APOLLO: THE ASTEROID THAT COULD STRIKE EARTH ON FRIDAY, APRIL 13, 2036

BACKGROUND
APOPHIS IS AN ASTEROID WHICH IS A ROCKY AND METALLIC OBJECT SMALLER THAN A PLANET LEFT OVER FROM THE FORMATION OF THE SOLAR SYSTEM ~ 4.5 BILLION YEARS AGO. APOPHIS HAS A SLIGHTLY OFFSET ORBIT TO THAT OF THE EARTH'S. DISCOVERED IN JUNE 2004, ASTRONOMERS HAVE DETERMINED THAT ON APRIL 13, 2029, IT WILL PASS 36,000 Km FROM THE EARTH. THE EXACT PATH THAT APOPHIS FOLLOWS IN 2029 WILL DETERMINE WHETHER IT CRASHES INTO THE EARTH 7 YEARS LATER.

WHY GIVE THE ASTEROID SUCH A THREATENING NAME? APOPHIS WAS THE ANCIENT EGYPTIAN GOD OF EVIL, DARKNESS, CHAOS, AND DESTRUCTION WHO TRAVELED THROUGH THE UNDERWORLD OR NIGHT SKY THREATENING TO DESTROY THE SUN GOD RA. A SMALL CHANCE EXISTS, ~ 1 IN 250,000, THAT IT COULD HIT EARTH. IF APOPHIS DID HIT EARTH, IT WOULD HAVE AS MUCH DESTRUCTIVE POWER AS AN 880 MEGATON BOMB. IF APOPHIS STRIKES LAND, IT WILL OBLITERATE EVERYTHING FOR HUNDREDS OF KILOMETERS AROUND. IF APOPHIS STRIKES AN OCEAN IT WILL SET OFF GLOBAL TSUNAMIS.

ASTEROID BELT
MOST ASTEROIDS, MILLIONS OF THEM, ORBIT THE SUN IN THE ASTEROID BELT BETWEEN MARS AND JUPITER. HOWEVER, SOME OF THE ASTEROIDS HAVE BEEN TUGGED OUT OF THAT BELT BY THE GRAVITATIONAL PULL OF JUPITER. WHEN 1 CELESTIAL BODY PASSES CLOSE TO ANOTHER 1, THEIR ORBITS ARE ALTERED A BIT BY THE GRAVITATIONAL FORCES INTERACTING BETWEEN THE 2 BODIES. SINCE APOPHIS IS MUCH SMALLER THAN THE EARTH, 325 m IN DIAMETER, ITS ORBIT WILL BE THE 1 EFFECTED.

MILLIONS OF REDIRECTED METEOROIDS, ROCKY AND METALLIC OBJECTS BETWEEN DUST AND MOUNTAIN SIZED RESULTING FROM ASTEROID COLLISIONS, HAVE SETTLED INTO ORBITS AROUND THE SUN VERY CLOSE TO EARTH'S ORBIT. ASTRONOMERS CALL THEM NEAR EARTH OBJECTS (NEOS). MOST SCIENTISTS REASON THAT A 12 Km NEO STRUCK EARTH 65 MILLION YEARS AGO, RESULTING IN DUST AND HEAT CHANGING THE PLANET'S CLIMATE AND ERADICATED THE DINASOURS.

NASA AND ASTRONOMERS ARE COLLABORATING ON A PROJECT CALLED THE SPACEGUARD SURVEY. THE SURVEY USES TELESCOPES TO IDENTIFY NEOS AND CHART THEIR ORBITS. ASTRONOMERS ESTIMATE THAT MORE THAN HALF OF THE NEOS BIGGER THAN 1 Km IN DIAMETER HAVE BEEN FOUND. SO FAR, NONE SEEM TO BE ON A COLLISION COURSE WITH EARTH.

KEYHOLE IN SPACE
APOPHIS'S ORBIT IS SLIGHTLY SMALLER THAN EARTH'S; IT REVOLVES AROUND THE SUN EVERY 323 DAYS. EVERY SEVEN YEARS, IT COMES CLOSE TO EARTH. DANIEL DURDA A PLANETARY SCIENTIST AT THE SOUTHWEST RESEARCH INSTITUTE IN BOULDER COLORADO AND OTHER ASTRONOMERS HAVE MAPPED APOPHIS'S TRAJECTORY (CURVED PATH) AND DETERMINED THAT THE ASTEROID WILL MAKE A CLOSE PASS BY EARTH IN 2029.

APOPHIS WILL BE 36,000 Km FROM THE EARTH, EFFECTING SOME SATELLITES. ASTRONOMERS DETERMINED THAT APOPHIS WOULD NOT IMPACT THE EARTH APRIL 2029. ASTRONOMERS RAN SIMULATIONS AND DETERMINED THAT THE ORBIT OF APOPHIS WILL BEND ~ 28 DEGREES, ALTERING ITS COURSE.

THE ORBIT OF APOPHIS WILL BECOME A LITTLE BIGGER AND A LITTLE SLOWER. HOW MUCH THE ORBIT OF APOPHIS CHANGES DEPENDS ON HOW CLOSE IT GETS TO EARTH. IF APOPHIS FLIES THROUGH A SPECIFIC 610 m WIDE KEYHOLE IN SPACE AS IT TRAVELS PAST EARTH IN 2029, THEN APOPHIS AND EARTH WILL BE IN THE EXACT SAME SPOT 7 YEARS LATER ON FRIDAY APRIL 13, 2036.

BECAUSE ASTRONOMERS WILL NOT KNOW UNTIL 2029 WHETHER APOPHIS WILL HIT EARTH IN 2036, IT IS TEMPTING FOR THEM TO DO NOTHING ABOUT THE PROSPECT OF A COLLISION. BUT THAT IS A MISGUIDED APPROACH, WARNS RUSTY SCHWEICKART, A FORMER NASA ASTRONAUT AND FOUNDER OF THE B612 FOUNDATION, A PRIVATE GROUP WHO'S MISSION IS TO DEMONSTRATE HOW TO DEFLECT AN ASTEROID. THE FOUNDATION IS NAMED AFTER B612, THE ASTEROID THE LITTLE PRINCE LIVED ON.

THE PROBLEM WITH THE WAIT AND SEE APPROACH, SAYS SCHWEICKART, IS THAT THOUSANDS OF LARGE NEOS EXIST THAT SCIENTISTS DO NOT KNOW ABOUT. ASTRONOMERS MIGHT NOT DISCOVER 1 OF THEM UNTIL IT IS BEARING DOWN ON EARTH WITH LITTLE WARNING. "WE'RE TALKING ABOUT SECURITY HERE," SCHWEICKART SAYS. IMPACTS HAVE OCCURRED BEFORE. IT IS WIDELY ACCEPTED THAT AN IMPACT BY AN ASTEROID WAS RESPONSIBLE FOR CHANGING THE EARTH AND ANNIHILATING THE DINASOURS.

THERE ARE MANY OBJECTS LIKE APOPHIS REVOLVING AROUND EARTH. THERE IS AN ACTUAL CHANCE THAT EARTH CAN BE STRUCK BY AN ASTEROID WE HAVE NOT SEEN YET. BECAUSE ASTEROIDS ARE SMALL, THEY ARE DIM AND CAN EVADE OUR TELESCOPES.

DEFLECTION MISSION
HOLLYWOOD PRODUCED A STORY OF A ROGUE ASTEROID IN THE 1998 MOVIE ARMAGEDDON. HEROIC ASTRONAUTS IN THE FILM BLOW UP THE ASTEROID WITH A NUCLEAR BOMB. BUT DOING THAT TO A REAL ASTEROID WOULD BE A MISTAKE. A NUCLEAR BLAST COULD BURST THE ASTEROID INTO SMALLER PIECES, ALL OF WHICH STILL COULD SAIL TOWARD EARTH.

SCHWEICKART AND DURDA EACH HAVE A METHOD OF ASTEROID DEFLECTION. SCHWEICKART PREFERENCES THE "ASTEROID TUGBOAT" TACTIC. THE ASTEROID TUGBOAT INVOLVES FLYING A SPACECRAFT TO AN ASTEROID AND PUSHING THE CRAFT'S NOSE GENTLY INTO IT. THE CRAFT WOULD THEN START A SLOW BURN OF ITS ENGINE AND CAREFULLY PUSH THE ASTEROID INTO A NEW TRAJECTORY, JUST AS A SMALL TUGBOAT PUSHES A TANKER THROUGH A HARBOR.

DURDA PREFERENCES PULLING INSTEAD OF PUSHING, AND HIS FAVORED METHOD IS THE "LU-LOVE GRAVITY TRACTOR." A ROPE WILL NOT BE REQUIRED BECAUSE GRAVITY WILL ACT AS THE TOWLINE. A SPACECRAFT IS POSITIONED NEAR AN ASTEROID AND FIRES ITS ENGINES, OVER MANY MONTHS IT CAN PULL AN ASTEROID OFF COURSE, SAYS DURDA. GRAVITY EXISTS BETWEEN ALL MASSES, NOT JUST PLANETS. GRAVITY EXISTS EVEN BETWEEN 2 PEOPLE SITTING ACROSS AN AISLE IN A SCIENCE CLASSROOM, IT IS JUST TOO WEAK TO NOTICE. THE GRAVITATIONAL ATTRACTION BETWEEN THE SPACECRAFT AND THE ASTEROID WOULD BE STRONG ENOUGH TO PULL THE ASTEROID BEHIND THE CRAFT AND OUT OF HARM'S WAY.

SCHWEICKART AND DURDA ARE TESTING THEIR CONCEPTS AND HOPE TO FLY A REAL DEMONSTRATION OF AN ASTEROID DEFLECTION MISSION. SO FAR, NASA HAS NOT OFFERED ANY HELP, WHICH THE 2 SCIENTISTS SAY IS A SCANDAL. NEVERTHELESS, THEY ARE PRESSING ON WITH PRIVATE HELP BECAUSE, SAYS DURDA, "SINCE WE HAVE THE KNOWLEDGE AND TECHNOLOGY, WE MIGHT AS WELL NOT TAKE THE CHANCE OF GOING THE WAY OF THE DINASOURS."
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**PROCEDURE**

1. **LABEL AND COLOR:**
   - **SUN = YELLOW, EARTH = BLUE, MOON = GRAY, MARS = RED, JUPITER = ORANGE**
   - **AREA MOST ASTEROIDS ORBIT = LITE BLUE, NEAR EARTH ORBIT = RED**

**V. CONCLUSIONS**

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<td>5. WHAT YEAR COULD APOPHIS PASS THROUGH THE KEYHOLE?</td>
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