Impact on Jupiter

Taken from:
*Hubble 2009: Science Year in Review*


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Impact on Jupiter

In July 2009, Australian amateur astronomer Anthony Wesley was observing Jupiter with his home telescope when he discovered a surprising black smudge near Jupiter’s southern polar region. The feature appeared to be a fresh impact site — reminiscent of the scars left behind when of pieces of Comet Shoemaker-Levy 9 (SL9) collided with the giant gas planet almost exactly 15 years earlier.

Around the world, astronomers rushed to view the feature. At the Space Telescope Science Institute, scientists and engineers interrupted the post-Servicing Mission 4 checkout and calibration of Hubble to make way for observations by a team of astronomers led by Heidi Hammel of the Space Science Institute in Boulder, Colorado. Hubble’s importance in viewing such events had become clear in 1994, when the telescope observed the SL9 impact with Jupiter. Then, the space telescope provided a wealth of data, revealing exquisite detail and structure of the impact sites. Hubble was especially sensitive to fine particles in Jupiter’s atmosphere, affording astronomers a unique view of the aftermath of SL9.

In 2009, the Hammel team used Hubble’s new Wide Field Camera 3 and the newly restored Advanced Camera for Surveys to observe the impact’s debris field. The 2009 object appears to have been approximately one-third of a mile—or 500 meters—in diameter, based on comparison of the new impact site with measurements of the ejecta observed when fragments of SL9 struck Jupiter.

Significant differences between the Hubble images of the two impact events provide clues to the nature of the 2009 object. Ultraviolet (UV) band observations in 1994 showed a distinct halo around the impact sites, perhaps resulting from the large amount of dust associated with a comet-fragment collision. They also showed a strong UV contrast between impact-generated debris and Jupiter’s regular clouds that remained in place for more than two weeks.

Taken on July 23, 2009, this is the sharpest visible-light image of the impact feature. The observation was made with Hubble’s new camera, the Wide Field Camera 3.
The 2009 impact had no comparable halo, suggesting a relative lack of fine particles. In addition, the contrast in the 2009 images disappeared more quickly, implying that these particles may have swiftly sunk into the atmosphere and out of view due to a larger size or higher density than those of the 1994 impact. These observations provide circumstantial evidence for an impact by a solid, asteroidal body instead of a dusty comet.

The elongated shape of the recent impact site also differs from those of the SL9 impacts, suggesting that the 2009 object may have entered at a more oblique angle than SL9 and caused a shallower impact. Knowing that wind speeds in the 2009 impact region are slower than those of the SL9 impacts, researchers determined that the debris should have spread more slowly and the impact site should have maintained a more compact shape if the object had made a more head-on collision.

Finally, the solitary 2009 impact was simpler to study than the multiple impact sites created by over 20 fragments of SL9 because researchers could more easily track the spreading and clumping of debris in Jupiter’s atmosphere. They were able to use the *Hubble* images to compare the velocities of the impact’s debris clumps with the velocities of the winds at Jupiter’s cloud tops, and derive an independent measure of the altitude of the impact debris. The analysis showed a markedly higher altitude for the debris than that typical of the planet’s cloud tops.

Events like the SL9 impacts are estimated to occur only every 6,000 years, while smaller events—like the most recent collision—are expected to occur approximately every 500 years. The 2009 impact, coming so remarkably soon after the SL9 impact, provided the astronomical community with an opportunity that may never be replicated: two distinct impacts on Jupiter, both occurring within a time span that allowed them to be observed with *Hubble’s* unique capabilities, thus providing a wellspring of data for future research.
For comparison, this image shows the July 1994 impact sites of fragments D and G from Comet Shoemaker-Levy 9. The large feature was created by the impact of fragment G. It entered Jupiter’s atmosphere from the south at a 45-degree angle, and the resulting ejecta appear to have been thrown back along that direction. The smaller feature to the left of the fragment G impact site was created by the impact of fragment D.

Further Reading


Dr. Heidi B. Hammel is a Senior Research Scientist and Co-Director of Research at the Space Science Institute in Boulder, Colorado, where she primarily studies the outer solar system planets and their satellites with a focus on observational techniques. She received her undergraduate degree from the Massachusetts Institute of Technology in 1982 and her Ph.D. in physics and astronomy from the University of Hawaii in 1988. After a post-doctoral position at the Jet Propulsion Laboratory in Pasadena, California, she spent nearly nine years as a Principal Research Scientist in the Department of Earth, Atmospheric, and Planetary Sciences at MIT. Dr. Hammel led the Hubble team that investigated Jupiter’s atmospheric response to the collision of Comet Shoemaker-Levy 9 with the planet in July 1994. She has been lauded for her work in public outreach, winning among other honors, the 2002 Sagan Medal for outstanding communication by an active planetary scientist to the general public. Asteroid 1981 EC20 was renamed 3530 Hammel in her honor.