Geosynchronous Sattelites

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July 25, 2018

1 Problem

What if you want to examine a satellite that simply stays stationary over the same place on the Earth at all times? In other words, a satellite whose period is the same as the Earth's 24-hour period? Can you do it? Such satellites do exist. They're very popular for communications, because they're always orbiting in the same spot relative to the Earth; they don't disappear over the horizon and then reappear later. They also allow for the satellite-based global positioning system, or GPS, to work. In cases of stationary satellites, the period, T, is 24 hours, or about 86,400 seconds. Can you find the radius a stationary satellite needs to have?

Holzner, Steven. Physics I For Dummies (For Dummies (Math & Science)) (p. 134). Wiley. Kindle Edition.

2 Solution

$$T = 86,400s$$

$$F = \frac{Gm_1m_2}{r^2}$$

$$G = 6.67 * 10^{-11}N * m^2/kg^2$$

$$M_{Earth} = 5.98 * 10^24kg$$

$$a_c = \frac{v^2}{r}$$

$$\frac{m_1v^2}{r} = \frac{Gm_1m_2}{r^2}$$

$$v^2 = \frac{Gm_2}{r}$$

$$v = \frac{2\pi * r}{T}$$

$$(\frac{2\pi * r}{T})^2 = \frac{Gm_2}{r}$$

$$\frac{4\pi^2 r^3}{T^2} = Gm_2$$

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$$\frac{4\pi^2 r^3}{86400^2} = 6.67 * 10^{-11} * 5.98 * 10^2 4$$

$$r = 4.23 * 10^7$$