The Inevitable Asteroid: The Way Our World Will End?

By Eugene F. Mallove

HOW SAFE IS HUMAN life from destruction by stray asteroids or comets?

Such a question is doubtless far down the list of most people's everyday concerns, but with roulette-like inevitability, Earth's number will come up, as it has many times in the past. The planet *will* once again collide with an asteroid weighing millions of tons.

Scientific evidence is mounting that the demise of the dinosaurs 65 million years ago was linked to such a collision between the Earth and a 6-mile-wide asteroid. It is becoming increasingly clear that a collision with an asteroid 5 to 10 miles in diameter would be akin to nuclear war: catastrophe would be global as the atmosphere was polluted by dust and debris.

There would be two major difference between an asteroid collision and nuclear war: The good news is, of course, there would be no radioactive fallout from an asteroid hit. The bad news is that asteroid impacts will occur *inevitably* unless action is taken to prevent them. As a result, scientists and even U.S. government agencies have been giving serious thought to the dangers posed by bombarding asteroids and comets.

In 1980, an advisory council to the National Aeronautics and Space Administration warned that "a large asteroid could someday destroy Earth civilization." It added: "In the 130 million years the dinosaurs roamed the Earth, they failed to develop the technology to avoid their own extinction. Homo sapiens has developed an adequate technology. He can avert any further extinction by asteroid impact. We think he should."

In 1981, NASA convened a conference in Snowmass, Colo., that examined these technologies of diverting dangerously large asteroids from Earth. The study concluded that if accurate information on an asteroid's orbit was obtained long enough ahead of time (perhaps 10 years), even a small, conventional explosive, or the thrust of a rocket engine could change its velocity enough to cause the asteroid to miss the Earth.

The NASA conclusions were similar to those reached in 1967 by a group of students and faculty members in the Department of Aeronautics and Astronautics at MIT. The group concluded that the asteroid Icarus, which is half a mile in diameter, could be diverted from a hypothetical collision course with Earth. In this case, it was assumed that properly placed nuclear charges would be used because the imagined warning time was only a year.

In 1971, the late Samuel Herrick, a recognized expert on celestial mechanics, suggested that a portion of the asteroid Geographos be broken off with explosives and propelled by rockets so as to *collide* with Earth on Aug. 25, 1994. The purpose would be to strike northwestern Colombia at the Atrato River and form an interocean "crater-canal." A byproduct of the impact, he contended, would be the landing of over $900 billion worth of nickel and rare elements such as iridium, platinum and gold.

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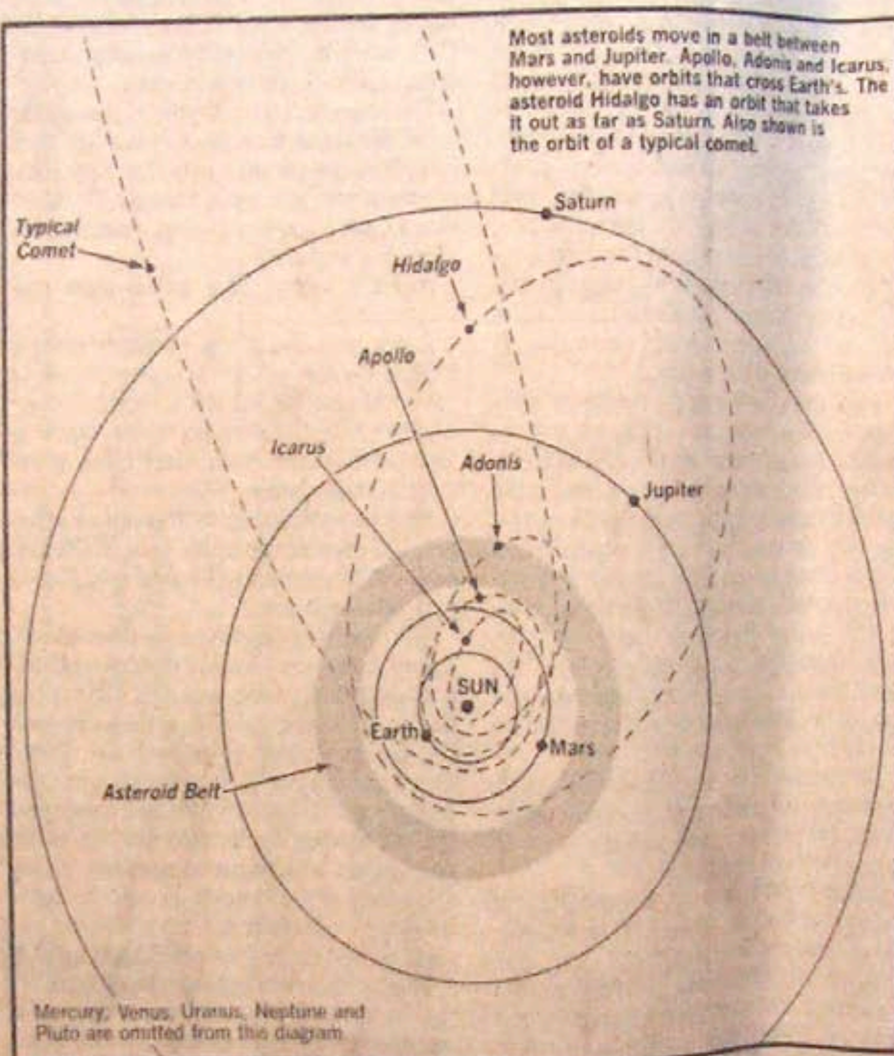

By Dave Cook — The Washington Post

Some asteroids from the belt between Mars and Jupiter have had their orbits distorted so they now have orbits which cross those of the Earth and other planets.

Eugene Mallove, an astronautical engineer, writes the syndicated column "Starbound."

Inevitable Cosmic Crash: The End of Our World?

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But whatever the possible positive result, Herrick wrote in a paper published posthumously in 1979, "We must gird ourselves to protect the whole Earth rather than just our lives, our environment and our ecology, by devoting a part of our space program to detecting, reducing, controlling and utilizing the predetermined fate of these little planets."

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In the past year, much scientific attention has been given to the effects of a nuclear war in which up to 10,000 megatons would be detonated. There is a developing consensus that the climate would change so dramatically that human survival would be in doubt. So much dust and soot from fires would be thrown high into the stratosphere that it would block out the Sun for months. This would put much of Earth into such a deep freeze that life forms that survived the initial blasts would be extinguished. The federal government will spend $50 million to study this "nuclear winter" problem.

A sufficiently large asteroid striking the earth could release much more energy than a nuclear attack, kick as much debris into the air and lead to extinctions in the same fashion as such a "nuclear winter." And we know that large asteroids have hit our planet in recent history, and will hit again. Were it not for the eroding effects of the planet's atmosphere and oceans, the asteroid impact craters of Earth accumulated over the eons would be as prominent and numerous as those of the moon.

On the morning of June 30, 1908, for example, a small asteroid or comet hurtled through the sky above the Stony Tunguska River in a remote area of Siberia. As it burned up in the atmosphere, it released an explosive energy equivalent to a 12-megaton hydrogen bomb (1,000 times the energy of the bomb that destroyed Hiroshima). It destroyed scores of square miles of forest and the thunderous blast was heard 500 miles away. It was only chance that it did not land on Moscow or New York City.

Eugene Shoemaker, a noted geologist and expert on asteroid impacts, has estimated the probability of another Tunguska-like event in the next 75 years at 12 to 40 percent, and other scientists agree with him.

An asteroid believed to have been no more than 300 feet in diameter left a crater near Winslow, Ariz., more than half a mile wide when it struck some 25,000 years ago. In the last two decades, high-altitude imagery has revealed outlines of dozens of other craters all over the world. Sudbury Basin in Ontario and Vredefort Dome in South Africa are among the largest craters, each more than 75 *miles* across.

To explain the extinction of the dinosaurs, and other abrupt changes in evolutionary direction, some astronomers have postulated the existence of a "death star," a small, dim and yet-undiscovered companion star which circles our Sun and which — at 26-28 million year intervals — swoops through the cloud of comets surrounding the solar system and gravitationally pulls millions of these large bodies towards the Sun. Several dozen of these would actually hit the Earth with devastating consequences for existing life forms.

(Relax — if the evidence is correct, the next naturally induced mass extinction will not happen for another 15 million years. However, a 50-megaton impact is likely every 1,200 years, and a 100,000-megaton impact of a half-mile-diameter asteroid could occur every 250,000 years.)

Of more immediate concern to Earthlings, however, is the belt of 400,000 large asteroids — from a half-mile to 600 miles in diameter — which orbit the sun between Mars and Jupiter. Another estimated 10 *billion* smaller fragments are in this belt.

While these pose no immediate threat, it is believed that over time a few come out of this belt into an orbit that eventually crosses that of the Earth. Once displaced from their normal orbit, they go into one whose plane can be tilted with respect to Earth's and other planets. As the planets disturb the motion of these wanderers, their orbits eventually can cross the path of the Earth, thus creating the possibility of a collision.

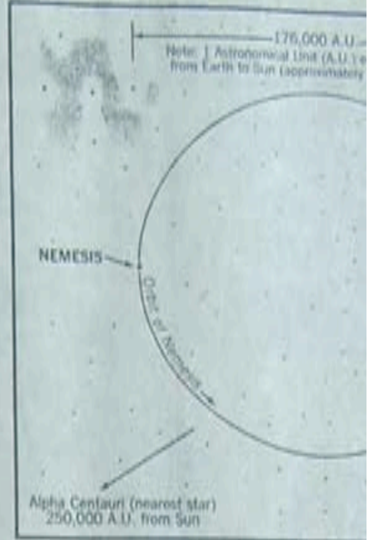
The entire group of Earth-orbit-crossing asteroids is named the Apollos (after one of the first Earth-crossers discovered). More recently the crossers have been named Apollo-Amor-Aten objects, after other members with different orbital characteristics.

Since the 1930s, a not very systematic search for Earth-crossers has uncovered about 60 asteroids that will in time collide with either Earth or its moon, Mercury, Venus or Mars. Statistical studies show that there are probably up to 1,000 Earth-crossers with a dimension on the order of half a mile — big enough to punch a 20-kilometer crater in a planetary surface. In 1937, the asteroid Hermes came within 500,000 miles of the Earth, the nearest recorded approach to date. (The moon is 240,000 miles away.)

How do these bodies escape the asteroid belt — if that is indeed from where they come? The opinion of astronomers is mixed, with some believing the crossers come primarily from the asteroid belt and others viewing them as "spent" comets.

One riddle is why the number of Earth-crossers has stayed fairly constant during 3 billion years, based on observations of craters. One explanation involves Jupiter and Saturn. These giant planets near the asteroid belt could, with their large gravities, distort the orbits of some asteroids in a rhythmic way, every time they pass in orbit. In effect, they would "pump" the orbits of some belt asteroids in a resonant fashion — much like the periodic pushing of a swing. These altered orbits could cause wayward asteroids to swing toward the inner solar system.

Other astronomers believe that the Apollo objects are remnants of comets from a vast reservoir of perhaps trillions of icy primordial bodies that surround the solar system in a gigantic halo — the so-called "Oort cloud." The tiny nucleus in a comet's head has been described as a "dirty snowball" — a mixture of ices of various gases which glue together solid fragments of stony material. When a comet enters the inner solar system, it flares as this material is vaporized by the heat of the Sun. The once-condensed and invisible comet grows a gigantic head or "coma" and a tenuous tail of gas and dust.



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After many passes through the inner solar system, a comet may lose most of its ice and become a rocky asteroid. Some believe that Comet Encke, for example, is now on its way to becoming an Apollo object. Recently, astronomer Kenneth Brecher of Boston University proposed that Encke fragmented into a swarm of large icy blocks which may have caused the Tunguska event, an observation in 1178 by a Canterbury monk of "flames" on the moon and moonquakes picked up by instruments left by the Apollo astronauts.

Although there is a long way to go, new developments in astronomy have greatly refined our knowledge of these little-known objects in the solar system. In 1973, the Palomar Planet Crossing Asteroid Survey was started by astronomers Eleanor Helin and Eugene Shoemaker using a photographic telescope known as a Schmidt camera. Only a few asteroids per year have been found by this and similar programs.

However, the Spacewatch Camera program at the University of Arizona, begun in 1983, marked a new step ahead. Rather than using photographic film, Spacewatch Camera scans the skies with a sensitive electronic device that transforms the view into electrical signals for computer processing. On repeated scans of the sky, the computer can detect what has moved — thus separating the image of background stars from that of an asteroid.

The goal of the project, headed by astronomer Tom Gehrels, is to discover and plot the course of the estimated 1,000 undiscovered asteroids larger than 300 meters in diameter that they theorize could be on collision courses with Earth. A new 72-inch diameter telescope scheduled to start work in 1986 is expected to increase the number of new asteroids discovered each year from 10 to 100.

The Planetary Society and a host of interested individuals and corporations have donated to the program to supplement NASA's contributions and keep it afloat.

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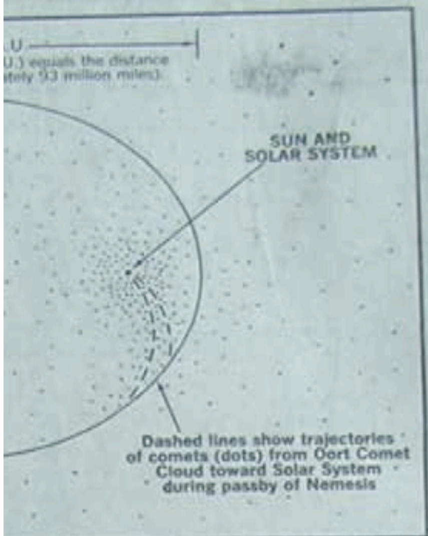
Earth-crossing asteroids pose numerous opportunities as well as dangers. Scientific missions to them have been proposed on



By Dave Cook — The Washington Post

nomer Richard Muller, may be a companion om the Oort Cloud to bombard Earth.

many occasions, and proponents of space industrialization point to the wealth of minerals and water that could be obtained from some asteroids. Asteroids have such low gravity that it would be relatively easy for a small robotic spacecraft to rendezvous with one, gather a surface sample and return to Earth without using large amounts of energy to leave its surface.

Soviet officials have hinted that they have plans for an unmanned space mission to rendezvous with an asteroid.

Scientists at the Jet Propulsion Laboratory have been planning reconnaissance missions, some of which make use of swingbys of Mars and Earth to visit a number of asteroids successively, even ones in the main belt. There is a likelihood that missions to the asteroids could be launced in the early 1990s with either the Inertial Upper Stage or Centaur Upper Stage carried by the space shuttle.

Chen-wan Yen at the Jet Propulsion Laboratory has plotted one mission that would be launched in September 1992 and after a swingby of Mars in 1993 would visit a panoply of asteroids — Flora in 1995, Medusa in 1996, Arachne in 1998, Hygeia in 2000 on July 4, Budrosa in 2001, Germania in 2004 and Penthesilia in 2006. A Planetary Society grant to The World Space Foundation's Asteroid Project resulted in the 1982 discovery of the two Earth crossing asteroids easiest for scientific missions to reach — 1982DB and 1982XB.

Life on Earth in all its forms may owe a lot to interplanetary wanderers — much more than had been imagined prior to 1978. In that year, Walter Alverez, his father, Nobel laureate Luis Alverez, and colleagues at the University of California at Berkeley found in a geological sedimentary stratum concentrations of the element iridium much greater than normal for surface rocks. This concentration of iridium occurred in clay dating to 65 million years ago. That is also the time that almost half of all species then existing were made extinct. They reasoned that the extinction could be explained by the impact of a huge, iridium-rich asteroid in effect causing a "nuclear winter."

Then in 1983, David Raup and John Sepkowski Jr. at the University of Chicago, in an intensive study of fauna extinction over the past 250 million years, found that the animal disappearances appeared to come at 26 million year intervals. At least 12 episodes were identified. Astronomers who had gingerly accepted the notion of the asteroid explanation of the Cretaceous-Tertiary dinosaur extinction were electrified and rushed to publish theories based on extraterrestrial causes to explain the periodicity.

Richard Muller and Marc Davis at the University of California at Berkeley along with Piet Hut at Princeton proposed that a dim companion star to the Sun with a long orbital period could be behind the extinctions. Likewise did Daniel Whitmire at the University of Southwestern Lousiana together with Albert Jackson of Computer Sciences Corporation.

The mathematical soundness of the theory of periodic extinctions is still being debated and may yet doom the theorists, if statistical errors have been made. Yet strong supporting evidence for the idea of a visiting star was proposed by Richard Muller and Walter Alvarez in their study of the ages of large craters on Earth. They claim a high correlation of the extinctions with peaks of cratering during the last 250 million years.

Their conclusion: a yet-to-be-found companion star to the Sun periodically bombards Earth with comets as the star moves through the Oort comet cloud toward its closest approach to the Sun. Thus, the analog of nuclear winter — literally "darkness at noon" — occured many times millions of years before ours.

Muller is conducting a search for the Sun's companion with an automated telescope. He hopes to find it by observing its distinctive motion among thousands of candidates in astronomical catalogues.

According to projections, this star should be closer by far than any star yet detected — only 2½ light years at its furthest distance. The difficulty detecting it arises from its size (its mass is thought to be only 5 to 20 percent of the Sun's) and its dimness (it is either so burned out or so slow burning that it may emit only a soft glow).

Muller's team has aptly named the hypothetical star Nemesis, the Greek god who made sure no mortal began to look or act too much like the gods. But other scientists would prefer to call it Shiva, the Hindu god of destruction and reproduction.

It is clear that if periodic mass extinctions caused by extraterrestrial bodies are real, then evolution owes a lot to the "death star." To produce the diversity and direction of life forms on Earth today may, some suggest, require the occasional mass extinction of other groups to give new forms ecological breathing room.

Those who study asteroids, comets and animal extinctions do not ordinarily make headlines. Their work, uncovering further evidence of an intricate cosmic connection to the rest of the universe, often goes unnoticed in the bustling world of politics of the moment and concerns about the nuclear sword of Damocles. What perverse trait of the race causes us to spend billions to deflect hostile projectiles which beings on the other side of our planet may never dispatch, yet makes us oblivious to the realities of our tenuous dominion in the natural world?

The silent telescope at the Steward Observatory is now gathering its precious data as it hunts for celestial intruders. Will there be enough time to turn even a fraction of our military arsenal toward defending the Earth? Or will there be a supreme irony: that the freed nuclear genie — ever the object of fear — will not even be asked to help us save our skins?