cause they apparently can't associate with the altered receptor.

Significantly, the T cell alteration appears to be a general phenomenon. The NCI team, for instance, has found the same defect in different strains of mice with different types of cancer. What's more, the changes are apparent in both of the two major types of T cells, the "killer" CD8 cells and "helper" CD4 cells, although it is only in the CD8 cells that the NCI group can observe impaired function: The CD8 cells don't "lyse" or kill other cells as efficiently as they should. How the alteration affects the performance of CD4 cells is an important issue, admit both Longo and Ochoa, and tough to resolve because it is more difficult to assess their normal function. Even more important, the NCI group has extended its work to human cancer patients and has found similar alterations of peripheral blood T cells in more than half of the approximately one dozen studied so far, although not in any of the normal controls.

As with any major new finding, this one has raised more questions than it answers. The mouse studies show that all the T cells in the animals, not just those that react with the tumor, can undergo the alteration in less than 48 hours. The researchers propose that the change is brought about by a soluble factor, which is released by the tumor into the bloodstream and can thus come in contact with all T cells. But they have few clues to how the putative factor works. Since both the zeta chains and the two kinases appear to be synthesized, Longo speculates that the hypothetical tumor substance leads to the degradation of the zeta chain and that the kinases, which can no longer couple with CD3 to preserve their form, are also degraded as a result. Of course, says Pardoll, "the big question is whether there truly is a humoral substance that can be isolated."

If there is and if it can be isolated, the challenge will then be to translate that accomplishment into the therapeutic arena. "We should be able to give a treatment that could prevent or reverse the defect," says Longo, pointing to test tube experiments showing that the altered T cells, when they are no longer in contact with the mystery substance, return to their normal state. In other cases, he hazards, such as autoimmune diseases or in organ transplantation, physicians may want to do the reverse, depressing the immune system with the hypothetical agent. Still, Longo and his co-authors agree with other cancer researchers that any such possibilities will remain conjectural until the years of work needed to understand this T cell surprise are completed. "This is just the beginning. It opens up lots of lines of inquiry," he predicts.

–John Travis

ASTRONOMY

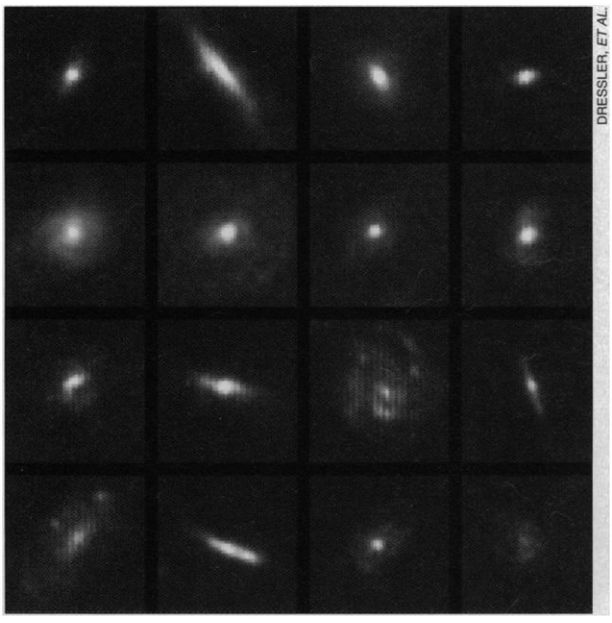
Hubble Sees a Zoo of Ancient Galaxies

Like a chalkboard seen from the back of a lecture hall, the history of galaxies has been too blurry to read. The history is there in the form of galaxies seen at such great distances that they lie a large fraction of the way back to the Big Bang. But to earthbound telescopes, those distant, early galaxies are no more than formless smudges. Now, thanks to the Hubble Space Telescope, a page in the history of galaxies has suddenly come into focus. By training the telescope on a galaxy cluster 4 billion light-years away, a team of astronomers has seen the shapes of galaxies past—and they are puzzlingly different from those of today.

In their galaxy cluster, a third of the way back to the Big Bang, Carnegie Institution astronomer Alan Dressler and his colleagues spotted all the different galaxy types seen in today's universe: elliptical, lens-shaped, and a garden of spirals. But the proportions were quite different. In this ancient cluster, code-named CL 0939+4713, spiral-shaped galaxies made up about 30% of the population, a surprising abundance considering that only about 5% of the galaxies in modern clusters are spirals.

If the cluster is typical of the earlier universe (and the researchers caution that it may not be), what could have happened to the teeming spirals between then and now? Dressler and his colleagues—Augustus Oemler of Yale University, James Gunn of Princeton University, and Harvey Butcher of the Netherlands Foundation for Research in Astronomy—think they see clues. Astronomers believe spirals are the active star-formers of the cosmos while other types of galaxies, such as the ellipticals, lie dormant, having long ago finished making new stars. And the spirals in this cluster look even more active than most—they burn bright with the characteristic blue glow of newborn, massive stars. That raises the possibility, say Dressler and his colleagues, that the fast-living spirals may simply have used up all their star-forming material and burned out. Their dim relics may be lurking unnoticed in today's clusters.

Oemler brings up another possible fate. "Some fraction of the [spirals] we see are in the process of merging," he says. "They look like galactic wrecks." Such collisions can intensify star formation, and they can also transform the shape of a galaxy. The extra spirals, says Oemler, may have vanished by crashing together into shapeless ellipticals.



DRESSLER, *ET AL.*

Denizens of the past. A different mixture of galactic species inhabited the cosmos 4 billion years ago.

Besides explaining how the spirals were weeded out, the turmoil seen in the Hubble image fits with earlier observations suggesting that the intermediate chapters of galactic history were surprisingly eventful. Analyzing the light from even more distant galaxies, astronomers had seen little of the blue that signals prolific star formation. Young as these galaxies must have been, they looked mature, their time of starbirth long past, says Oemler. In the late 1970s, though, Oemler and Butcher found many galaxies in the more modern universe that, paradoxically, looked to be in an earlier stage of evolution—bluer, more active, younger. But no one could make out their shapes until this latest observation from Hubble.

Just why these youthful galaxies should have appeared so late in cosmic history isn't clear, say other astronomers. "It's been quite difficult to produce a coherent picture [of galaxy evolution]," says Princeton astronomer Jeremiah Ostriker. The latest Hubble images can't resolve that mystery. But Dressler and his colleagues are heartened by their success. "We are beginning to see the universe when it was young and to see galaxies in the act of formation," he says.

That means a bright future for cosmic time explorers, he adds. "All these questions about galactic evolution are approachable now." And Dressler and his colleagues are hoping for an even better view after the repair of Hubble's faulty mirror, scheduled for 1993.

–Faye Flam