

CENTRIPETAL FORCE FROM GRAVITY

Units 14 & 8 Dr. John P. Cise, Professor

of Physics, Austin Com. College, 1212 Rio Grande St., Austin Tx. 78701 jpcise@austincc.edu & NYTimes , Aug. 16,2016 by E. Wong

China Launches Quantum Satellite in Bid to Pioneer Secure Communications



Video Researchers hope to beam transmissions from space to earth with quantum technology, a type of communication that could prove to be the most secure in the world.

INTRODUCTION: Gravity supplies the required centripetal force to keep the satellite in orbit:
 $G \frac{M}{R^2} = m \frac{v^2}{R}$, where $v = R \omega = R \left(\frac{2\pi}{T} \right)$, thus
 $G \frac{M}{R^2} = \frac{m [4\pi^2/R^2] R}{T^2}$ Thus, $M = \left[\frac{4\pi^2}{G} \right] \left(\frac{R^3}{T^2} \right)$
 $G =$ gravitational constant = $6.67 \times 10^{-11} \text{ N m}^2/\text{kg}^2$
 $R = R_{\text{EARTH}} + h$ (above earth surface), $M =$ earth mass,
 $T =$ period of orbit around earth.

QUESTIONS: (a) Find R (in meters) for this Quantum satellite 310 miles above earth surface?,(b) Knowing earth mass as $M = 5.9722 \times 10^{24} \text{ kg}$. confirm article statement that period is about 90 minutes (T) ?
Continued below.

BEIJING — **China launched the world's first quantum communications satellite** from the Gobi Desert early Tuesday, a major step in the country's bid to be at the forefront of quantum research, which could lead to new, completely secure methods of transmitting information. Researchers hope to use the satellite to **beam communications** from space to earth with quantum technology, **which employs photons, or particles of light**. That type of communication could prove to be the most secure in the world, invulnerable to hacking. Scientists and security experts in many countries are studying the technology. **(((The satellite is expected to circle the earth every 90 minutes after entering orbit at an altitude of about 310 miles,)))** according to a report by Xinhua, the state news agency.. The country's 13th Five-Year Plan, an economic blueprint that was announced in March, **listed quantum technology as a focal point for research and development. Traditional communications satellites send signals using radio waves. But a quantum communication satellite uses a crystal that produces a pair of entangled photons whose properties remain entwined even as one is transmitted over a large distance. Messages could be sent by manipulating these properties.** An article about the Chinese program **published by the journal Nature** in July said any tinkering with quantum communications would be detectable, which is why the method is secure. "Two parties can communicate secretly," the article said, and could be "safe in the knowledge that any eavesdropping would leave its mark." The Chinese researchers hope to use the satellite and quantum communications to establish secure transmissions between two ground sites. In theory, the satellite can provide the connection between them. The first major link in China would be between Beijing and Shanghai, and might open this year, according to Xinhua. The satellite, which weighs over 1,300 pounds, is called Quantum Experiments at Space Scale, or Qess, and nicknamed Micius, after a Chinese philosopher and scientist in the fifth century B.C.

HINTS: $R_{\text{EARTH}} = 3959 \text{ miles}, 1609.344 \text{ meters} = 1 \text{ mile},$

ANSWERS: (a) $6.87 \times 10^6 \text{ meters}$, (b) 5668 seconds = ~ 94.5 minutesCLOSE to what is stated in article.

COMMENT: Note in article the orbit was listed as "ABOUT" 310 miles. Kepler's 3rd. law was used here and in the calculation of T the cube of R was done and when cubing a small variation in R would have an effect on computation result for T . So, here obtaining $T = 94.5 \text{ min.}$, and not exactly 90 min. would be reasonable.