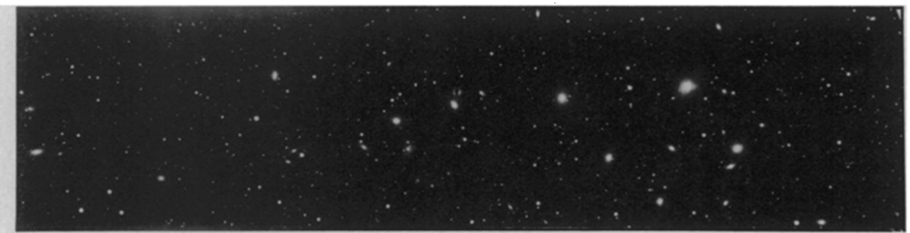
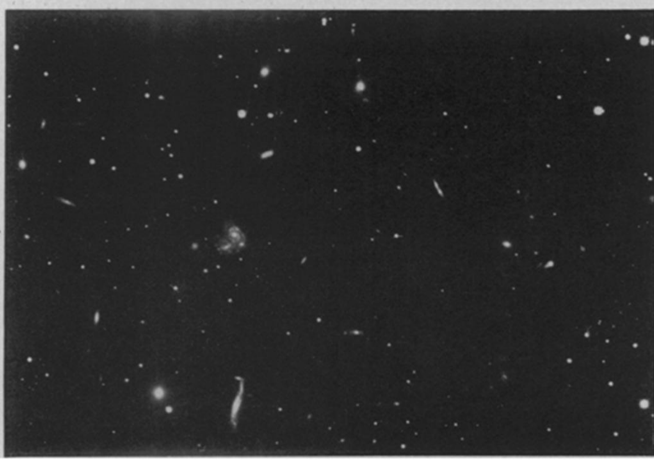
Survey of galaxies sheds light on shape





Photos: Kitt Peak National Observatory

The cluster of galaxies in the constellation Perseus (above) is an example of a high-density region, where galactic and stellar evolution stop early. The one in Hercules (left) is a low density region, where star formation and evolution last longer.

The evolution of galaxies presents astronomers with problems similar to those that the evolution of species presents to biologists. It is not merely whether the chicken or the egg came first, but that we have seen neither the first chicken nor the first egg. The universe presents the galaxies to us in some stage of development and from that astronomers must deduce how they began and evolved.

One theory of galactic beginnings that has gotten a good deal of support lately from the work of Stephen E. Strom of Kitt Peak National Observatory and a number of co-workers says that galaxies began as clouds of gas condensing under their own gravity. Stars began to form later. (There are theories that say star clusters came first.) If protogalactic gas clouds came before stars, there should be a correlation between stellar evolution and cnemical evolution. Heavy elements, especially metals, are made by thermonuclear fusion inside stars and then thrown back into the galaxy. So where the galaxy is brightest, that is, where the most stars are, there should also be the heaviest concentration of metals. In a survey of several dozen galaxies, Strom and collaborators found that this is indeed so (SN: 11/6/76, p. 209). Now, Strom reported at the recent meeting of the American Astronomical Society at Honolulu, a further survey of 180 galaxies shows that the environment in which a galaxy is born has a lot to do with how it evolves.

As Strom puts it, the survey found two basic things, one of which he had anticipated, the other something of a surprise. The anticipated result is that galaxies in clusters that have a high density of intergalactic matter tend to age prematurely. Star formation stops sooner for them than for those in clusters with a low density of intergalactic material.

The motion of a galaxy through dense intergalactic material, Strom anticipated, would set up a ram pressure that would drive out of the galaxy the gas from which new stars could form, bringing star formation to an early end. An early end to star formation, cutting it off after only a few generations, means incomplete evolution of metals. A metal-poor galaxy should look bluer than others, and so they do. This seems especially true of a lot of spirals similar to our own galaxy.

The unexpected result is that the density of the medium in which a galaxy is born can affect the shape of the elliptical galaxy that develops from the protogalactic cloud. In a low-density region, a distended ellipse will form with a gradual trailing off of brightness toward the edges and a change in chemical composition from center to edge. In a high-density region a more compact truncated ellipse forms with a fairly uniform distribution of brightness and chemical composition. Strom's interpretation of this is that in the high-density case star formation begins quickly; a lot of chemical processing occurs in the first generation of stars, and so a fairly uniform appearance results. In the low density case, star formation goes slower, and successive generations of stars leave their marks on the galaxy's brightness and chemical distributions. □

Circling mice: Clue to human disorder

Geneticists are continually on the lookout for animal abnormalities that resemble the inborn errors of human metabolism. While doing routine screening a few years ago, workers in an Edinburgh laboratory discovered that descendants of some Peruvian mice had high levels of the amino acid histidine in their urine, livers, blood and brains. High histidine levels characterize a human genetic disorder called histidinemia, which is found in about one in 15,000 newborns.

The basis for both the mouse and human disorders is a deficiency in the enzyme that breaks down histidine. In the mice strains with increased levels of histidine and its chemical derivatives, a balance defect, causing circling behavior, was common. In humans, physicians disagree as to the effect of the biochemical abnormality. At first it appeared to be associated with mental retardation and speech defects, but now many human geneticists believe histidinemia produces no demonstrable effect on the nervous system.

Experiments on the mice indicate that children of women with histidinemia may suffer the consequences of the disorder. If studies of humans do turn up deleterious effects on offspring, the effects might be avoided by reducing histidine in the prenatal diet.

Henrik Kacser and co-workers at the University of Edinburgh and at the Medical Research Council report in the Jan. 20 NATURE that the balance defect in mice is associated with damage to the inner ear during prenatal development. They found that this damage could also result from a high histidine diet in pregnant mice who, on a normal diet, would give birth to normal offspring. By altering the time of the high histidine diet, the researchers learned that the middle third of pregnancy is the critical period. Other studies have shown that this period is also when X-rays produce damage to the developing ear.

In an encouraging experiment the British researchers found that diet could decrease the number of abnormalities among the offspring of histidinemic mice. Those eating a low histidine diet during the middle week of pregnancy gave birth to 3.1 percent pups with mild balance defects, compared with 25.2 percent with mild or severe defects among pregnant mice on normal diet.

Because any one litter may contain both affected and unaffected offspring, factors beside the mother's chemicals must be involved. Further experiments by Kacser and co-workers indicate that the genetic makeup of the fetus also plays a role in determining susceptibility to histidine damage. In the same histindinemic mother, fetuses with two genes for histidinemia are most likely to be affected,