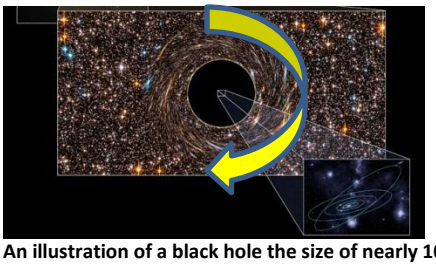
CENTRIPETAL FORCE & GRAVITY Units 14 & 8 Dr. John P. Cise ,

Professor of Physics, Austin Com. College, 1212 Rio Grande St., Austin Tx 78701 jpcise@austincc.edu & NYTimes Dec. 6, 2011 by Dennis Overbye , Please send Dr Cise an e-mail on how you used this NYTimes physics application. Thanks! Dr Cise

---

Astronomers Find Biggest Black Holes Yet



An illustration of a black hole the size of nearly 10 billion Suns. Inside it, where gravity is so in- tense that not ever light can escape, our solar system is shown to scale.

INTRODUCTION: **Gravitational force($F = G\,mM/R^2$) provides the centripetal force (mV^2/R) to keep stars rotating around black holes:**

$$Gm_{star}M_{black\ hole}/R^2 = m_{star}\,V^2/R \qquad (1)$$

Thus:

$$GM_{black\ hole}/R = V^2 \qquad (2)$$

$$\sqrt{GM_{black\ hole}/R} = V \qquad (3)$$

As is stated in the last sentence below the larger black hole Mass the larger velocity V of stars rotating about the black hole. This can be seen in equation (3) above. G = gravitational constant = 6.67×10^{-11} N m^2/kg^2 .

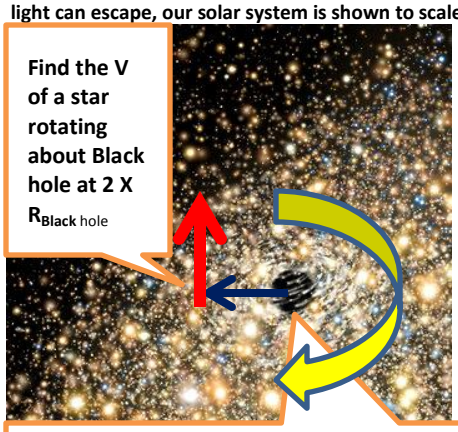
QUESTIONS: **(a) At twice the black hole radius distance from the center of a black hole..... R = 14.96×10^{16} m, find a stars V(in m/s and mph) about the 21 Billion sun mass($M_{black\ hole}$) black hole?**

HINTS: **$M_{sun} = 2 \times 10^{30}$ kg , Billion = 10^9. 2.327 mph per m/s. Equation (3) above is useful in question (a) and (b).**

(b) Answer question (a) for the 9.7 Billion Sun mass black hole?

ANSWERS: **(a) 4.327×10^6 m/s or 9.679×10^6 mph**
(b) 2.941×10^6 m/s or 6.579×10^6 mph

Find the V of a star rotating about Black hole at 2 X $R_{Black\ hole}$



As is said below these black holes are 10 times bigger than our solar system. Our solar system is 10^5 AU In diameter. 1 AU = 1.496×10^8 km. Thus, black hole radius = $10 \times 10^5 \times 1.496 \times 10^8 \times 10^3$ m/2 = 7.48×10^{16} m

An artist's conception of stars moving in the central regions of a giant elliptical galaxy that harbors a black hole.

Astronomers are reporting that they have taken the measure of the(((biggest, baddest black holes yet found in the universe, abyssal yawns(((10 times the size of our solar system))) into which billions of Suns have vanished like a guilty thought))). Such holes, they say, might be the gravitational cornerstones of galaxies and clues to the fates of violent quasars, the almost supernaturally powerful explosions in the hearts of young galaxies that dominated the early years of the universe. One of these newly surveyed monsters, which(((***weighs as much as 21 billion Suns***,))) is in an egg-shaped swirl of stars known as NGC 4889, the brightest galaxy in a sprawling cloud of thousands of galaxies about 336 million light-years away in the Coma constellation. The (((***other black hole, a graveyard for the equivalent of 9.7 billion Suns***,))) more or less, lurks in the center of NGC 3842, a galaxy that anchors another cluster known as Abell 1367, about 331 million light-years away in Leo. These results are more than just cool and record-setting. Observations with the Hubble Space Telescope over the years have shown that such monster black holes seem to inhabit the centers of all galaxies — the bigger the galaxy, the bigger the black hole. Researchers said the new work could shed light on the role these black holes play in the formation and evolution of galaxies. Mr. McConnell and his thesis adviser, Chung-Pei Ma, led a team of astronomers who used telescopes in Hawaii, Texas and outer space **to weigh the black holes in the centers of galaxies by clocking the speeds of stars zooming around them; the (((faster the stars are going, the more gravity — and thus mass — is needed to keep the stars from flying away))).**