Aβ 7. Refraction.

7.1.

By using the formula and calculating we can find that it is correct till Zm≤70° , for Zm=80° the difference is already 10″ .Answer is: Zm≤70° .

7.2.

$$Z_t = Z_m + R \approx (Z_m),$$

$$R(Z_m) \approx 17'' \approx 0.3'$$

$$Z_t = 16°34.4' + 0.3' = 16°34.7'$$

For the Sun, which has highest altitude in June, the observing site may be only in Northern hemisphere and may be used the formula:

$$Z_t = \phi - Z_t,$$

$$\phi = Z_t + \varepsilon.$$

Latitude is $\phi = 16°34.7' + 23°26.4' = 40°01.1'N$

7.3.

According to the answer of the suppoint 1 of this problem, for solving this problem we have use the table, not formula. On the horizon, Zm=90°and R=2123″≈35.4′

Thus, when we saw the end of sunset, the Sun's upper edge has actually stayed 35.4′ below the horizon. Sothe zenith distance of the centre of Sun is

90° 35.4′ +16′ =90° 51.4′ .

7.4.

Let we define the upper point on the solau disk as A and lower point as B. When the sun is sitting on the horizon, ZmB=90° , so

$$Z_{tB} = 90° + 2123'' \approx 90°35.4'.$$

For the A point the true zenith distance is

$$Z_{tA} = Z_{tB} - 32' = 90°03.4'$$

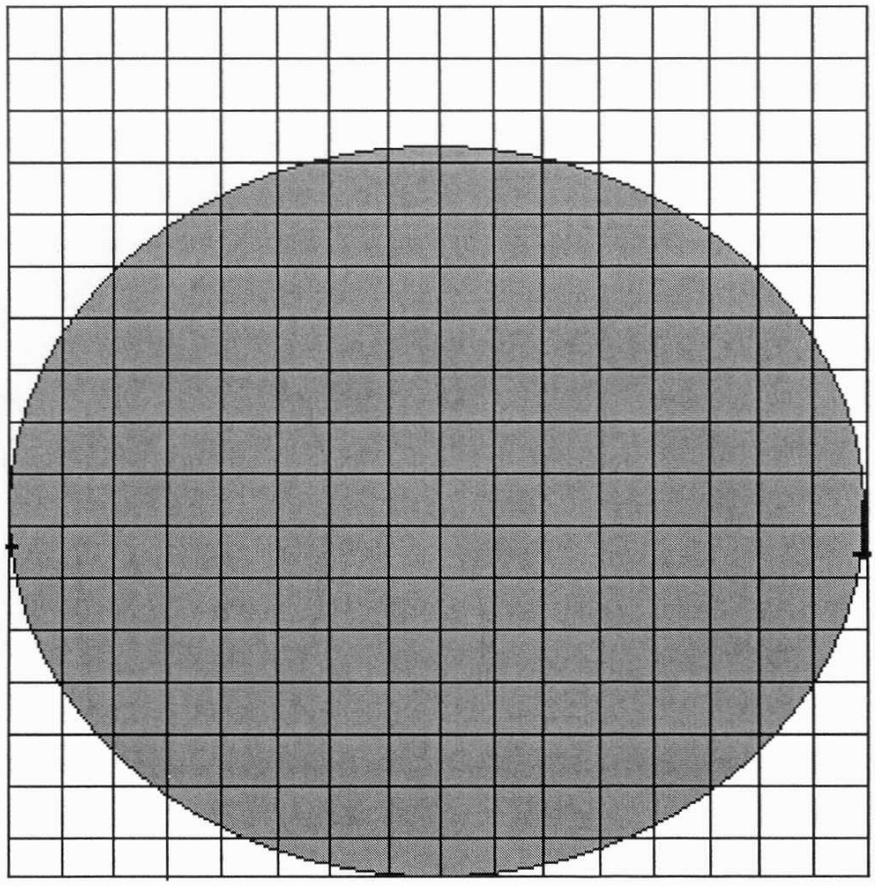
By interpolation and plotting R vs. Zt (note: between 89° 30′ <Zm<90°)we can find that

$$Z_{mA} = 89°33.5' \quad (R(89° \ 33.5') \approx 29.9').$$

Analogously for the centre of the sun true zenith distance is

$$Z_{m0} = 89°46.9' \quad (R(89° \ 46.9') \approx 32.5').$$

The sun appears flattened, the shape is oval 32′ ×26.5′ . And the upper half (13.4′) is larger than the lower one (13.1′). The figure is about the following:



A8.1:

We use horizon coordinate system to solve this problem. First, it is easy to use the Kepler's law getting the distance between the craft and the earth.

h=348km

In Wuqiang, the craft is near pole star. So its altitude: A1=38°, azimuth is 0°(calculate from North pole). The two places' ~~latitude~~ longitude are the same. So the craft is in the south when we observe at another place at the same time. Position of the craft can see in the picture. O is the center of the Earth, W is Wuqiang, X is Xilinhaote, S is the craft. Now we use sine and cosine low to get the solution.

$$\frac{R+h}{\sin(90°+A_1)}=\frac{R}{\sin\theta}$$

$$\theta=\arcsin(\frac{R}{R+h}\cos A_1)=48°.4$$

$$sow:\varphi_1=180°-(90°+A_1)-\theta=3°.6$$

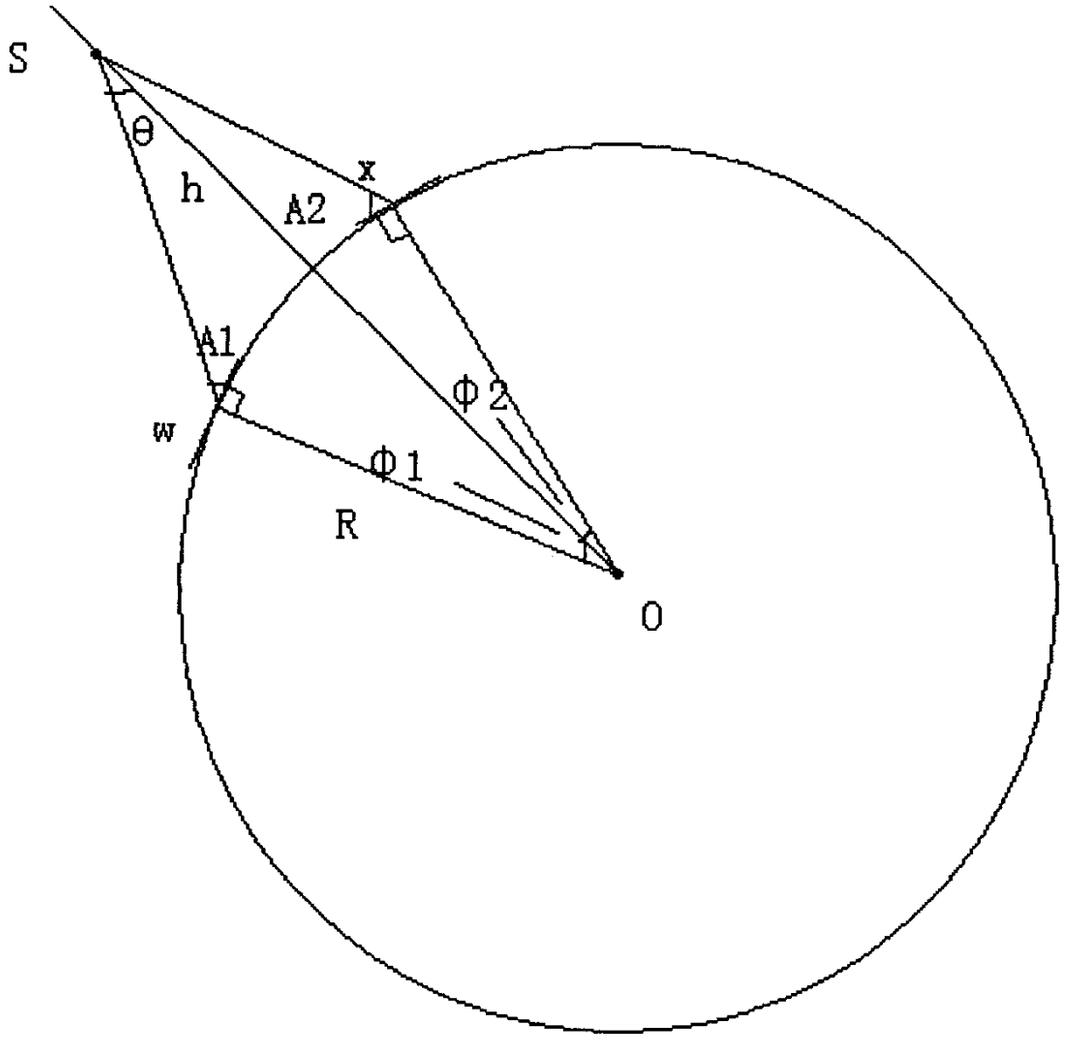
$$sox:\varphi_2=43°.9-38°-3°.6=2°.3$$ = latitude difference $= \phi_X - \phi_W - \phi_1$

$$\overline{sx}^2=R^2+(R+h)^2-2R(R+h)\cos\varphi_2$$

$$sx=300.0km$$

$$\frac{sx}{\sin\varphi_2}=\frac{R+h}{\sin(90°+A_2)}=\frac{R+h}{\cos A_2}$$

$$A_2=\arccos(\frac{R+h}{sx}\sin\varphi_2)=51°.8$$

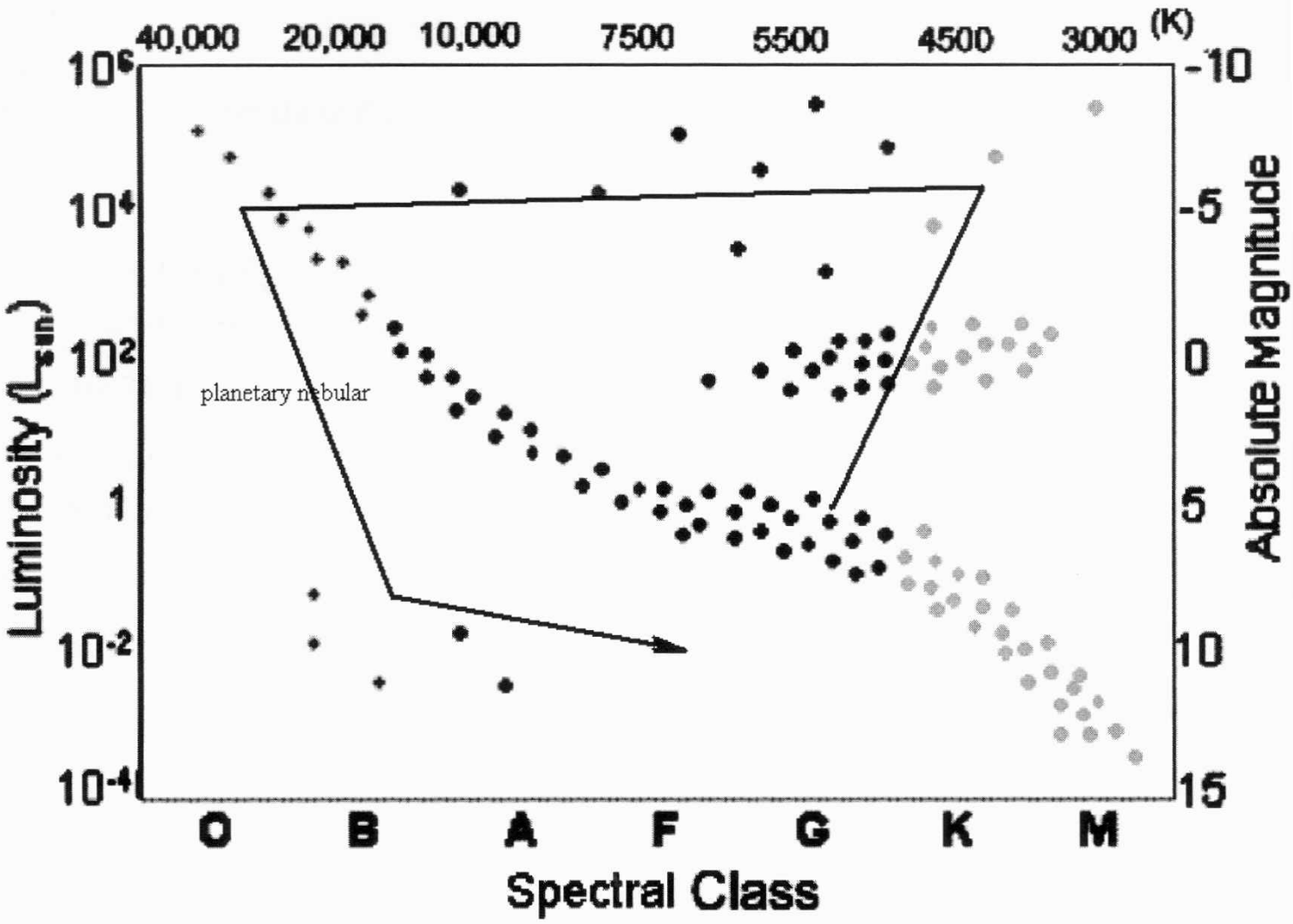


Now we know the craft in Xilinhaote, altitude: A2=51.8, in the south. See in the map, this position is between constellation Orion and Unicorn.

A8.2:

We know The Earth's rotation period is 24 hours, the craft's rotation period is about 1.5 hour. So after one day, the position of the craft will be the same and we can see it at both two place.

B8.1. See the approximate graphs below



8.2.

According to the figure 2, the expansion velocity of the shell may be found from:

$v\cos\phi / c = \Delta\lambda / \lambda,$

Where $\Delta\lambda$ is a difference between the laboratory and observed wavelengths and Φ from the picture seen to be about 30° .

$v = c \cdot (\Delta\lambda / \lambda) / \cos\phi \approx c \cdot (2\Delta\lambda / \lambda) / \sqrt{3} \approx 3\times10^8 \times 0.53 / 5200.26 / 1.732 \approx 17.6 km / s.$

The diameter of the planetary nebula is:

$D = \alpha \cdot L = 330 pc \times 12'' = 5.95\times10^{11} km$

$D = \alpha \cdot L = 330\times3.09\times10^{13} km \times 12 \times \pi / (3600\times180) \approx 5.95\times10^{11} km$

Or (by the way, the most easier solution)in astronomical units:

$D = 330\times12 AU = 3960 AU \approx 5.95\times10^{11} km$

Thus the dynamical age of the planetary nebula IC418 is:

$T = R / v = D / 2v = 5.95\times10^{11} km / 35 km / s \approx 1.7\times10^{10} s \approx 540 yrs.$