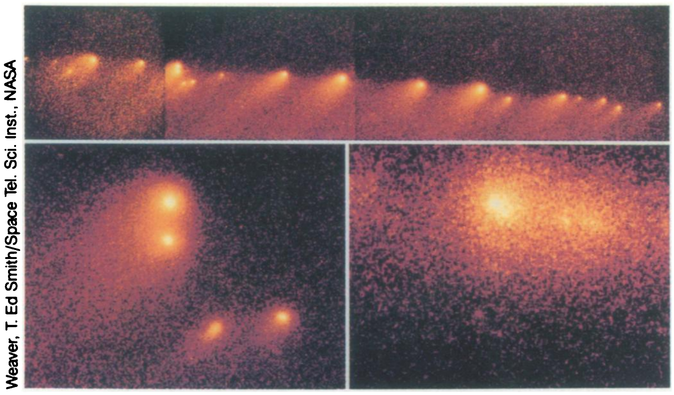
Repaired Hubble eyes Jupiter-bound comet

The fragments of Comet Shoemaker-Levy 9 are shifting position, and some may continue to splinter before they crash into Jupiter this July. The new findings come from the first pictures of the comet taken by the Hubble Space Telescope since the instrument's repair.

The Hubble images, recorded in late January and released by NASA last week, show that some of the cometary chunks no longer fit the orderly lineup that astronomers have likened to pearls on a string. The orientation of these out-of-kilter fragments may indicate that they formed after the main breakup 2 years ago of Shoemaker-Levy 9, says Harold A. Weaver of the Space Telescope Science Institute in Baltimore.

The pictures show that 9 of the 20-odd pieces of the comet seem to march to the beat of a different drummer, no longer following the same path along the sky as their companions. Three of these off-line chunks lie near the brightest fragment and were also seen — though less clearly — in pictures taken by Hubble last July, before its optical flaw was fixed (SN: 10/23/93, p.260).

Since July, notes Weaver, the three chunks have dramatically shifted position. The chunk nearest the brightest fragment increased from 35° to about 90° the angle it makes with the in-line pieces. Moreover, this piece now lies about 3,700 kilometers away from the brightest, more than triple the separation in July.



Weaver, T. Ed Smith/Space Tel. Sci. Inst., NASA

Top: A repaired Hubble views Shoemaker-Levy fragments. Bottom: July 1993 image (right), taken before the repair, shows that the brightest fragment has three companions. In a January image (left), the companions have shifted.

Studies indicate that the tidal gravitational force that shattered the comet when it passed near Jupiter in 1992 gave the trail of fragments a unique geometry. They would separate but remain in the same line, as viewed from Earth.

Based on these studies and the new images, Weaver suggests that the off-line chunks were created more recently and by a force other than Jupiter's gravity. He says that rapid rotation of a fragment or the sudden venting of volatile compounds from beneath its surface could split a chunk into smaller pieces. "There's no question that there's further fragmenting," says Donald K. Yeomans of NASA's Jet Propulsion Laboratory in Pasadena, Calif.

The total energy dumped into Jupiter's atmosphere this July will remain the same whether or not fragmenting continues, Weaver says (see page 120). But because smaller chunks make a smaller splash, each impact would be more difficult to detect, he adds. Weaver is now analyzing the Hubble images to get a better estimate of the average diameter of the chunks, the best indicator of the power of each Jovian collision. "That's what everyone is at the edge of their seats waiting for," he says.

That task will require making assumptions about the reflectivity of the fragments since their sizes can't be determined directly. Given the distance of Shoemaker-Levy 9 from Earth, Hubble can only resolve objects 360 km across. Alas, the fragments probably measure no more than 4 km. *—R. Cowen*

130-year-old pollination mystery solved

Botanists have struggled to piece together how some plants avoid self-fertilization — and the loss of genetic diversity that goes hand-in-hand with it — ever since Charles Darwin noticed that some plants can fertilize themselves while others cannot.

Now, biologists at Pennsylvania State University in University Park have found the first direct evidence of a self-incompatibility gene, or S gene. Biochemist Teh-hui Kao and his colleagues confirm in the Feb. 10 NATURE a theory of genetic self-incompatibility underlying years of research in plant genetics.

According to this theory, a plant that cannot fertilize itself has an S gene that is turned on, causing it to make an S protein in the pistil that recognizes and rejects its own pollen. Most plants have at least two versions, or alleles, of this gene. Plants with an S gene that is turned off do not produce this S protein, so they can fertilize themselves.

Working with S2 and S3 alleles in petunias, Kao first triggered a loss of self-recognition by using bacteria to insert antisense DNA, which mirrors normal DNA, into the flower's genome. Just how antisense technology prevents translation of the normal DNA into protein remains a mystery, Kao says.

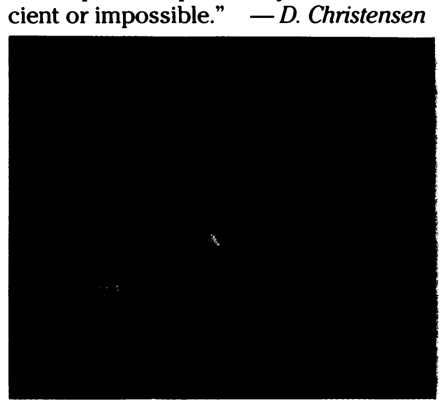
The genetically modified petunias no longer produced the S3 allele's protein and, because of the similarity between the two alleles, sometimes did not produce the S2 protein. When fertilized with genetically similar S3 pollen, Kao found, "they produced the same large number of seeds as you would get from compatible pollination."

In a second experiment, Kao's team slipped an extra allele, S3, into petunias containing S1 and S2 alleles. If these plants produced normal amounts of S3 protein, they formed no seeds at all when pollinated with S1, S2, or S3 pollen. Petunias with low S3 expression produced fewer seeds than usual. This, says Kao, shows that S proteins alone control a plant's ability to reject its own pollen.

More than half of all flowering plants depend on the S gene to prevent self-pollination. Others separate male and female parts so they develop on different plants or at different times. And a little bit of inbreeding isn't always a bad thing: If the plant population is changing rapidly, inbreeding can prevent the parent species from being swamped by its variable offspring.

Kao is still in search of his "holy grail" — the precise biochemical mechanism behind self-incompatibility. He wants to understand exactly how the S proteins inhibit self-pollination. What he's already found, however, may give a big boost to commercial growers, whose major crops grow from hybrid seeds.

"The potential could be quite high to create hybrid seeds at a reasonable cost," says Robert Griesbach, a research geneticist at the U.S. Department of Agriculture in Beltsville, Md. "This basic work may allow us to produce hybrids in many crops where this technique has previously been inefficient or impossible." *— D. Christensen*



Howard P. Nurenberger

Self-pollinated petunias.