CENTRIPETAL FORCE FROM GRAVITY

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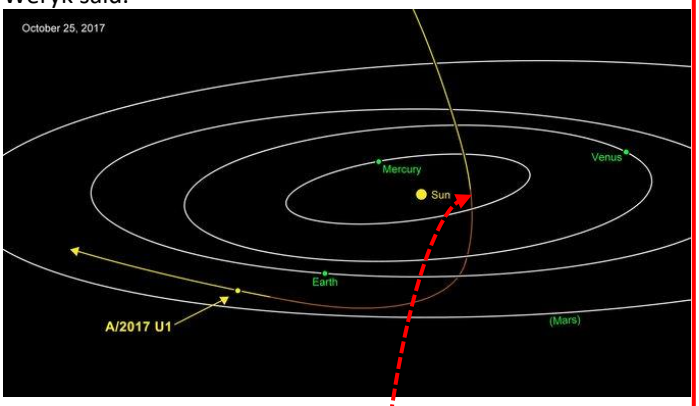
Astronomers Race to Study a Mystery Object From Outside Our Solar System

For the first time that we know, **an interstellar visitor has zoomed through our solar system. The small space rock,** tentatively called A/2017 U1, is about a quarter of a mile long and astronomers across the world are racing to study it before it departs just as quickly as it arrived. "We've never seen anything like this before," said Rob Weryk, an astronomer at the University of Hawaii Institute for Astronomy. On Oct. 19, Dr. Weryk was reviewing images captured by the university's Pan-STARRS 1 telescope on the island of Maui when he came across the object. At first he thought it was a type of space rock known as a near earth object, but he realized its motion did not make sense. It was much faster than any asteroid or comet he had seen before. He quickly realized that it was not of this solar system. **(((**"**It's moving so fast that the Sun can't capture it into an orbit**"**)))**," Dr. Weryk said.



Astronomers say that A/2017 U1 came from outside the solar system and is leaving again.

"It was obvious that the object **has a hyperbolic orbit,"** he said, meaning **that its trajectory is open-ended rather than elliptical like the objects in our solar system.** That shows that it came **from outside the solar system** and will leave the solar system. The **object came closest to the Sun on Sept. 9, at a distance of about 23 million miles. With a boost from the star's gravity, it zoomed by at about 55 miles per second with respect to the Sun**. Then on Oct. 14 the object came within about 15 million miles of Earth, zipping by at about 37 miles per second, with respect to the Earth. That's more than three times as much velocity as the escape trajectory for the New Horizons spacecraft, which completed a flyby of Pluto in 2015. Now it's moving away at about 25 miles per second, he said, and will exit the solar system at about 16 miles per second. That is faster than the current velocity of the Voyager 1 spacecraft, which became the first spacecraft from Earth to enter interstellar space in August 2012. **Because the object came from outside our solar system, it may be made up of completely different material than the asteroids and comets that we have studied.** Scientists did not have much warning about this object when it came into the solar system because it was blocked by the brightness of the sun.

INTRODUCTION: Sun's gravity (GmM/R^2) provides the centripetal force (Mv^2/R) to keep planets in orbit about the sun (our star). Equating: $GmM/R^2 = Mv^2/R$, solving for $v^2 = MG/R$. M = sun mass = ~ 2 X 10^{30} kg., G = gravitational constant = 6.67 X 10^{-11} N $m^2/kg.^2$. Purpose of this application is to show the speed (55 mi/s….see below) of this interstellar object exceeds needed to speed to be captured by sun at a distance of 23 million miles from the sun. Inside Mercury orbit.

QUESTIONS: (a) Convert 55 mi./s. to m./s.?, (b)Convert 23 M miles to meters?, (c) To be captured by Sun, find speed the interstellar object "should" have at 23 M miles from Sun?

QUESTIONS (CONTINUED): **(d) Mercury's orbit varies between 46 and 70 M km. from the sun (NASA data). Find average orbital distance R of Mercury's orbit? , (e) Find Mercury's orbital speed ?, (f) Comment on Mercury orbit speed vs. capture speed needed to orbit at 23 M miles from sun and interstellar object's speed at 23 M miles from sun?**

HINTS: 1.62 X 103 m. = 1 mile,

ANSWERS: (a) V = 89.1 km./s., (b) R = 37.26 X 109 m., (c)$V_{\text{Needed to be captured}}$ = 60 km./s., Thus, 89.1 km./s. exceeds the smaller 60 km./s. needed at 23 M miles from the sun. You can see in the graphic above how the object made a turn due to solar pull of gravity and speeded past the earth., (d) $R_{MERCURY}$ = 58 X 109 m., (e) $V_{MERCURY}$ = 48 km./s., Wikipedia data says speed is 47.36 km./s. , Thus, your computed value for VMERCURY is close. (f) Thus, closer to sun the higher orbital speed Is needed. This can be seen in R = 23 M miles vs. 58 M miles with orbit speeds of V = 60 km./s. vs. 48 km./s.. So. The interstellar objects 89.1 km./s. at 23 M km. was too much to be captured by sun. So the object just made a big turn into space.