correction for refraction are 1'4" and 1'9" respectively. Determine the latitude of the place.

Solution:

$$Z_1 = 20^{O},\ Z_2 = 30^{o}$$
$$K_{1=1'4"},\ K_{2=1'9"}$$

Zenith distance

$$Z_1' = Z_1 + K_1 \tan Z_1$$
$$= 20^{O} + 1'4" \tan 20^{O}$$
$$= 20^{O} + 1'4" \times 0.36$$
$$= 20.02^{o} \times 0.36$$
$$= 7^{o}12'25"$$
$$Z_2 = Z_2 + K_2 \tan Z_2$$
$$= 30^{o} + 1'9" \tan 30^{o}$$
$$= 30^{o} + 1'9" \times 0.57$$
$$= 30.01^{o} \times 0.57$$
$$= 17^{o}6'21"$$

True altitude are $a_1 = 90^{o}\text{-}z_1$

$$a_2 = 90^{o}\text{-}z_2$$

$$\text{Latitude of the place} = \frac{a1+a2}{2}$$
$$= 90^{o} - \frac{7^{\circ}12'25" + 17^{\circ}6'21"}{2}$$
$$= 90^{o} - 24^{o}18'44"$$
$$= 65^{o}41'24"$$

2) If the meridian altitude of a circumpolar star are 30° and 70° and the corresponding corrections for refraction are 3'9" and 4'5" respectively. Determine latitude of the place.

Solution:

$Z_1=30^o$ $Z_2=70^o$

$K_1=3'9''$ $K_2=4'5''$

Zenith distance

$Z_1'= Z_1 + K_1 \tan Z_1$

$=30^o+3'9''\tan 30^o$

$=30^O+3'9''\times 0.57$

$=30.05^O\times 0.57$

$=17^o14'33''$

$Z_2= Z_2+ K_2 \tan Z_2$

$= 70^o + 4'5'' \tan 70^o$

$=70^o +4'5\times 1{,}22$

$=70.06^o\times 1.22$

$=85^o28'24''$

True altitude are $a_1= 90^o-z_1$

$a_2= 90^o-z_2$

Latitude of the place $= \frac{a1+a2}{2}$

$= 90^o - \frac{17^\circ 14' 33'' + 85^\circ 28' 24''}{2}$

$= 90^o – 51.3^o$

$=38^o42'1$

II. Conclusion

Daily motions of celestial objects reflect the earth's daily rotation about its axis. Circumpolar star are those always above or below the local horizon. From our above paper we wish to conclude that circumpolar star seems to be major role that place in astronomy. Learning to identify Polaris in the sky, and hence the direction north, can be a short but useful lesson in celestial navigation.

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