This gravitational illusion, based on the principle that gravity distorts the path of light, was first proposed by Albert Einstein in 1916, and astronomers have seen the handiwork of gravitational lenses with ground-based telescopes since the late 1970s.

But in previous images, both those captured on the ground and those made by Hubble, the lensed objects appear as blurs. Ellis says that the unprecedented sharpness of the new Hubble picture, which shows L-shaped structures at the edges of the lensed images, enabled him to determine more accurately the concentration and mass of the material in AC114 that acted as a lens. His team has identified a third lensed image of the same distant galaxy in the Hubble photograph, he adds.

Assuming that the gravitational lens coincides with the center of the cluster and obeys similar laws of physics, Ellis calculates that the hidden material has 50 to 100 times the mass of visible material in the cluster and is much more densely concentrated. He reported the findings last week at a press conference in Washington, D.C.

The results match estimates of the amount of dark matter in galactic clusters made by observing lensed images from the ground. But J. Anthony Tyson of AT&T Bell Laboratories in Murray Hill, N.J., likens the impact of Hubble's single set of high-resolution lensed images to the diagnostic power of a single brain scan: One or two images may reveal only limited detail. He asserts that the blurrier but far more numerous lensed images seen from Earth still provide the best estimates of the amount of dark matter.

While Ellis disagrees, both scientists say the real revolution in the way astronomers calculate dark matter will come once Hubble begins to record many more gravitationally lensed objects.

Astronomers first postulated the existence of dark matter because the observed mass of the universe is too small to bind large objects gravitationally. The total amount of dark matter may determine the universe's fate — whether the cosmos has the gravitational power to collapse in on itself or will expand forever.

Ellis notes that the spectra of the lensed galaxy, recorded from Earth, suggest the galaxy lies 8 to 12 billion light-years away.

In a separate report at the press conference, C. Stuart Bowyer of the University of California, Berkeley, announced that another space-borne observatory, the recently launched Extreme Ultraviolet Explorer, detected a quasar-like object about 2 billion light-years from Earth. Researchers had thought the observatory would detect few, if any, sources outside our galaxy because of the patchy fog of hydrogen that bathes the stars and absorbs extreme-ultraviolet radiation (SN: 5/23/92, p.344). *—R. Cowen*

Gene-spliced rice resists stripe virus

In the Japanese language, the terms "rice" and "a good meal" are synonymous, reflecting the importance of the white grain to both the diet and the culture of Japan. Accordingly, the Japanese regard anything that threatens their rice crop as Public Enemy Number One.

A group of Japanese agricultural researchers has now made an advance that takes aim at one of the most serious rice scourges. Takahiko Hayakawa of the Plantech Research Institute in Yokohama and his colleagues have developed two genetically engineered rice varieties that resist infection by the rice stripe virus.

The rice stripe virus destroys millions of dollars' worth of rice harvests each year in Japan, Korea, China, Taiwan, and the former Soviet Union. An insect pest called the brown planthopper transmits the virus as it eats rice plant leaves. Rice stripe virus stunts the growth of rice seedlings, causes yellow stripes to develop on the leaves of mature plants, and reduces the amount of seed produced.


Hayakawa/PNAS

A rice seedling infected with rice stripe virus (right) displays stunted growth and reduced grain yield compared with a genetically engineered seedling (left) that contains a gene conferring resistance to the virus.

To foil the disease, Hayakawa's group turned to a modern-day adaptation of a classical agricultural technique: viral cross-protection. This strategy, which farmers worldwide have used for decades, involves inoculating young plants with relatively benign viruses in order to prepare them to fend off subsequent infection by more destructive viral strains.

In the mid-1980s, plant biotechnologists refined the technique by using genetic engineering to create plants whose cells make their own, benign bits of otherwise virulent invaders. Roger N. Beachy of Washington University in St. Louis and his colleagues demonstrated in 1986 that tobacco plants containing the gene that directs the production of the outer, or coat, protein of the tobacco mosaic virus can resist later infection by the virus.

Since then, the U.S. Department of Agriculture has approved 70 proposals by nearly two dozen research teams to grow outdoor test plots of plants containing genes for viral coat proteins. These field tests have included evaluations of tomatoes resistant to tomato mosaic virus, potatoes resistant to potato leaf-roll virus, and cantaloupe and squash resistant to cucumber mosaic virus (SN: 8/19/89, p.120). None of the gene-spliced vegetables has yet reached the market.

In the new report, published in the Oct. 15 Proceedings of the National Academy of Sciences, Hayakawa's group describes the first successful use of the viral-coat-protein strategy in a cereal crop. Working with clumps of immature rice-plant cells taken from two Japanese varieties of rice, the researchers inserted a gene that directs the production of the rice stripe virus' coat protein. They found that the clumps grew into young plants that made the coat protein.

To test whether the coat protein would allow the genetically engineered plants to resist infection by the rice stripe virus, Hayakawa and his colleagues placed virus-infected brown planthoppers onto 31 rice plants containing the coat protein and onto 17 control rice plants lacking the protein. They found that while 80 percent of the controls developed viral symptoms, only 20 to 40 percent of the genetically engineered plants did.

Moreover, the plants that did not display the viral symptoms also lacked a second protein marker of rice stripe virus infection, says Plantech researcher Ko Shimamoto, a member of Hayakawa's team. Shimamoto says the group plans to grow outdoor test plots of the genetically engineered rice plants next year.

Sivramiah Shantharam, a microbiologist at the USDA's Division of Biotechnology, Biologics, and Environmental Protection in Hyattsville, Md., says Hayakawa's team has taken steps toward solving a significant agricultural problem. However, he adds, "the exact mechanism of protection is not really known. . . . The coat protein might interact with an incoming viral particle, preventing its replication, but we really don't know how it works." *—C. Ezzell*