SCIENCE NEWS OF THE WEEK

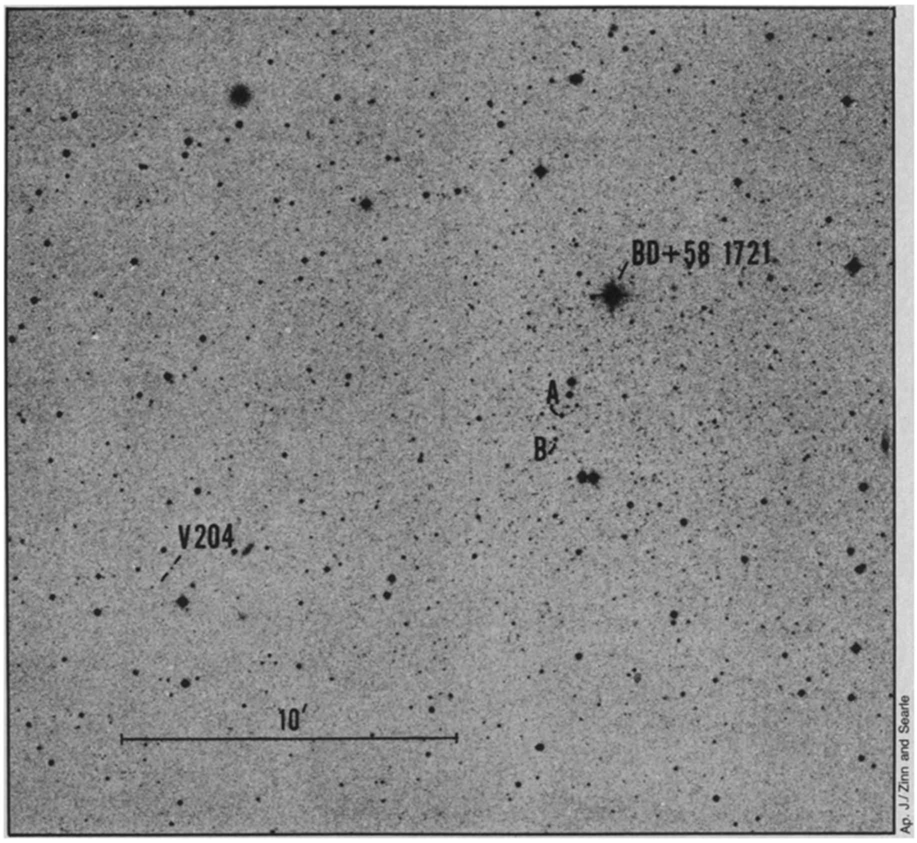
The Anomalous Cepheid Mystery

Variable stars have fascinated astronomers at least since the medieval Arabs gave Algol its ghostly name. In recent years observation of variables has been very helpful in the formation of astrophysical and cosmological theories. Now, a study of an unusual class of variables leads two astronomers from the Hale Observatories, Robert Zinn and Leonard Searle, to suggest either that the two members of a binary star system may sometimes coalesce into a single star or that something strange has happened in the evolution of some small galaxies that are close to our own. Those at least appear to be the most tenable hypotheses of six brought forward by Zinn and Searle in the Nov. 1 ASTROPHYSICAL JOURNAL to explain the character of a group of variable stars they refer to as "anomalous Cepheids."

There are several classifications of what might be called well-behaved Cepheids, including classical, globular-cluster and RR Lyrae varieties. The classical and globular-cluster Cepheids have the useful characteristic that their intrinsic brightness varies according to the length of the period of their variation. Thus, by observing the periods of these kinds of Cepheids in another galaxy, astronomers can figure out their intrinsic brightnesses. Comparing intrinsic and apparent brightnesses will yield the distance to the galaxy by a simple law of optics. Thus these kinds of Cepheids are important for establishing cosmological distance scales. (The intrinsic brightness of RR Lyrae types is apparently the same—Zinn and Searle assume it so—no matter what their periods may be.)

What Zinn and Searle call anomalous Cepheids do not obey any of these laws. The distribution of the anomalous Cepheids is a bit curious. They are found in all the dwarf spheroidal galaxies near our own that have been searched: the Draco, Sculptor, Leo II and Ursa Minor systems. They are abundant in the Small Magellanic Cloud, but none have been found in the Large Magellanic Cloud. They are also virtually nonexistent in the globular clusters of stars that form a halo around our galaxy. It is this distribution that makes them a mystery so long as they are to be regarded as a single astrophysical class with a common sort of origin.

In an attempt to determine something about the origin of the anomalous Cepheids, Zinn and Searle studied seven stars in the Draco galaxy, five anomalous Cepheids and two RR Lyrae stars. The main purpose was to discover the mass of the anomalous Cepheids by comparison with the RR Lyrae stars. (There are relations between density and period and luminosity and radius that allow this to be done.) A hypothesis to be tested had suggested that the properties of the anomalous Cepheids could be explained by regarding them as having approximately twice the mass of the sun and being very poor in metals. That hypothesis might work for the anomalous Cepheids in the Small Magellanic Cloud, where stars are known to be still forming out of metal-poor gas, but it runs counter to what is believed about conditions in the dwarf galaxies.



Anomalous Cepheid V204 in the Draco galaxy was one of those included in the study.

It turns out that the anomalous Cepheids in the Draco galaxy are heavier than its RR Lyrae stars. This, Zinn and Searle state, is the main result of their investigation, and it tends to prove the hypothesis they started with. They give six possible explanations for this circumstance and the most telling objection to each. The two that are least objectionable are that the progenitors of the anomalous Cepheids were close binaries that somehow coalesced into a single, large-mass star or that the anomalous Cepheids are more massive because they were born so; that is, the anomalous Cepheids are younger than the RR Lyrae stars.

Either explanation involves a dilemma: It appears from previous studies that at least one kind of binary can coalesce into a single star, but why should these systems be abundant in the dwarf galaxies and virtually absent in the globular clusters and the Large Magellanic cloud?

On the other hand, if the anomalous Cepheids are younger than the RR Lyrae stars, how can they appear in a system like Draco, which is too loosely constructed and has too weak a gravitational field to have retained the gas from which young stars might form? This objection can be avoided if one assumes, as several astronomers have proposed, that all these dwarf galaxies were once part of a single system (called the Greater Magellanic Galaxy) that somehow broke apart. If so, the dwarfs might have retained gas from the parent system, or the Cepheids may have formed in the parent system before the breakup. But for them all to have been part of one progenitor, they should lie more or less in the same plane. Unfortunately, Sculptor does not lie in one of the two Greater Magellanic planes that have been proposed, and Leo II does not lie in the other.

Thus, although the investigation seems to have verified the hypothesis it began with, that verification has raised an even greater mystery, and the solution of that mystery should have an important bearing on the theory of binary stars, the theory of galactic morphology or both. ☐