THE SMALL MAGELLANIC CLOUD

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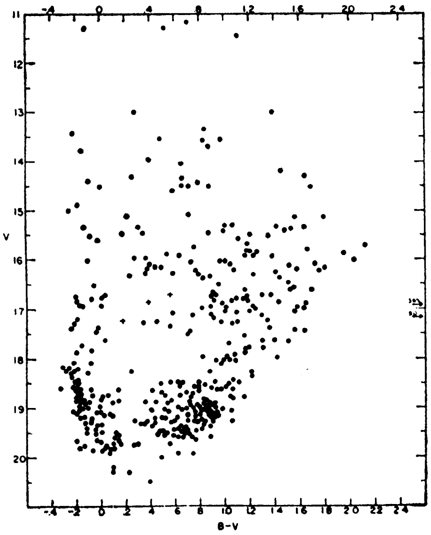

FIGURE 1. Color-magnitude diagram for a field in the SMC adjoining NGC 419.

In 1957 a two-year photometric study of the Small Magellanic Cloud, sponsored by Indiana University and supported by the National Science Foundation was completed. Six region swere investigated. They are three on the edge of the SMC centered on conspicuous star clusters and three nearer the center.

A network of local standards from the 7th to the 12th magnitude was transferred photo-electrically from Johnson-Morgan B, V standards in the northern hemisphere to the SMC with the 24-inch refractor of the Royal Observatory. Using these local standards for reference, fainter photoelectric sequences were set up in each of the six regions with the 74-inch reflector at the Radcliffe Observatory. Photographic plates on the same B, V photometric system were also taken with the 74-inch reflector and the 24-inch refractor. Iris-diaphragm measures of stars on these photographic plates could then be calibrated by the photoelectrically established sequences in each region. In this way the color-magnitude diagrams of five star clusters and six different regions in the SMC were obtained.

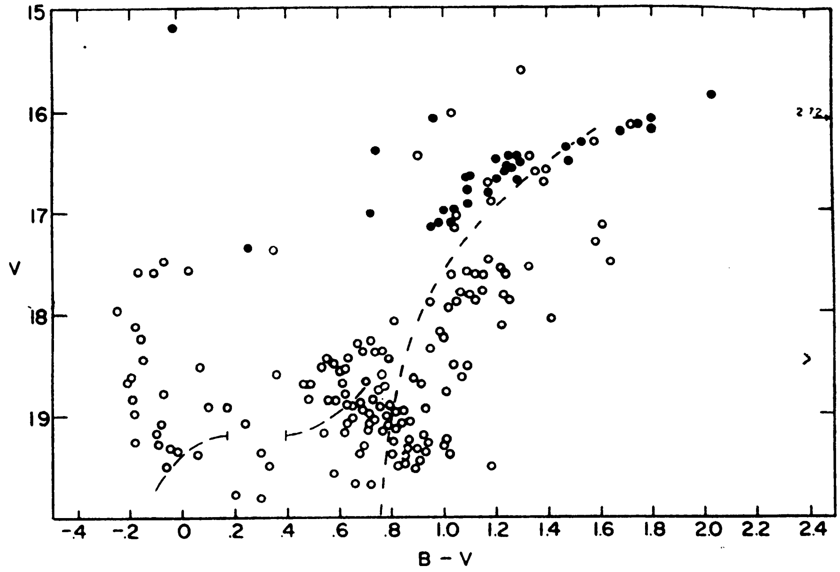

FIGURE 3. Color-magnitude diagram in NGC 419. The dashed line is the normal globular cluster diagram in our Galaxy.

https://doi.org/10.1017/S0074180900177538 Published online by Cambridge University Press

Figure 1 shows the color-magnitude diagram for the field of the SMC adjoining NGC 419. This particular field lies as close to the center of the SMC as one can measure to this V = 19.5 mag. limit. This field is typical of all the fields measured. The most conspicuous features of the color-magnitude diagram are the strong main sequence and the strong red giant branch. These sequences are sharply limited on the blue side and red side, respectively. Above V = 17 mag. there are relatively many stars of intermediate color index, below V = 17 mag. there are almost no stars of medium color indices. In other words, above V = 17 mag. the Hertzsprung gap is not conspicuous, but fainter than this it is very pronounced. It is surprising to note, however, that even at faint magnitudes where the Hertzsprung gap is well defined, it is narrower than the gap defined by open clusters in our own Galaxy. The only stars which are known in our own Galaxy which inhabit this region of the HR diagram are globular cluster sub-giants.

In Figure 2 (Pl. I, p. 58) the SMC star cluster, NGC 419, is shown. In addition to its geometrical appearance, its integrated magnitude and color-index are the same as those of a globular cluster in our own galaxy. Figure 3 shows that the color-magnitude diagram of this cluster follows generally the sequences of globular clusters (dashed line). There is a break in the NGC 419 giant sequence at about V = 17, however, which is unlike any globular clusters previously investigated, nor is there any noticeable "blue or horizontal" branch to the level investigated here. Figure 4 (Pl. I, p. 58) shows the star cluster NGC 361 which has a fainter integrated magnitude than the previous cluster but it is more spread out and consequently it is easier to measure individual stars in the cluster. Figure 5 shows that the color-magnitude diagram of this cluster is identical to that of NGC 419 and confirms the peculiar features of these color-magnitude diagrams. Further, since it can be shown that a substantial part of the general field consists of such a color-

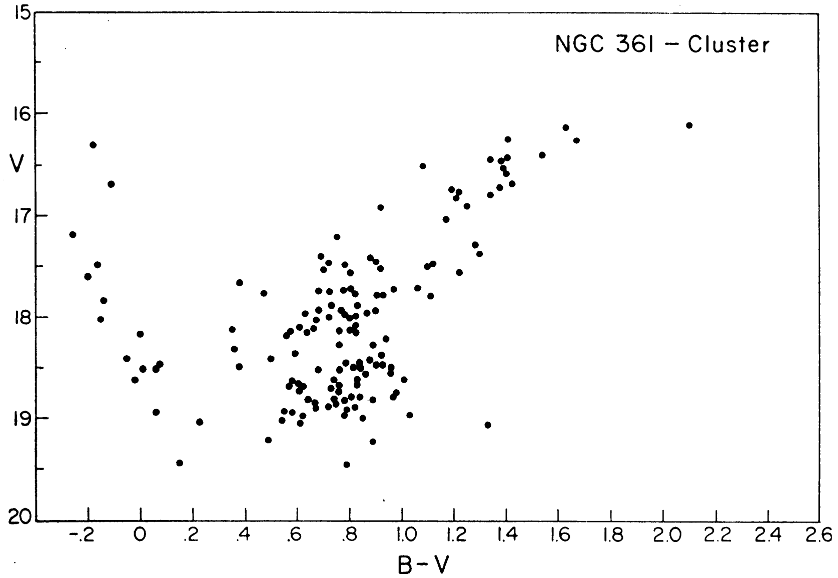

FIGURE 5. The color-magnitude diagram of NGC 361.

magnitude diagram, the kind of stars in these clusters must be considered representative of a good part of the general stellar population of the SMC.

Figure 6 (Pl. I, p. 58) shows a star cluster which has an integrated color-index which is very blue. The color-magnitude diagram of this so-called "blue globular cluster" is shown in Figure 7.

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This diagram is startling because it is so unlike any known for clusters in our own Galaxy. The luminosity of stars in NGC 458 means that it corresponds roughly to the Pleiades or NGC 6664. In no clusters in our own system, however, do we know of giant branches which are so

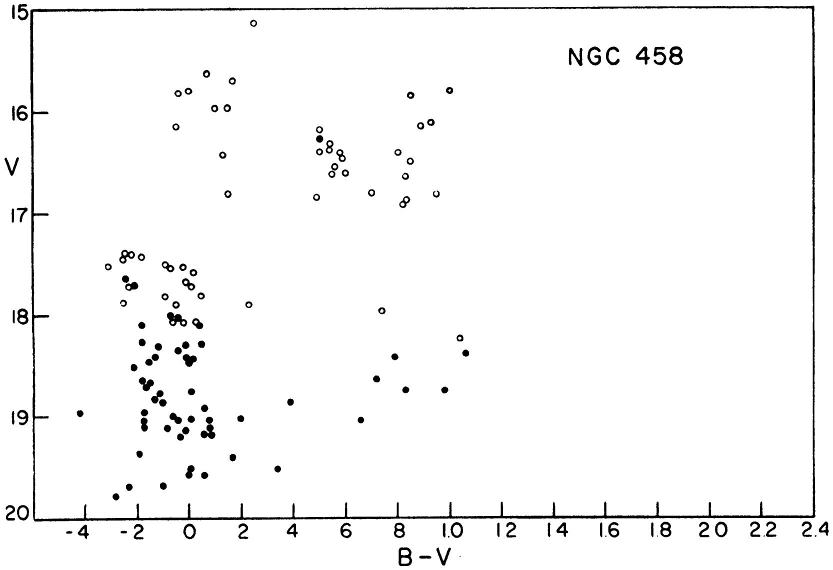

FIGURE 7. The color-magnitude diagram of NGC 458, which is completely different from those of NGC 361 and 419.

blue, placed so close to the Hertzsprung gap as in this SMC cluster. There is a variable, presumably a cepheid, in NGC 458, and as a sidelight it might be remarked that the distribution of giants around the Hertzsprung gap shown here probably is the reason for the large number of cepheids near this magnitude in the SMC. The distribution of stars shows a hole, or gap, as it breaks away from the main sequence which is also unknown in galactic clusters in our own

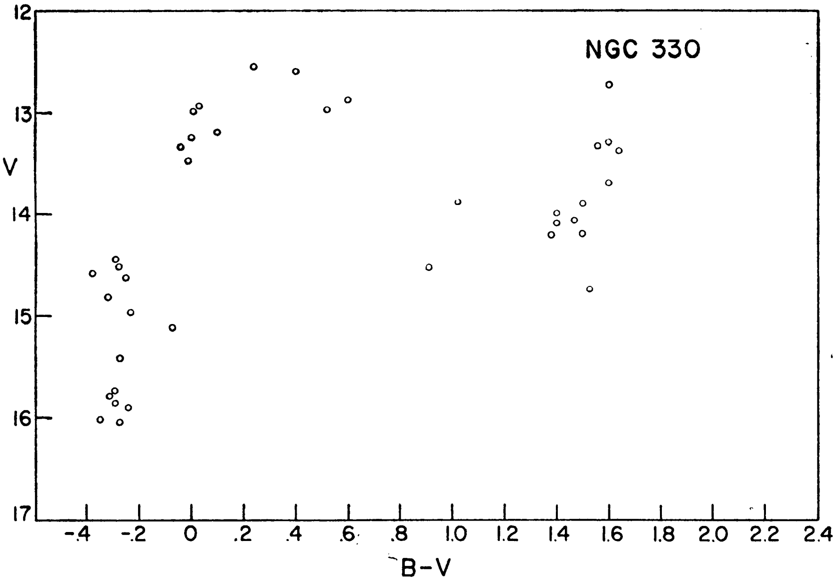

FIGURE 8. The diagram for NGC 330, another "blue" cluster, resembling NGC 458.

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system. Figure 8 shows another SMC cluster, NGC 330, which confirms the same gap in the bright main sequence. The stars in NGC 330 are much brighter than those just discussed in NGC 458. The NGC 330 stars are of a luminosity comparable to that of *h* and χ Per in our Galaxy. Again, however, the giants in the SMC cluster go much bluer.

There are two major points of interpretation to be considered. First the composition of the general field of the SMC as characterized by Figure 1 may be explained in either of two ways : 1) The field is made up of young stars from age zero to about 5×10^7 years (NGC 458 characterizes the latter) plus stars which are 10^9 years of age or older (NGC 419 and NGC 361 characterize these stars), but very few stars of intermediate age. These groups of stars could be somewhat separated in space and merely project into the same field. 2) Above $V = 17$ mag. the Hertzsprung gap is intrinsically very narrow, but immediately below this becomes much larger. In this case, giants undergoing stellar evolution from intermediate-age star groups may spend very little time in the more luminous reaches of the HR diagram.

The second major point of interpretation and the major conclusion of the investigation so far is that the chemical composition of the SMC stars must be, in part, different from stars in our own Galaxy. Since we see a range of ages in the SMC clusters and the oldest are the closest in color-magnitude to the globular clusters in our own Galaxy, which have low metal content, the present conclusion is that the SMC stars have, generally, a low metal content. As a consequence, the very large differences in the young clusters in the SMC are attributed to the fact that all the young clusters in the SMC also have relatively low metal content, whereas in our own Galaxy all young clusters have high metal content.

Discussion

Idlis : From dynamical considerations I have found that both Magellanic Clouds have been torn from the periphery of our Galaxy 4.1×10^9 years ago. Therefore there must be no older stars in them. It seems that your results do not contradict mine.

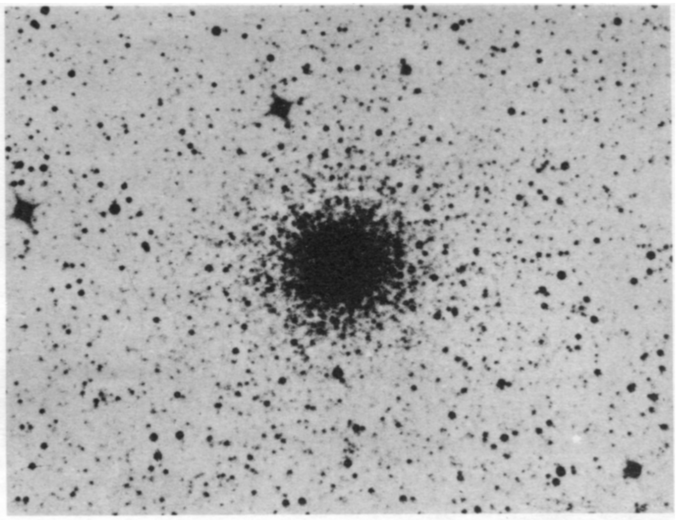
Captions for the plates

FIGURE 2. The cluster NGC 419 in the SMC.

FIGURE 4. The cluster NGC 361 in the SMC.

FIGURE 6. A "blue globular cluster" in the SMC, NGC 458.

Fig. 2



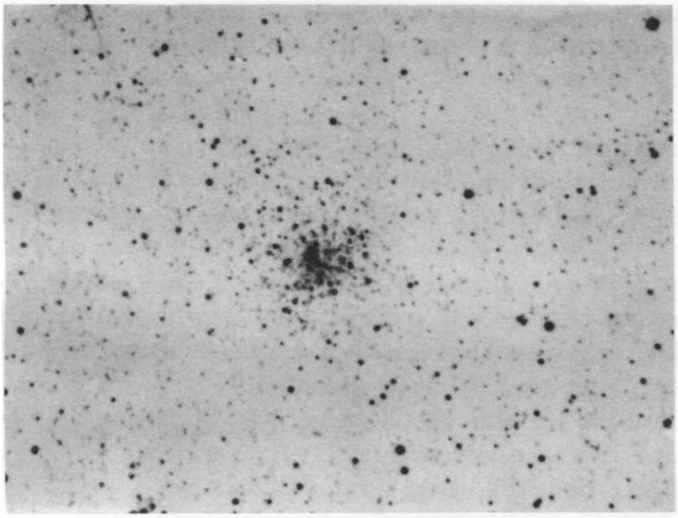
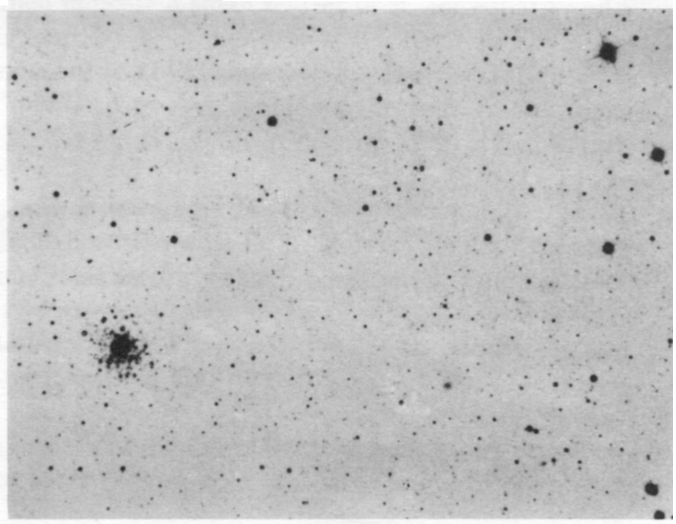


Fig. 4

Fig. 6



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