THE HERTZSPRUNG-RUSSELL DIAGRAM OF METAL-POOR DISK STARS

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A quarter of a century ago Keenan and Keller (1953) showed that the majority of high-velocity stars near the Sun outline a Hertzsprung-Russell diagram similar to that of old Population I. This result, which did not appear to fit into Baade's (1944) two-population model of the Galaxy was ignored (except by Roman 1965) for the next two decades. Striking confirmation of the results of Keenan and Keller was, however, obtained by Hartwick and Hesser (1972). Their work appears to show that high-velocity field stars with an ultraviolet excess (which measures Fe/H) of $\delta(U-B) \simeq +0\overset{m}{.}11$ lie on a red giant branch that is more than a magnitude fainter than the giant branch of the strong-lined globular cluster 47 Tuc for which $\delta(U-B) \simeq +0\overset{m}{.}10$. Furthermore Demarque and McClure (1977) show that the red giants in the old metal poor [$\delta(U-B) \simeq +0\overset{m}{.}11$] open cluster NGC 2420 are significantly fainter than are those in 47 Tuc. Calculations by these authors show that the observed differences between the giants in 47 Tuc and in NGC 2420 can be explained if either (1) 47 Tuc is richer in helium than NGC 2420 by $\Delta Y \simeq 0.1$ or (2) if 47 Tuc has a ten times lower value of Z(CNO) than does NGC 2420.

Presently available chemical abundance determinations for galactic disk and halo stars do not allow one to make a clear-cut choice between these two alternatives. Nevertheless the remarkable uniformity of Y values observed in different galaxies tends to favour the suspicion that the peculiarity of NGC 2420 should probably be interpreted in terms of an anomalously low Fe/CNO ratio. At this point it should perhaps be emphasized again that Z is largely determined by the abundance of the most plentiful elements i.e. C, N, O and Ne, whereas the ultraviolet excess $\delta(U-B)$ is

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mainly a function of the Fe abundance.

The bright red giants that Baade (1944) discovered in the disk of M31 are embedded in a much richer population of faint giants which contribute most of the light. Baade referred to the bright Population II giants in the Andromeda Nebula as "the frosting on the cake".

Recently Sandage (1977) has emphasized the fact that the red giants in the disk of M33, in NGC 6822 and in IC 1613 (Sandage 1971) are all bright ($V \sim 21^{m}.5$) and easily resolvable. Sandage points out that the surface density of bright red stars in M33 is ~100 times greater than it is in the galactic disk near the Sun. It follows that these bright red giants in M33 constitute the dominant old population in the Triangulum Nebula; not a "frosting on the cake" as they do in M31 and the Galaxy.

Probably the most straightforward interpretation of this result is that the old red giants in M33, NGC 147, NGC 185, NGC 205 and NGC 6822 lie on tall red giant branches because they have low Z values. The alternative hypothesis that these stars lie on tall branches because they have high Y values appears to be ruled out by the observation that the present helium abundance in M33 and in NGC 6822 (Peimbert and Spinrad 1970a, b) is similar to or slightly below that prevailing in galactic HII regions.

The results obtained above may be summarized as follows: The galaxies of the Local Group may be divided into two groups according to the properties of their dominant red giant populations. In M33, the LMC, NGC 6822, NGC 147, NGC 185, NGC 205 and probably in the SMC and IC 1613 as well the red giants are bright indicating a relatively low heavy element abundance. In the Galaxy and M31 the dominant red giant population consists of old faint giants that are composed of material with a relatively high Z value. The red giants in M32 seem to have characteristics that are intermediate between those of the high-luminosity and low-luminosity members of the Local Group. This result is consistent with the work by Faber (1973a, b) who finds that M32 has lost a considerable amount of mass by tidal stripping resulting from encounters with M31. Its CN + Mg index suggests that M32 may now be ~5 times less luminous than it was originally.

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DISCUSSION

BUSCOMBE: Augensen and Buscombe (this symposium, page 413) obtained an HR diagram for 800 southern high-velocity stars (with UBV photometry, individual parallaxes and space motion data) showing a close fit to the diagram for the old galactic cluster M67.

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