Grid 2. The Sun on the Horizon

The astronomical refraction correction, ρ_r, has the minimum value, $\rho_{r,min} = 0$, when the star is at the zenith of the Earth's surface observer $(z = 0; h = 90^0)$, and the maximum value of the astronomical refraction correction, $\rho_{r,max}$, is made when the star, whose light passes through the Earth's atmosphere, to reach the Earth's surface observer. $(z = 90^0; h = 0)$, is on the horizon when the star rises or sets

It is known that, for an observer, atmospheric refraction raises the Sun in the moments of sunrise and sunset, that is, when it is below the horizon, at its limit, approximately, with an apparent disk**.**

Knowing : the radius of the Sun, $R_S = 6{,}96 \cdot 10^5$ km; the distance between the center of the Earth and the center of the Sun, $d = 15 \cdot 10^7$ km, then :

a) $\rho_{r,max} = 23{,}7'$; b) $\rho_{r,max} = 43{,}7'$;

c) $\rho_{r,max} = 53{,}7'$; **d)** $\rho_{r,max} = 33{,}7'$.

Solution

Atmospheric refraction raises the Sun above its horizon, at its limit, at sunrise and sunset, approximately, with an apparent disk, as shown in the drawing in Figure 1.

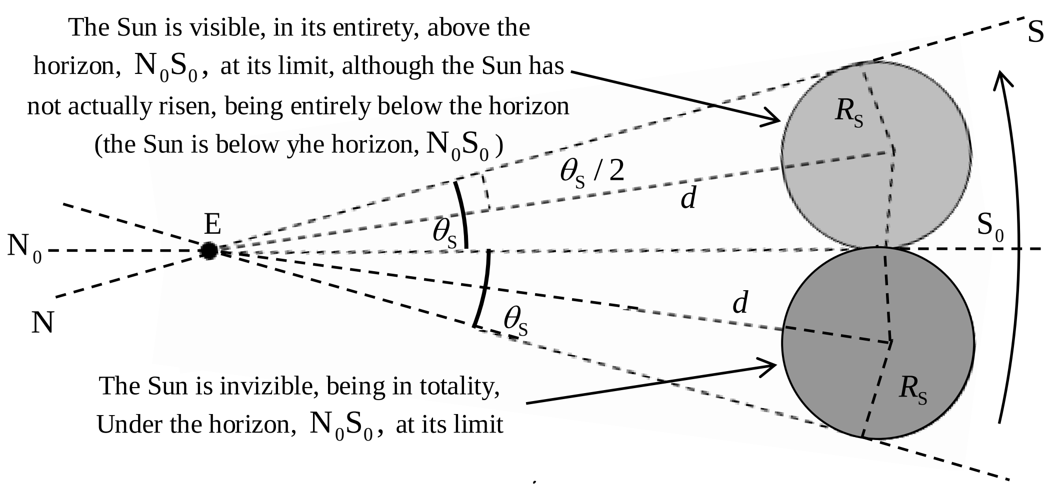

Fig. 1

Therefore, in reality, the rising of the upper arc of the Sun's disk begins after the moment when we already see the entire solar disk above the horizon. We see the sunrise and sunset, later than they actually occur, which makes the day a little longer.

I mean, I see the disk of the whole Sun above the horizon, at its limit, but the Sun has not yet risen, it is still below the horizon !

I mean, the sun went down, it went down below the horizon, at the edge of it, but I still see the whole disk of it above the horizon !

Under these conditions, the astronomical refraction has the maximum value :

$$\rho_{\mathrm{r,max}} = \theta_{\mathrm{S}};$$

$$\sin\frac{\theta_{\mathrm{S}}}{2} = \frac{R_{\mathrm{S}}}{d} \approx \frac{\theta_{\mathrm{S}}}{2};$$

$$\theta_{\mathrm{S}} = \frac{2R_{\mathrm{S}}}{d} = \frac{2\cdot 6{,}96\cdot 10^{5}\ \mathrm{km}}{15\cdot 10^{7}\ \mathrm{km}} = 0{,}0098\ \mathrm{radiani};$$

$$1\,\mathrm{rad} = \frac{180\cdot 60'}{3{,}14};$$

$$\theta_{\mathrm{S}} = 0{,}0098\cdot\frac{180\cdot 60'}{3{,}14} \approx 33{,}7' = \rho_{\mathrm{r,max}},$$

which proves that the value of the maximum astronomical refraction correction, $\rho_{\mathrm{r,max}}$, is approximately equal to the apparent angular diameter of the Sun, θ_{S}.