At about 5 p.m. PST on March 25, 1993, David Levy, Eugene Shoemaker, and Carolyn Shoemaker asked Jim Scotti at Kitt Peak Observatory near Tucson, Ariz., to confirm their codiscovery of a new comet with the Spacewatch 36-inch telescope.

"Do we have a comet?" David Levy asked. The response: "Boy, do you ever have a comet!" Jim Scotti reported seeing at least five separate comet pieces side by side with additional comet matter between them.

The confirmation of their discovery of Shoemaker-Levy 9 (SL9) initiated one of mankind's most exciting periods of scientific findings. It was the first time in history that human beings would witness a collision between a comet and a planet.

**Impending Impact!**

On the night of March 23, 1993, one comet almost missed having its picture taken! The California weather at Mount Palomar would not cooperate. Thick clouds flowed in from the west. Some of the film for that night's pictures could not be used because it was black from being accidentally exposed to light. Astronomers did manage to salvage film that had been partially exposed to light and was black around the edges.

Unwilling to sacrifice their limited viewing time, the team proceeded with their photography. The clouds parted briefly, and the SL9 team took pictures during the only two viewing times possible with their equipment. Two days later, Carolyn Shoemaker viewed the two images. To her surprise, she saw a squashed-looking comet near Jupiter!

**Comet Nearly Undiscovered!**

Astronomer David Levy

"This comet totally dominated the lives of its discoverers — Carolyn and Gene Shoemaker and me — from the time we discovered it in March 1993 to the most recent conference devoted entirely to the impact the comet caused. That conference took place in Paris in 1996. The impacts were a watershed in the history of astronomy, for they marked the first time that humanity saw such an important process taking place. Comet impacts are responsible for the delivery of the building blocks of life to Earth, and for many changes in Earth's biosphere since life began."
A Fateful Breakup

Shoemaker-Levy 9 (SL9) did not always exist as bits and pieces of a comet. Back in July 1992, the comet came too close to the massive planet, Jupiter. Comets are very fragile objects. SL9, for example, started drifting apart when the powerful forces of Jupiter's gravity began pulling at it. Jupiter, exerting what is called a "tidal force," pulled more strongly at the side of the comet closest to the planet. The uneven pull was just too much for the tiny comet. Its internal forces could no longer hold it together, and it fell apart.

It's Happened Before!

Tidal forces, such as those our moon exerts on the Earth's oceans, can cause other objects to break apart and possibly hit more massive objects that have a greater gravitational pull. Fragments of celestial bodies that were torn apart by tidal forces have hit Jupiter's system of moons in the past. Callisto, one of Jupiter's moons, bears the scars of such damage.

A chain of craters on our own moon was caused when an object passed too close to Earth at the wrong angle and speed. Our planet's gravity, exerting a tidal force on the object, pulled it apart, and some of its pieces collided with the moon's surface.
Shoemaker-Levy 9: First of its Kind

Shoemaker-Levy 9's (SL9) crash into Jupiter was the first time in the history of humankind that a comet and a planet were observed to collide. Amateur and professional astronomers, using every major telescope on Earth, viewed the impacts and recorded them. As the comet neared Jupiter, it began to speed up. Jupiter's powerful gravity then "captured" the comet, and it began orbiting the planet. Jupiter's gravitational tug was strongest on the part of the comet closest to the planet. This uneven gravitational force broke apart SL9.

What Happens?

An object moves faster when it comes close to the gravitational pull of another celestial object, such as a planet. If the object breaks up, the pieces stretch out into a line, just like the SL9 fragments. The piece closest to the planet experiences the greatest gravitational force. This fragment moves faster, and is the first to slam into the planet!
Comet Behavior

Comets are small, dirty snowballs that were created at the beginning of the formation of our solar system. Observing a comet is like looking at a time capsule from about 4 billion years ago. Comets are very small objects, ranging from pebble-sized to mountain-sized material. Most exist in the Kuiper belt, a region beyond the planet Pluto, or in the Oort cloud, located even farther away on the distant outskirts of the solar system. These comets are so far out (5 billion to 1,500 billion kilometers) that they travel in a very loose orbit around our Sun. If one of these orbiting snowballs passes another small body, such as another comet or asteroid, its path is hardly changed at all. But if it comes close to a planet, the results are more exciting.

The planet's effect on this tiny body depends on the comet's speed and angle of approach. A planet the size of Earth will most likely cause a small bend in a comet's orbit. More dramatic events result if a tiny comet passes close by a huge planet like Jupiter. (Comet Shoemaker-Levy 9 did just that in July 1994.) The stronger a planet's gravitational attraction, the more a comet's orbit bends. The comet's orbit may be altered so much that it passes close by the planet, and is eventually pulled apart.

Comet Shoemaker-Levy 9 (SL9) fragments on collision course with Jupiter

COMET NEWS from ‘It’s a Matter of Mass’

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After studying Shoemaker-Levy 9's (SL9) erratic orbit, Brian Marsden of the Central Bureau for Astronomical Telegrams sent a startling e-mail announcement: SL9 was going to collide with Jupiter in July of 1994. David Levy read the announcement and exclaimed to Carolyn Shoemaker, "Carolyn, our comet is gonna hit Jupiter!" Carolyn did not seem pleased at all that their comet was headed on a collision course. When her husband, Gene, read the same e-mail, he said, "I never thought I'd live to see this! We're going to see an impact!" The Earth was in for the show of the century.

Same Data, Different Viewpoints

The impending impact created quite a buzz among scientists. They debated whether SL9 was a comet or an asteroid, and they couldn't agree on whether the object would affect hefty Jupiter at all. "The Big Fizzle is coming!" said Paul Weissman in the journal Nature. He thought that the comet would fall apart before it ever collided with Jupiter's atmosphere. Astronomer Brian Marsden didn't think that scientists would see any evidence of the impact on Jupiter. So far, the planet hadn't suffered any visible damage from kilometer-sized comets striking it every few years. These disagreements among astronomers are not unusual. Often, scientists interpret the same data in a different way.

After fifteen months of anticipation, was it possible that SL9 would provide a spectacular show?

Words from a Scientist: Heidi Hammel – Boom, Boom, Boom!

Shoemaker-Levy 9's (SL9) wreck with Jupiter created quite a show! Heidi Hammel, an astronomer from the Massachusetts Institute of Technology, realized that within a 20-hour span, three chunks of the comet were going to hit one after another in the same region of the planet, creating "one heck of a mess!"
Once in a Blue Moon

Astronomers witnessed a rare event when they watched comet Shoemaker-Levy 9 (SL9) smash into Jupiter. Gene Shoemaker explained that a comet 1.5 kilometers wide should strike Jupiter about every 100 years. But the odds that a comet the size of Shoemaker-Levy 9 – about 8 kilometers across – would break up and hit Jupiter are once every 2,000 years!

Most comets reside in the Kuiper belt, a region beyond the planet Pluto, or in the Oort cloud, located even farther away in the distant outskirts of the solar system. But they don't spend all their time there. Their wide, looping orbits bring them into our solar system and around the Sun. Sometimes, our Sun and planets can be unkind to these visitors. Their gravitational muscle can break off a piece of a comet that wanders too close to them. Comets, after all, are delicate objects; they are loosely held together chunks of rock and ice.

But SL9 was different from the normal comet visitor. During a voyage to the solar system, the comet was "captured" by Jupiter after it traveled within the massive planet's gravitational grasp. SL9 became one of only two comets known to have orbited a planet instead of the Sun. And it was the only comet that astronomers witnessed orbiting a planet. Then SL9 made its closest pass by the planet and was ripped apart by tidal forces. Some astronomers estimate that the comet had been orbiting Jupiter for 20 years before the breakup. More than 20 comet chunks, lined up in a row, began looping around Jupiter in an unstable orbit. Soon, astronomers calculated that SL9 was heading straight for Jupiter. The predicted collision occurred in July 1994.
How About Earth?

Is Earth a target for wayward comets or asteroids? Scientists have determined that it is possible but unlikely. Duncan Steel, a member of Spaceguard, estimates that if an object were to slam into Earth, the size would range from very large objects (larger than 10 kilometers) to very small ones (30 meters or smaller). The odds of a very large object hitting Earth is once in 100 million to 1 billion years, and would cause total mass extinction!

The odds of a very small object striking Earth are once every 1 to 100 years. Such an impact would create less widespread destruction, like the one that occurred in the Siberian town of Tunguska on June 30, 1908. Astronomers aren't sure whether the object, which was about 30 to 60 meters across, was an asteroid or a comet. The object streaked across the sky, exploding about 5 kilometers above the remote Siberian town. The explosion was more powerful than the Hiroshima and Nagasaki nuclear bombs.

Most trees were incinerated just below the blast site, and forests were flattened as far as 30 kilometers away. A shock wave produced by the explosion blew carpenters off a building about 200 kilometers away. The closest surviving observers on record were some reindeer herders asleep in their tents about 80 kilometers from the blast site. The explosion blew the herders and their tents into the air. All of the reindeer herders survived, but many of their reindeer weren't as lucky. About 1,500 of them were killed.
The Bully Planet

The larger a planet, the more it can bully a comet or asteroid. Jupiter, the largest planet in our solar system, has more than twice the mass of all the other planets combined. You can imagine the enormous gravitational tug Jupiter can exert on a small comet or asteroid!

The Earth also can tug at passing comets or asteroids. But Jupiter has much more influence on such relatively small objects. If we say that Jupiter is the bully exerting tremendous pull on passing objects, picture what our Sun does. The Sun is 100 times more massive than Jupiter the bully!

Jupiter as seen by the Hubble Space Telescope, 1997. The black dot is the shadow of one of Jupiter’s moons.

Words from a Scientist: Carolyn Shoemaker

"Comet Shoemaker-Levy 9 was a beautiful comet, and the week of the crash, when it joined Jupiter, is not to be forgotten. We were glad so many could enjoy the fireworks. Since then, our search for comets and little planets called asteroids has continued."