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Preface

In February 2005, the **A**ryabhatta **R**esearch **I**nstitute of Observational Scienc**ES** (ARIES) in Nainital hosted a one day International meeting on Star Clusters along with the $23^{\rm rd}$ meeting of the Astronomical Society of India. 2005 also marked the $50^{\rm th}$ anniversary of the founding of the Institute. Star Clusters is one of the topics to which the Naini Tal observatory has made major contributions over many years.

The meeting attracted a large audience from all over India, together with a number of overseas experts in star cluster research. This volume publishes together several of the mainly international contributions. Some unfortunately are missing, but may appear elsewhere or in later volumes of BASI. Here I will try to give an overview of what was a very enjoyable and stimulating meeting. About half of the talks dealt with globular clusters in our own and other galaxies, the other half were concerned with Galactic open clusters.

The first two talks, by Russell Cannon from Sydney, Australia, and Giampaolo Piotto from Padua, Italy, reviewed the dramatic recent advances, and some unforeseen problems, in our understanding of the origin and evolution of globular clusters. As so often happens in astronomy, recent technological advances have led to enormous gains in both the quality and quantity of data available. These have helped to answer some long-standing questions but raise at least as many new questions, some of them completely unexpected.

The sensitivity of modern detectors on large telescopes, combined with the use of optical fibres to observe many stars simultaneously, means that it is now feasible to do accurate chemical abundance analyses for large samples of faint stars in Galactic globular clusters. For some elements, notably the crucial iron group, the composition of little-evolved main sequence stars is very similar to that of highly evolved red giants, presumably representing the proto-cluster mix. Other elements, notably the CNO group, show large differences along the giant branch which can be attributed to internal mixing and the dredging up of processed material from the cores of the stars. However, there are some patterns which are hard to understand in any scenario, such as the strong anti-correlated variations in C and N abundances seen in some clusters on both the main sequence and the giant branch, but with no corresponding spread in the Fe abundance. This seems to indicate some sort of self-enrichment process whereby the ejecta from intermediate-mass stars are retained, but this was not expected theoretically. The answer to the long-standing battle between mixing and 'primordial' hypotheses seems to be that both occur.

Other surprises have come from the superb precision of modern photometry, both from the ground and from the Hubble Space Telescope. The very massive cluster ω Cen

has long been known to have a uniquely large internal spread in chemical composition. This spread has recently been shown to correspond to several distinct giant branches, presumably from different episodes of star formation. Distinct splitting is also seen well down the unevolved main sequence, but the big surprise is that most of the stars lie on the redder main sequence, whereas the opposite is seen on the giant branch. Such behaviour cannot be understood simply as an effect of age or metallicity: the best explanation so far, but again one with no simple theoretical basis, is that the two populations have very different helium abundances.

Tom Richtler, from Concepcion, Chile and Myung Gyoon Lee, Seoul, Korea, both discussed the global properties of systems of globular clusters around external galaxies. Some contain what seem to be young massive globular clusters, studies of which may eventually lead to a better understanding of the early evolution of the ancient system of Galactic globulars. Many galaxies have a bimodal mixture of relatively blue and red clusters, but disentangling the effects of age and metallicity is always difficult. There may be a connection with the Ultra-Compact Dwarf (UCD) galaxies found recently in the Fornax cluster of galaxies, and it may be that ω Cen is itself the remnant of the core of a dwarf spheroidal galaxy captured by the Milky Way Galaxy. There are large differences between the populations of globular clusters around different Local Group galaxies.

Annapurni Subramaniaum, IIA Bangalore, compared the history of star formation in the general field of the LMC with the age distribution of its star clusters. Some correlation was found for old and young populations, but the two processes seem to be anti-correlated over long periods: perhaps dynamical interactions between the Clouds stimulate a cluster formation mechanism but not star formation in general. Anurav Kundu, Michigan State University, USA, discussed the connections between understanding globular clusters and the formation of X-ray binary stars in such dense environments, investigated by combining observations at IR, optical, UV and X-ray wavelengths.

The emphasis then shifted to the generally younger and smaller open star clusters, almost exclusively in the Milky Way. Katsuo Ogura, Tokyo, Japan, argued for two distinct modes of star formation in HII regions, one producing large clusters with a wide range of stellar masses and the other producing only small numbers of low mass stars. D. K. Ojha, TIFR Mumbai, inferred a similar result from near-IR photometry of clusters of Young Stellar Objects. Anatoly Piskunov from Moscow, Russia, described an all-sky search for new open clusters in the Hipparcos catalogue. Giovanni Carraro, Santiago, Chile, has combined observations and N-body modelling to try to identify clusters which are close to disruption, and to understand their contribution to the field star population. Jasonjot Singh Kalirai, Lick Observatory, USA, described a deep photometric survey of 25 open star clusters. Initially intended to investigate the white dwarf populations of the clusters, the data are proving useful for many other studies. Luigi Bedin, Padua, Italy, also discussed the white dwarf cooling sequence in star clusters. Finally, two local contributions from ARIES staff involved photometry of sets of open clusters. Anil Pandey has used the Kiso Schmidt Telescope for a photometric investigation of the extended

coronas surrounding several open clusters, while R. K. S. Yadav has investigated the interstellar extinction law and occurance of dust in four young open clusters.

One fascinating general contribution was from Prof. D. Sharma, former Vice-chancellor of Gorakhpur and Indore Universities and a long-standing supporter of the Institute. He spoke on the evolution of astronomical ideas over time and the challenges of teaching new generations of students.

Overall, the day provided a fascinating overview of many aspects of current work on star clusters, a relatively old field of research which has been revitalised by recent advances in instrumentation and which is turning out to have surprising connections with many different branches of modern astronomy. There is no shortage of important problems to be tackled with the facilities available in Naini Tal and elsewhere over the next 50 years! Those of us who were priviledged to attend must thank Prof. Ram Sagar and his colleagues at ARIES for organising a very stimulating meeting.

R. D. Cannon