

BRIEF COMMUNICATIONS

COMMENTS ON THE QUESTION OF THE FREQUENCY OF SUPERNOVAE

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The article by B. V. Kukarkin, published in this number of the journal, discusses the very important problem of differences in the frequencies of supernovae in different physical types of galaxies. His conclusion that Sc galaxies (and especially those of them which have a high luminosity) exhibit a high flare frequency is entirely correct and must be of the greatest cosmogonic significance.

The following three facts emphasize still more clearly the special position of Sc galaxies in relation to the supernova frequency pointed out by Kukarkin.

1. If all the galaxies having a Harvard visual photographic magnitude ≤ 12.0 , which are north of declination $\delta = -30^\circ$ and which also, according to the detailed Vaucouleurs classification, belong to one of the subclasses bc, c, and cd (thus including type Sc and its neighbors), are taken from the Shapley-Ames catalogue, we then have a group of 94 galaxies. For brevity we will call it the group Sc 12.0.

We find from Zwicky's circular No. 8, reporting the discovery of supernovae in 1964 and the first half of 1965, that supernovae appeared in four galaxies of the Sc 12.0 group. These galaxies were NGC 3631 (Sc), 4303(SBbc), 3938(Sc), and 4666(Sc). If it is assumed that no supernova explosion in the galaxies of this group was overlooked during this period, we obtain for the mean frequency of flares per galaxy in this group 1/36th flare per year.

2. Among all the galaxies in which repeated flares have been observed, six belong to the group Sc 12.0. All five galaxies in which three supernovae have appeared are included in this number. Although for rigorous statistical conclusions this number of observations is inadequate, nevertheless it can be said that if all the galaxies of the Sc 12.0 list had the same mean supernova frequency, then on the basis of the

frequency of one supernova per 36 years it follows that the mathematically predicted number of galaxies for which two flares should occur in four years is approximately half. However, in the last four years of increased observations two supernovae have occurred in two galaxies (NGC 3938 and 4303). It is therefore very probable that either the mean frequency exceeds the derived value of 1/36th of a supernova per year or that the Sc 12.0 group is non-uniform with respect to the frequency of flares. Both factors apparently are operate here.

3. The Sc 12.0 list includes both supergiant galaxies and galaxies with a lower luminosity. As pointed out by Kukarkin, the mean flare frequency should be particularly high in the supergiants.

On the other hand, the Sc 12.0 list includes a galaxy of moderate luminosity, M 33, a member of the local system. It is extremely improbable that a supernova flare could have been overlooked in this system if it had occurred in the last 75 years. In weaker form this argument can also be applied to the giant M 51. This means that in Sc galaxies, which are not supergiants, the supernova frequency is actually low. This is probably a simple result of the relatively small star population of these systems. If it is assumed that supergiants constitute half of this group (an exaggerated estimate), we obtain for the lower limit to the frequency of supernovae in supergiants 1/18th of a flare per year, that is, almost the same as the estimate made by B. V. Kukarkin.

It should be further emphasized that his conclusion is of great importance for understanding the role of supernovae in the evolution of galaxies.

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