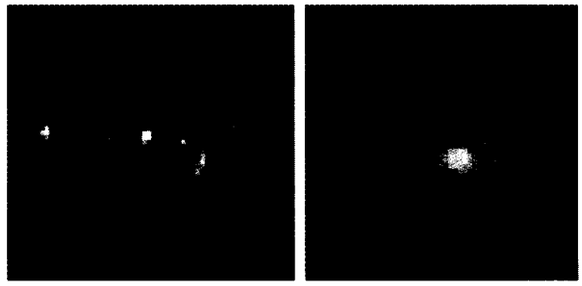
ASTRONOMY

Seeing the Universe's Red Dawn

Hidden in a corner of the nondescript patch of sky called the Hubble Deep Field, astronomers have found what may be the farthest and oldest galaxies ever seen. So distant that the expansion of the universe has stretched their light all the way into the infrared region of the spectrum, they may have formed just a few hundred million years after the universe itself. If the universe was born 13 billion years ago, they are probably 12.3 billion years old.

The discovery, announced last week at a NASA press conference, is a follow-up to the original Deep Field exposure by the Hubble Space Telescope (HST) in 1996. In an exposure lasting 10 days, the HST soaked up light from that patch of sky, revealing a swarm of blue, silver, and gold galaxies 11.7 billion years old. Those galaxies originally shone brightly in ultraviolet light because of the hot young stars populating them, but the expansion of the universe has "reddened" the ultraviolet into visible wavelengths. Even more distant galaxies, reddened all the way to the infrared, would have eluded the original Deep Field observation.



Rosy picture. A distant galaxy that looks fragmentary in visible light *(left)* fills out when seen in infrared light *(right)*.

Last January, Rodger Thompson of the Steward Observatory at the University of Arizona, Tucson, and his team went looking for those galaxies by aiming HST's infrared camera, called NICMOS, at one-eighth of the Deep Field for 36 hours. In a corner of the Deep Field that held more than 300 galaxies in visible light, NICMOS found 100 more. The light from most of those appeared to have been reddened by dust, not great distance, but the light of 10 of the dimmest ones seemed to have been stretched all the way from ultraviolet to infrared, giving them redshifts of 5.0 to 7.0. That would make them the oldest, farthest objects known. "What we see may be the first stage of galaxies in formation," said Alan Dressler, an astronomer at the Observatories of the Carnegie Institution in Pasadena.

"Next, we have to sort them out and find out what they are," said Thompson—"how similar these are to everyday galaxies." For now, these 10 ancient objects are too dim for anyone to see their shapes, estimate how quickly they're forming stars, pinpoint their distance, or even decide whether they're small galaxies or pieces of galaxies. One of them, Thompson thinks, looks a little like an edge-on spiral galaxy and another like a small elliptical. But their identities won't be certain until they're observed with HST's successor, the Next Generation Space Telescope, to be launched in 2007.

NICMOS did reveal details about other galaxies—ones that were seen in the original Deep Field, where they looked, says Thompson, like blue "jumbled-up bunches of things." These jumbles, which some astronomers had speculated might be pieces of galaxies in the process of merging, turned out to be brilliant knots of new stars forming among older, redder stars of fully formed spiral galaxies. "The [early] universe was better organized than we thought," says Dressler. Next, theorists have to figure out how the universe managed to organize itself into galaxies in only a few hundred million years.

–ANN FINKBEINER

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AGRICULTURE RESEARCH

1999 Budget: One Step Forward, Two Back

Last week was a bittersweet moment for agricultural researchers in the United States, as Congress finally agreed on a 1999 budget for the U.S. Department of Agriculture (USDA). The good news is that the bill provides a 23% jump in funding for the department's centerpiece competitive research program, the National Research Initiative (NRI). But the bad news is that Congress killed funding for a major new research initiative and axed a smaller research program focused on rural communities to help pay for NRI's increase. "Every little bit helps," says Louis Sherman, a plant molecular biologist at Purdue University in West Lafayette, Indiana. "But we're disappointed that the funding for the [new research] initiative was not appropriated."

Last June, Congress raised the hopes of plant and animal scientists by approving a $600 million, 5-year program that would support agricultural genomics, nutrition, food safety, biotechnology, and natural resources management (*Science*, 3 April, p. 23). The bill's sponsors and researchers saw the Initiative for Future Agriculture and Food Systems as a way to revolutionize agricultural research with large grants to multi-institution collaborations attacking major problems. Researchers also welcomed a move by the Senate to double the research component of the department's $100-million-a-year Fund for Rural America, now in its second year. That program supports work on animal waste management, alternative fuels, and other subjects important to rural communities.

But when it came time to pay for these ventures, Congress balked. A panel of conferees from the House and Senate cut both research programs and shifted some of the funds into other activities. Instead of the $120 million that the Senate had recommended for the futures' initiative, the conferees upped NRI's budget from $97 million to $119 million. The Agricultural Research Service, which supports USDA scientists, received an additional $26 million, to $782 million, and the $222 million in formula funds allotted to states was increased by 7% instead of the Administration's 3% request. But Terry Nipp, a lobbyist for directors of agricultural experiment stations and extension programs, says that "[the additions] in no way get close to the money we lost. We're deeply disappointed."

The increase for NRI is, at least, welcome news for a program whose budget has been stuck at its initial level of $100 million a year for 7 years—even though Congress itself had once agreed that it should grow to $500 million. That steady state has prevented NRI from making the type of larger, multidisciplinary awards now standard for many cutting-edge research projects or for using the latest molecular techniques in plant and animal science.

Even NRI's new budget falls well short of President Clinton's request for $130 million, however, and the increase is not spread evenly across the program. The funding bill doubles NRI's spending for food safety research,

Counting chickens. Researchers hoping for a new ag initiative must make do with more money in existing programs.

CREDITS: (TOP) RODGER I. THOMPSON/UNIVERSITY OF ARIZONA/NASA; (BOTTOM) BRUCE FRITZ

to $16 million, and adds $4 million for plant genome studies and $5 million for animal genome studies. These efforts would have been part of the new foods initiative, but it's logical for NRI to fund them, says Sally Rockey, a deputy NRI administrator, because it is already supporting projects in these fields. But some things are lost in the trade-off, says Nipp. NRI-funded projects do not have the education and extension components that were to be part of the new initiative, and traditionally NRI awards are small, single-institution grants, he notes. "The NRI is not structured to do some of the things that the initiative was supposed to accomplish."

Although the bill's ultimate fate is uncertain—Clinton vetoed it in an attempt to win more emergency aid for farmers—most observers expected its provisions to be retained in a catch-all budget bill passed before Congress adjourned for the year. But supporters of the new initiative are not yet ready to throw in the towel. When Congress considers the agriculture budget next year, says Rockey, "we would hope we can resurrect it."

–ELIZABETH PENNISI

EVOLUTION

Male Mating Blocks New Cuckoo Species

The common cuckoo thrives by hoodwinking other birds, and it has mystified biologists as well. Cuckoos lay their eggs in the nests of many other bird species, but individual females specialize in nests of just a single species, leaving eggs that match those of the host bird to fool it into tending them. In spite of this specialization, the cuckoo itself remains a single species. Now, a study on page 471 reports that the reason lies not in the struggle between host and parasite, but in another ancient battle—between male and female.

Genetic analyses of cuckoos reveal that even as they specialize on different hosts, the different reproductive strategies of males and females prevent speciation. "They're at odds with each other," explains co-author Karen Marchetti, an evolutionary biologist at the University of California (UC), San Diego. Although it's in the interest of the female to mimic a particular host as closely as possible, Marchetti and her colleagues found that the male mates with females that parasitize many different hosts, spreading his genes around. "And that prevents the development of new species," says Marchetti.

"They've confirmed what we suspected but has been hard to show," says Bruce Lyon, an evolutionary biologist at UC Santa Cruz. "These are hard-won data," he says, noting that the secretive behavior of the cuckoo has hindered earlier efforts to study its reproductive patterns. But the jury is still out on some of the team's theories—for example, that cuckoos pass egg traits such as color, pattern, and size only from mother to daughter, enabling them to produce a variety of egg patterns in spite of the males' homogenizing effect. "It's tantalizing, but it raises more questions than it answers," says John Eadie, a behavioral ecologist at UC Davis.

To solve the mystery of how cuckoos specialize without speciating, Marchetti and her co-authors studied the mating patterns of the Japanese common cuckoo. This bird lays its eggs in the nests of three other species, then leaves, letting the hosts perform all the chick-rearing chores. There's always the risk that the host species will learn to recognize foreign eggs and push them out of the nest. "That puts selective pressure on the female cuckoos to lay eggs that match their host's," explains Marchetti. Such evolutionary pressure is beginning to lead to the formation of "host races," with eggs specialized for a particular host species—a process that is more advanced in the European cuckoo, in which females lay very distinct eggs for each host. These races would seem to be poised to develop into different species—but the cuckoos don't go that far. "That's the mystery," says Marchetti.

The Japanese cuckoo has been carefully studied in the field by one of the authors, ornithologist Hiroshi Nakamura of Shinshu University in Nishinagano, Japan. He noted that just 30 years ago, the cuckoo added the third host, the azure-winged magpie, to its surrogate parent list. To see how this new specialization affected the bird's genetics, Nakamura collected blood samples from 83 adult male and 79 female cuckoos. He also sampled 136 chicks, recording which of the three host nest types the chicks were found in.

Marchetti then used this material to determine each chick's parenthood. Family tree in hand, she could then see where each female's chicks grew up. It quickly became clear, as researchers had guessed from field observations but never shown, that females are typically faithful to their host species, laying eggs in the kind of nest in which they were born. If an egg gets laid in the wrong nest by mistake, as happens about 5% of the time, and if the naïve host rears the chick, the cuckoo can immediately be set on a new evolutionary path, leading to the formation of host races—and potentially a new species.

But when researchers looked at the chicks' paternity, they found that the males willingly mate with any female, regardless of which host she is attached to. That behavior should block the development of any new species. "It's a conflict between the sexes," says Marchetti. "The males want to maximize the number of their offspring ... [while] the female is under pressure to produce the best matching egg, one the host won't reject."

Because the father's genetic contribution cannot foster specialized eggs, the team speculates that egg-mimicry traits are passed only from mother to daughter. That would increase the chances of the females laying well-matched eggs—even though the male mating habits are working against them. But Eadie and others note that this is still a theory, and the team has yet to muster evidence on how egg mimicry comes about and is maintained. "That's still a big, black box," says Eadie. "This paper has opened the door," says Paul Harvey, an evolutionary biologist at Oxford University. "We're going to see a lot more" now that genetic techniques can be applied to the cuckoo's sneaky reproductive habits.

–VIRGINIA MORELL

CREDIT: A. J. KNYSTAUTAS/VIREO

Birds of different feathers. Unwitting warbler feeds cuckoo chick.

SOLAR ASTRONOMY

Recovered SOHO Passes Health Check

Solar astronomers are breathing a sigh of relief this week. After a couple of months out of contact with Earth, spinning out of control, and exposed to extremes of temperature, the hugely successful Solar and Heliospheric Observatory (SOHO) appears to have come through its ordeal unscathed. As *Science* went to press, seven of the 12 instruments on board had been switched on successfully and recommissioning is complete for four of them, reports Bernhard Fleck, the European Space Agency (ESA) Project Scientist for SOHO at NASA's Goddard Space Flight Center in Greenbelt, Maryland. (SOHO is a joint project between NASA and ESA.) "We haven't observed any adverse effects due to the thermal stress so far," Fleck says. He is still surprised at how well the recovery has gone. "It is a miracle," he says.

When SOHO spun out of control in June, following a series of ground control errors (*Science*, 11 September, p. 1585), astronomers feared they would lose a unique vantage point in space to watch the sun as it reaches its 11-year maximum in solar activity around 2001. "The loss would have been a major setback," says Jørgen Christensen-