Answer on question #59209, Physics / Mechanics — Relativity

Question a satellite is moving in an orbit in equatorial plane at height of 1400km above earth surface.if it is travelling in the same direction as the direction of rotation of the earth what is the time interval between two successive times at which it will appear vertically overhead to an observer standing on the equator?

Solution Condition of stationary orbit:

$$G\frac{mM}{(R_{earth}+r)^2} = m\nu^2(R_{earth}+r)$$

Let us find angular velocity

$$GM/(R_{earth}+r)^2 = \nu^2(R_{earth}+r)$$

$$\nu = \sqrt{\frac{GM}{(R_{earth} + r)^3}} = \sqrt{\frac{6.67 \cdot 10^{-11} \cdot 6 \cdot 10^{24}}{(6400000 + 1400000)^3}} \approx 0.000918 \, rad/s$$

Now we have to subtract the rotation of Earth:

$$0.000918 - \frac{2\pi}{86400} \approx 0.000846 \, rad/s$$

The time interval between two successive times at which it will appear vertically overhead to an observer standing on the equator is

$$t = \frac{2\pi}{0.000846} \approx 7427 \, s$$