Shoemaker-Levy Comet Crash and Consequences

Fragments of Comet Shoemaker-Levy 9 lined up along the comet's orbital path, in a composite of images taken by the Hubble Space Telescope in 1994. A close encounter with Jupiter in 1992 broke up the comet's single nucleus into more than 20 pieces, which subsequently assumed their notable "string-of-pearls" appearance. Credits: NASA 360

Twenty-nine years ago, humanity first witnessed a collision between a comet and a planet. From July 16 to 22, 1994, enormous pieces of the comet Shoemaker-Levy 9 (SL9), discovered just a year prior, crashed into Jupiter over several days, creating huge, dark scars in the planet's atmosphere and lofting superheated plumes into its stratosphere.
Humanity had never before been able to watch an impact while it was happening. [1]

Comet Shoemaker-Levy 9 (SL-9)

Eugene Shoemaker was born in Los Angeles ninety-five years ago (1928). After graduating, he accepted a job with the United States Geological Survey at the age of 22. Together with his wife Carolyn, he revolutionized the view of the small bodies in the solar system.
The two Shoemakers recognized that many craters on Earth, previously thought to be volcanic in origin, are the marks of cosmic impacts.
Because of his expertise about craters Eugene Shoemaker trained the Apollo astronauts in the Arizona meteorite crater in preparation of their moon-landing. Besides craters on the earth, moons and planets, he also studied comets and asteroids.
The Shoemakers achieved worldwide fame when they discovered the Shoemaker-Levy 9 comet together with David Levy in the early 1990s. This comet had broken apart earlier in a close swing-by orbit around Jupiter.
Gene Shoemaker died in 1997 at the age of 69. In the middle of the Australian outback, his car collided with another car on a blind curve while he and his wife were on their way to an impact crater. Carolyn Shoemaker survived the accident with serious injuries. She continued his work.
A sample of Eugene Shoemaker's ashes was placed aboard the Lunar Prospector spacecraft two years later and "buried" on the Moon. When the battery of the spacecraft failed, NASA crashed the spacecraft deliberately on the Moon planned as an experiment to find traces of water in the resulting plume.
The 52 km diameter lunar crater Shoemaker, located near the south pole of the Moon between the surrounding craters Haworth, Nobile, Faustini and Shackleton, is named in his honor. [2]

David H. Levy was born on May 22, 1948, in Montreal, a Canadian astronomer and science writer. Levy developed an interest in astronomy at an early age, but in college he studied English literature, receiving a bachelor's degree from Acadia (Nova Scotia) University and a master's degree from Queen's University, in Kingston, Ontario.
Because of his interest in astronomy, Levy was an ardent comet watcher; by the beginning of the 1990s, he had discovered more than 20 comets. He first met the Shoemakers in 1988, when the couple was tracking a comet he had discovered.
In March 1993 the team discovered Shoemaker-Levy 9 in orbit around the planet Jupiter while they were working at the Palomar Observatory in southern California.

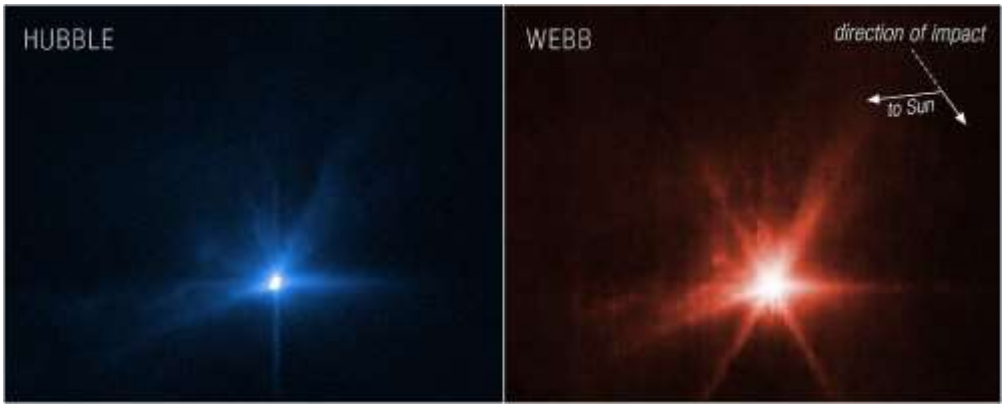
The discovery was made on 24 Mar 1993 on a photographic plate taken at Palomar Observatory, the image revealing the comet to be in orbit around the planet Jupiter. Comet Shoemaker–Levy 9 was the first comet observed to be orbiting a planet rather than the sun and, at the time of discovery had already broken up into a number of fragments due to the effects of Jupiter's tidal stresses. Subsequent calculation showed that these fragments would collide with Jupiter during the period 16-22 Jul 1994. The comet hit Jupiter as predicted, the event being unique in that it provided astronomers with their first-ever opportunity to observe the planetary impact of a comet.

In 1994 Levy and the Shoemakers watched through telescopes as the major fragments of Shoemaker-Levy 9 collided with Jupiter. Following months of speculation as to what the impacts would entail, the event itself proved equal to the most optimistic predictions. From the atmosphere of a bruised and battered Jupiter arose tall, bright plumes that left broad, dark stains beneath them, providing a spectacular show for sky watchers around the world. [3]
< *Dark spots showing the impact plumes of SL9*

Consequences
NASA's Galileo spacecraft had a front-row seat for the event. At the time of the impacts, Galileo was on its way to study Jupiter and its moons, and approaching at the right geometry to witness the fragments of SL9 slam into the gas giant. From 238 million kilometers (148 million miles) away, the spacecraft started snapping photos.
The best images, though, came from the NASA Hubble telescope, which just had gotten crucial repairs in its first servicing mission. Above Earth's atmosphere, with its high-resolution camera, Hubble's exquisite image quality allowed scientists to track the plumes growing and collapsing onto the cloud tops of Jupiter. Slowly, as the planet rotated, dark scars were revealed in its atmosphere where the comet fragments had impacted. Astronomers saw expanding waves of dark material, the shapes of the plumes, and details in the explosions' debris fields with unparalleled detail.

Before the SL9 impact, the term "*planetary defense*" didn't exist. These days, there are many teams of scientists tracking near-Earth objects (NEOs): asteroids that come within 30 million miles (50 million kilometers) of Earth's orbit. But back in the mid 1990's, only a few teams (including the Shoemakers) were looking for asteroids in the inner solar system.
In the year before the impact, a study team in the Air Force led by *Lindley Johnson*, now NASA's first Planetary Defense Officer, had been trying to convince their leadership that finding and tracking NEOs should be a part of the Air Force's space situational awareness mission. When SL9 was found to be on a collision course with Jupiter, Johnson's research became a major element in the Air Force's study of future space capabilities.
By 1998, Congress—influenced by Eugene Shoemaker and other scientists advocating for NEO research and with Hubble images of Jupiter's devastation fresh in their minds—officially directed NASA to find 90% of the asteroids in our celestial neighborhood 1 kilometer or larger. By the end of 2010, NASA had achieved that goal. Now, the agency is working to identify at least 90% of the asteroids between 450-3,000 feet (140-1,000 meters) wide, and they're still finding new ones e.g., the just recently detected object 2023DW which could collide with Earth in 2046.

“The Shoemaker-Levy 9 event showed us that we are vulnerable to impacts in the present day, not just in the distant past,” said Johnson. “These impact events occur in the Solar System right now, and we should do our best to find hazardous objects before they are of imminent danger of impacting Earth.”[4]



This imagery from NASA’s Hubble Space Telescope from Oct. 8, 2022 (left), shows the debris blasted from the surface of Dimorphos 285 hours after the asteroid was intentionally impacted by NASA’s DART spacecraft on Sept. 26. The shape of that tail has changed over time. Scientists are continuing to study this material and how it moves in space, in order to better understand the asteroid. Credits: NASA/ESA/STScI/Hubble
Right: Image of the impact from the James Webb Telescope (Credits: NASA)

NASA's first test mission for planetary defense, the Double Asteroid Redirection Test (DART) project, seeked to test and validate a method to protect Earth in case of an asteroid impact threat. The mission aimed at testing a method of planetary defense against near-Earth objects. It was designed to assess how much a spacecraft impact deflects an asteroid through its transfer of momentum when hitting the asteroid head-on. Impact date: 26 September 2022, 23:14 UTC.
From the data, the DART investigation team, led by the Johns Hopkins Applied Physics Laboratory (APL) in Laurel, Maryland, found that a kinetic impactor mission like DART can be effective in altering the trajectory of an asteroid, a big step toward the goal of preventing future asteroid strikes on Earth. [5]

References

[1] https://www.nasa.gov/feature/goddard/2019/how-historic-jupiter-comet-impact-led-to-planetary-defense
[2] https://www.deutschlandfunk.de/vor-90-jahren-wurde-eugene-shoemaker-geboren-der-entdecker-100.html
[3] https://www.britannica.com/topic/Comet-Shoemaker-Levy-9
[4] https://www.nasa.gov/feature/goddard/2019/how-historic-jupiter-comet-impact-led-to-planetary-defense
[5] 1 Mar 2023Wikipedia (DART results)