# Star hunt: Hubble looks at the heavyweights

In their brief lives, massive stars evolve at a furious pace. Known for their fierce stellar wind and high temperature, these heavyweights don't let up to the bitter end. Some may die in a supernova explosion; others may collapse to form a black hole — a superdense object from which not even light can escape.

Such flamboyant behavior has long captivated astronomers, but researchers have often been stymied in tracking massive stars. The short lifetimes of these behemoths prevent them from straying far from the crowded star clusters in which many of them formed. Ground-based telescopes can't pick out individual stars from the crowd, but a repaired Hubble Space Telescope has now managed that feat.

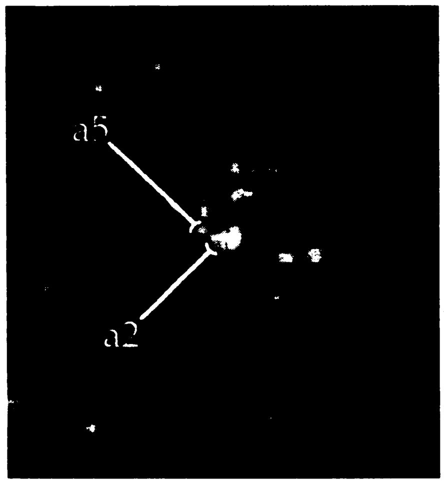
In doing so, the telescope is likely to revolutionize the study of stars 10 to 100 times more massive than the sun, says Sara R. Heap of NASA's Goddard Space Flight Center in Greenbelt, Md. Consider her own Hubble study, which suggests that some massive stars may have *too much* mass to form a black hole.

Astronomers have known for several decades that stars would need a minimum mass to gravitationally collapse into a black hole, but theorists have only recently begun to speculate that stars greater than a certain mass would fail to do so.

Heap presented her team's findings last week at a meeting of the American Astronomical Society in Minneapolis.

She and her colleagues base their results on the spectra of a massive star in the crowded cluster R136a, which lies in the nearby Large Magellanic Cloud galaxy. Using Hubble's Goddard high-resolution spectrograph, the team managed to home in on the ultraviolet spectrum of an individual star, called R136a5, even though a neighboring star in the cluster, R136a2, lies less than 0.2 light-year away.

The spectrum reveals unexpectedly strong emissions from ionized helium, which is formed in the wind that streams out from R136a5. The emission indicates that the star, about 60 times the mass of the sun, loses as much mass as 20 suns every 1 million years. That rate, eight times higher than predicted, suggests that instead of forming a black hole, very massive stars such as R136a5 "will peel off to next to nothing," Heap says.




Heap et al./NASA-Goddard

*Hubble image resolves individual stars in a dense cluster in the Large Magellanic Cloud. The star R136a5, labeled as a5, may be too massive to form a black hole.*

A combination of features may explain the finding. Stars such as those in the R136a cluster, which formed late in the history of the universe, have a higher content of what astronomers call "metals" — elements heavier than helium. That's because they've incorporated metals from previous stellar generations. Studies show that metals are more opaque than previously thought.

Therefore, the intense radiation from massive stars has more to push against when it slams into an outer shell of metal-rich material. The encounter creates a huge outflow, ultimately stripping the star of most of its mass, Heap says.

The metals' opacity has a second effect. It helps set up violent pulsations in the star that further rev up the mass loss rate, according to Norbert Langer of the Max Planck Institute for Astrophysics in Garching, Germany, and his colleagues.

Heap notes that stars born much earlier in the universe contained fewer metals and that their outer shells are more transparent to light. Thus, the first generations of very massive stars may have formed black holes more easily than stars of equal mass born today, she says. These latecomers may be subject to more constraints: Some don't have enough mass to form a black hole, some may have too much, but those in the middle may be just right.

Though her findings stem from just one star, they explain several puzzles, Heap says. She notes that the higher opacity can explain why many stars in R136a have stayed very hot for some 3 million years and why most don't appear bright in visible light. *— R. Cowen*

# Agricultural lands upset predatory insects

In many parts of the world, farms have split up vast meadows and other natural ecosystems. This fragmentation appears to hurt the predators of plant-eating insects more than the herbivores themselves, a new study finds. That's good news for plant eaters but bad news for farmers.

Herbivorous insects seem less finicky about where they settle than their predators, or parasitoids, reveals the study in the June 10 SCIENCE. "Habitat isolation affects species diversity, having the greatest impact on parasitoids, thereby releasing pest insects from parasitism," report German researchers Andreas Kruess of University Fridericiana in Karlsruhe and Teja Tscharntke of Georg August University in Göttingen.

The new report "says what people have been predicting for a long time," states Deborah Letourneau of the University of California, Santa Cruz.

Kruess and Tscharntke planted patches of clover measuring 1.2 square meters either in meadows or in areas 100 to 500 meters away from a meadow. In the meadow patches, researchers identified 8 species of herbivores and 13 species of parasitoids in one growing season. All but one predator species ate *Apions*, the most abundant herbivorous pest. *Spintherus dubius*, a wasp, was the most common parasitoid, accounting for almost 80 percent of the specimens captured.

The investigators then compared the plots in meadows with the clover islands. The patches farthest from a meadow had the fewest *Apions* and the least species of parasitoids — only two to four. They also had the lowest ratio of predators to herbivores. Plant-eating bugs in the clover islands located nearer a meadow suffered a much higher death rate from enemy insect attacks, Kruess and Tscharntke report.

In a separate, ongoing study, the researchers are finding that meadow size influences the relative proportion of insect predators and the vetch-eating herbivores on which they munch. In meadows 800,000 square meters in size, this ratio was more than double the ratio in meadows measuring just 300 square meters. Plant density did not account for the difference.

The data from this new study "really help substantiate what they're finding [in the clover-patch experiments]," says Letourneau. Meter-size plots can provide misleading results because not all insects come equally equipped to locate such small feeding grounds, she says.

Kruess and his colleagues are looking into why parasitoids appear to be so sensitive to fragmentation of natural ecosystems. Either fewer predators than herbivores try to colonize the isolated patches, or as many try but have less success than their prey, Kruess believes. Parasitoids may migrate from large meadows less often than herbivores do, he adds. Also, because their numbers start out smaller and fluctuate with the availability of herbivores, predator populations are more fragile.

Farmers could give predatory insects a boost by setting aside whole fields or strips surrounding fields, Kruess suggests. *— T. Adler*