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Farming's New Wave

Astronomers find evidence of missing matter

If astronomers were in charge of a lost-and-found department, they would have been fired long ago. Most have come to terms with the notion that at least 90 percent of the matter in the universe must consist of some strange, dark material that they cannot directly detect. More embarrassingly, astronomers had lost track of most of the baryons—ordinary, visible matter made of protons, electrons, and neutrons.

In the standard picture of cosmic evolution, so-called dark matter provided the scaffolding upon which the baryons collected. During the first several billion years of cosmic history, the baryons—mostly hydrogen—formed vast gas clouds. Some ended up in galaxies and galaxy clusters, but that accounts for less than half the baryons originally in the clouds.

New observations suggest that astronomers may have found the missing material just where theorists predicted: in intergalactic space. Over billions of years, the vast clouds of hydrogen gas condensed into a spidery network of filaments connecting galaxies and galaxy clusters.

Stripped of its electrons, the hydrogen in the filaments can't radiate light and isn't easily detected. Instead, the Hubble Space Telescope found evidence of that hydrogen by searching for highly ionized oxygen. Forged at the core of stars and dumped into space when the stars died an explosive death, the ionized oxygen associated with the ionized hydrogen.

To look for the oxygen, Todd M. Tripp and Edward B. Jenkins of Princeton University and Blair D. Savage of the University of Wisconsin-Madison studied light from a distant quasar that slices through billions of light-years of space. The ionized oxygen absorbs specific wavelengths of light from the quasar beacon. Tripp's team used the Space Telescope Imaging Spectrograph on Hubble to find the characteristic fingerprints.

Looking at the quasar QSO H1821+643, the researchers detected four fingerprints that serve as evidence of relic gas clouds, they report in the May 1 ASTROPHYSICAL JOURNAL LETTERS. With the Far Ultraviolet Spectroscopic Explorer (FUSE) satellite, Tripp and other colleagues found an additional absorption feature, they note in an upcoming issue of the same journal.

Although Tripp emphasizes that he's working with small numbers, he says the remnant clouds that his team has found indicate that relatively nearby reaches of intergalactic space could hold about half the missing hydrogen. Other studies with FUSE and Hubble corroborate the finding, he notes.

The observations, says Jeremiah P. Ostriker of Princeton, confirm the results of computer simulations that he and Princeton colleague Renyue Cen had previously developed (SN: 6/20/98, p. 390). According to their model, half of all cosmic baryons are now floating in intergalactic space at temperatures between 100,000 and several million kelvins.

Richard Mushotzky of NASA's Goddard Space Flight Center in Greenbelt, Md., says that he's now calculating whether NASA's Chandra X-Ray Observatory can record the faint emission from gases in that temperature range. If Chandra succeeds, astronomers will have more confidence that they've finally located some of the missing matter that roams the universe. *—R. Cowen*

John Godfrey/Space Telescope Science Institute

Artist's depiction of quasar light probing filaments of invisible hydrogen.

Female owls: First to advertise good genes

Taking an uncommon perspective on fashions that entice the opposite sex, European researchers have documented the first case of females in the wild decked out to advertise their good genes to picky males.

The more sexy black spots that a female barn owl sports on her breast feathers, the more disease resistance she passes to her offspring. This link between spots and good genes could explain male taste for spottier females, Alexandre Roulin, now at the University of Cambridge in England, and his colleagues report in the May 7 PROCEEDINGS OF THE ROYAL SOCIETY OF LONDON B.

"This is the first female signal of genetic quality," Roulin says.

Evolutionary theorists have long explained male fashion exuberance, such as peacock tails, as competitive advertising to win females. Evidence is building that some of the flashiness signals prime fathering quality.

"People were always focusing on the male," Roulin fusses. "This is really like an obsession."

Now, it's time for a female perspective, proclaim such leading researchers as Trond Amundsen of the Norwegian University of Science and Technology in Trondheim. Understanding what pressures drive female ornaments "is essential for a complete and realistic understanding of animal mating dynamics," Amundsen argues in the April TRENDS IN ECOLOGY AND EVOLUTION.

Research is turning up evidence that female showiness does not come just as some side effect of male showiness but may have links to more useful qualities, Amundsen notes. For example, female pied flycatchers with brighter forehead patches suffer fewer parasite infections, and female cardinals with flashier underwings feed their offspring more often.

Female barn owls vary in spottiness, and the variation seems genetically determined, says Roulin, who spent years at the University of Bern in Switzerland monitoring European owls. Neither environmental stresses nor the birds' health correlates with their spot differences, he and his colleagues observed. These owl spots contrast with peacock tails, which vary with health.

Successive females nesting with the same male tend to rank similarly in spottiness, and owl sons mate with females of similar spottiness to their mothers. These and other signs suggest that males shop carefully for mates, Roulin says.

To check for genetic benefits, Roulin's research team switched hatchlings to foster nests to rule out any differences in rearing. Researchers then injected 175 young owls with sheep red blood cells, a harmless substance that kicks up an immune response. Roulin linked high spottiness in the mothers to the most intense responses in the hatchlings.

Many people have asked him how dark spots could serve as a mating advertisement for largely nocturnal animals, he chuckles. He responds that owls can check out a prospective partner in daylight, too.

Another researcher who writes about immunity and signaling, Marlene Zuk of the University of California, Riverside, says that the study by Roulin has given her a new appreciation of ornamentation. "I've looked at barn owls for ages, and it's never occurred to me that female spottiness could be considered ornamentation," Zuk says.

She laments that previous work on female ornamentation has mostly occurred in sex-role-reversed birds like jacanas, where a big bold female defends a territory and monopolizes the males within it (SN: 3/6/99, p. 149). "What's neat about this study is that it's your run-of-the-mill bird," she says.

But is it? Roulin suggests that male barn owls might be picky because females leave their mates partway through rearing a brood. The first male finishes feeding the first family, while she and a second male start another nest. *—S. Milius*