Title
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The globular clusters comprise the oldest stellar population readily avail- able to us for study. They ought, therefore, to be able to provide the answers to various questions in galactic and stellar formation and evolution- if only we knew which questions to ask. The chief difficulty lies in deciding whether they are the rare (about 10-• of the observed mass in the Universe) survivors of a population of once- common, fundamental building-blocks from which larger units (galaxies and clusters) have arisen , or the products of early fragmentation in previously- existing gas clouds that we might call protogalaxies.

Uncertainty on this basic point underlay and sometimes befuddled discussions of new observations and calculations at a recent NATO Advanced Study Institute on Globular Clusters.* For instance, the average heavy- element abundance of a population of globular clusters increases with the mass of the galaxy to which it is attached (S. van den Bergh), and, with- in at least the Milky Way and the Andromeda Galaxy , abundances range systematically from nearly solar at the centre, through a steep decline 5-10 kpc out, to one-twentieth of solar or less in the halo (with large scatters at all positions; L. Searle). But is this trying to tell us something about how star-formation rates (and, therefore heavy element production) depends on gas density or something about how dynamical friction juggles units of varying mass and degree of central concentration?

Dynamics of stars within individual clusters can be considered almost with- out regard to their origins, because at least the inner parts are relaxed. The identification of seven X-ray sources (including five bursters; W. Lewin, G. Jernigan) with globular clusters lends extra urgency to calculations of core evolution and collapse (L. Spitzer), although recent estimates of the surface area required to produce the bursts and the relative timing of optical and X-ray emission in one burst now strongly suggest that the source is an accreting neutron star rather than a massive black hole formed by core collapse. Core evolution may still have to be invoked to put a neutron star into a suitable X-ray-producing binary system, as it becomes increasingly clear that the clusters are deficient (relative to stars in the galactic disk, at least) in binary systems over a considerable range of parameters (J. Gunn, R. Griffin, M. Liller, E. Budding). But all is not lost, even if core collapse never occurs (J. Katz), as it may be possible to get the observed X-ray flux from single neutron stars occasionally passing through the stellar winds of red giant stars (A. Fabian). The amount of ambient gas implied by this is well below the 0. 1-1.0 M seen or set as upper limits from HI and HII studies of several clusters (G. Knapp, W. Liller). Some of these limits are, how- ever, uncomfortably low for standard theories of mass loss from evolving stars and gas escape from clusters (D. Faulkner).

Progress has been made on several traditional, vexing, rather technical issues. The wide giant branch in w Cen is undoubtedly to be attributed to real abundance variations, and because CN line strength is generally correlated with Ca, Fe, and Sr abundances (J. Norris) the variations must have been intrinsic to the gas from which the stars formed, and not just produced by mixing with- in individual giants. Real variations in CNO abundances occurring among and within other clusters (especially 47 Tue; A. Rodgers), are not always uniquely correlated with variations in Fe and heavier elements (J. Frogel, E. Persson), and may also be primordial (R. Kraf t); but they are not the whole answer to the traditional 'second parameter' problem.

The second parameter(s) is whatever is responsible for the lack of the theoretically-expected correlation of the appearance of a cluster's HR diagram with its heavy element abundance. The most conspicuous effect is the occurrence of both red and blue horizontal branches in metal- poor clusters, especially in the outer parts of the galaxy (R. Zinn), when only blue ones would be expected. High CNO (either primordial or mixed up from the core) would cure this, but CNO cannot deal (V. Castellani) with a more subtle effect seen in some far- halo clusters (R. Schommer) in which the red-giant branch is too red for the metal abundance implied by the main- sequence turn-off point and integrated cluster spectra . HR diagram morphology is also affected by helium abundance, cluster age, mass loss from red giants, and stellar rotation. It will probably be necessary to include the contributions of at least two 'second parameters' to match the full range of observed HR diagrams. Rotation is apparently also important (A. Sweigart) in finally making it possible to understand how processed material can be mixed up from the hydrogen-burning region to the surface of low mass stars by means of meridional circulation.

No consensus now seems possible on the meaning (or, in some cases, even the reality) of colour and abundance gradients within clusters other than w Cen (K. Freeman; M. Chun; G. Da Costa). The question of whether or not the absolute brightnesses of RR Lyrae variables are correlated with their metal abundances is 'controversial.' It is important because these stars are one of our standard candles, whose brightness partially determines the extragalactic distance scale, and so Hubble's constant and the age of the Universe. W. Liller and V. Clube strongly advocated a relationship (partially based on recent photometry by B. Carney) in which the RR Lyraes in clusters of lowest metal abundance are about one magnitude fainter than those in clusters of high Z. A constant brightness for these stars, independent of cluster composition, was equally strongly supported on both observational and theoretical grounds by P. Demarque, R. Kraft, and F. Hartwick.

The various problems of globular cluster astronomy are probably in as good shape as we can expect, considering that (although some of the clusters were recorded by Messier) the first classification of them by radius and central concentration was begun only about 50 years ago by H. Sawyer Hogg, who was an active participant at the Institute.

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*Held on 7-18 August at the Institute of Astronomy, Cambridge.