

STELLAR POPULATIONS

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PREFACE

Symposium **164** of the International Astronomical Union on “Stellar Populations” was held in the Hague, the Netherlands, from 15 to 19 August 1994, during the General Assembly. The proceedings were published in 1995. The volume was very much in demand and the publisher asked us as the editors to consider a reprinting of the book. We agreed to this and proposed that in the reprinted version the poster papers were deleted and that the authors of the invited reviews were given a chance to add a few pages with brief descriptions of recent developments and useful, up-to-date references to the literature.

A few of the authors have indeed provided us with such updates and we have added these at the ends of the chapters. Two of them (Osterbrock and Schweizer) have actually adapted their texts. In the editing process we have also updated the references that at the time of the original publication were still indicated as “in press” or “submitted”.

In the preface to “*Galactic Structure*”, Volume **V** of the series “Stars and Stellar Systems”, editors Adriaan Blaauw and Maarten Schmidt note: “... *deadlines are of restricted value. A well-known galactic astronomer has defined the deadline as ‘the date when the editor falls dead if he has received a manuscript’.* Our authors have generously collaborated in avoiding this risk.” Both for the original publication and this reprinted version many of our authors have put us at a much greater risk.

We thank Eugene de Geus and Harry Blom at Kluwer Academic Publishers for proposing this reprinting and further assistance, and the I.A.U. for agreeing to the publication of this version of the book.

P.C. van der Kruit and G. Gilmore



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“The modern conference resembles the pilgrimage of medieval Christendom in that it allows the participants to indulge themselves in all the pleasures and diversions of travel while appearing to be austere bent on self-improvement. To be sure, there are certain penitential exercises to be performed – the presentation of a paper, perhaps, and certainly listening to the papers of others. But with this excuse you journey to new and interesting places, meet new and interesting people, and form new and interesting relationships with them; exchange gossip and confidences (for your well-worn stories are fresh to them, and vice versa); eat, drink and make merry in their company every evening; and yet, at the end of it all, return home with an enhanced reputation for seriousness of mind. Today’s conferees have an additional advantage over pilgrims of old in that their expenses are usually paid, or at least subsidised, by the institution to which they belong, be it a government department, a commercial firm, or, most commonly perhaps, a university.”

David Lodge, *Small World*
© David Lodge, 1984
Published by Penguin Books 1985

PREFACE TO THE ORIGINAL PUBLICATION

The concept of Stellar Populations has played a fundamental role in astronomy in the last few decades. It was introduced by Walter Baade after he was able to resolve the Andromeda Nebula and its companions into stars when he used red-sensitive plates and realised that there were two fundamentally different Hertzsprung–Russell diagrams in our and these nearby galaxies (common stars in the solar neighborhood versus globular clusters). This result was published in two papers in 1944 in volume 100 of the *Astrophysical Journal*. Subsequent research gave the concept a much firmer basis and at the famous Vatican Symposium of 1957 resulted in a general scheme of the concept and a working hypothesis for ideas on the formation and evolution of the Galaxy. This has been a guiding principle of studies of our and other galaxies for decades.

Some years ago it seemed to us appropriate to commemorate Baade's seminal work in 1994, when it would have its 50-th anniversary, and to review its present status and also its role in contemporary understanding. While we were in Leiden for an administrative committee, we discussed the matter again and over beers on October 29, 1991 we decided to take the initiative for an IAU Symposium on the subject during the 1994 IAU General Assembly in Den Haag, the Netherlands. We envisaged a historical session covering the time up to the Vatican Symposium, various sessions on recent developments and a concluding session in which current terminology would be discussed. Also we drew up a list of subjects to be discussed and persons to be invited to serve on the Scientific Organizing Committee.

In April 1992 we contacted these prospective SOC members and received enthusiastic support. With the further support of presidents of the relevant IAU Commissions (see below) we proposed to the IAU Executive Committee to hold a symposium on Stellar Populations during the 22nd General Assembly. At its meeting in June 1993 the EC approved our proposal along with 5 others for this General Assembly. The supporting commission is commission 28 (Galaxies) and the co-supporting commissions are commissions 33 (Structure and Dynamics of the Galactic System), 35 (Stellar Constitution), 37 (Star Clusters and Associations) and 41 (History of Astronomy). We are grateful to the presidents and organizing committees of these commissions for their support.

The Scientific Organizing Committee consisted of P.C. van der Kruit (Netherlands) and G. Gilmore (UK) as co-chairmen, A. Blaauw (Netherlands), S.M. Faber (USA), M. Feast (South Africa), K.C. Freeman (Australia), O. Gingerich (USA), I.R. King (USA), P.O. Lindblad (Sweden), D. Lynden-Bell (UK), J.R. Mould (Australia), A. Renzini (Italy), A. Sandage (USA), L. Searle (USA) and S. Tremaine (Canada).

The Symposium was to take place during the first week of the General Assembly, starting on Monday afternoon and, leaving the Wednesday afternoon free for the first session of the General Assembly, lasting until Friday afternoon. This left us with 8 half-day sessions.

We envisaged the Symposium to start with a historical session on the history of the concept of stellar populations up to roughly the time of the Vatican symposium. For this session we hoped among others to hear from actual participants to the Vatican Symposium. Unfortunately, Martin Schwarzschild and Allan Sandage were unable to attend, but Adriaan Blaauw did and gave an invited paper on the meeting. Allan Sandage remained on the SOC and in particular was very helpful in defining the program of the historical session. In a letter to one of us (PvdK) he made some historical observations that we wish to record here:

“Baade had always been impressed by the non-resolvability of E galaxies compared with spirals. He knew this very well from the surveys he and Hubble had undertaken for galaxy morphology starting in the 1920’s, first in Hamburg and later at Mount Wilson. The concept of stellar populations grew from that fact, having more to do with the difference in the C–M diagrams between open clusters and globular clusters than being concerned with galactic structure per se. The concern with galactic structure came mainly later from the Vatican Conference.”

“But neither was stellar evolution, nor the age dating problem, nor chemical composition differences understood in 1940’s when Baade resolved M31 etc. So neither age differences, nor chemical composition, nor disk–halo connections were part of Baade’s initial concept. All of these essential elements of the modern view came gradually, all later than 1944 when he defined his concept in ApJ 100. These later, now central concepts, developed in the decade of the 1950’s when the method of age dating and chemical differentiation came to the front. Of course, kinematics was a strong part of his globular cluster – open cluster separation, based on the known RR Lyrae high velocities and the Oort (1926) high velocity field star results in Groningen Pub. #40. Stellar evolution became central in this history only after 1950.”

“Baade’s initial step started about 1935, and then began gelling with the Sculptor–Fornax central discoveries (the presence of RR Lyraes and

the resolution of the Fornax globular clusters at the same level as the Fornax galaxy stars themselves) done with Hubble in 1938, continuing with his resolution of M31, etc. The age dating breakthrough came only in 1952, together with Schwarzschild's explanation of the step beyond the Schönberg–Chandrasekhar limit as evolution off the MS. The role of chemical composition then began with Nancy Roman's discovery of the UV excess connection with kinematics (ApJ Suppl. 2, 1955) of individual high velocity stars. The joker in the deck (now known as the thick disk) by Keenen & Keller (ApJ 117, 1953), where "high velocity stars" did not have globular cluster-like spectra, took a long time being understood (à la Gilmore & Wyse with intermediate metallicity and intermediate kinematics). We thought at the time that the whole thing was in the air with the Keenen & Keller very persuasive result, a thing before the study by Roman (1955) on the real globular cluster-like field stars. We really did not know what was going on at that point, not understanding the intermediate population."

"One final point on the history is, I believe, important. The Vatican conference was not only important because of its later influence; it was also highly important re scientific venture. This, even as late as 1957, was the first major conference after the war which was truly international. Look at the list of participants and the countries they came from. I remember, for example, Heckmann so very well as we became good friends during the meeting. The most astonishing thing about that meeting that is still so strong in memory, is that the central idea of stellar evolution, of age differences among open clusters and the moving off the MS instead of up it (Gamow's incorrect dogma of 1938) seemed so new to Heckmann and to Oort, although it was 5 years old by then in the West. Some flavor of the newness of the idea can still be gained by reading the Vatican conference report, especially in Oort's various questions and especially his criticisms of age differences because of the absence of enough "old" ("if that was, in fact what they were") open clusters. So, the Vatican conference was the healing conference after the war, along with whatever else it accomplished."

After the historical session the conference continued with a session devoted to globular clusters, their stellar content, systems of globular clusters in our own and other galaxies, and halo stars in between them. Then we moved on to the Galactic disk (open clusters, early type stars, ages, metallicities, possible gas infall, chemical evolution) and the transition from disk to halo. The next session had a detailed look at the stars in Local Group galaxies and the history of star formation in these. Session 5 was entirely devoted to dark matter, reviewing the evidence for it and the amount and distribution in the disk of the Galaxy, spiral

and elliptical galaxies and clusters of galaxies. The following session was concerned with elliptical galaxies and questions of the origin of the UV–upturn, star formation histories, population synthesis, gradients of stellar populations and the effects of the environment and of merging. Then followed a session on galaxies at large redshift, their structure and populations, evolution as indicated by deep images and counts and on quasar absorption lines as probes of galaxy evolution and formation. The final session started by reviews of models of galaxy formation and developments from stellar evolution relevant to the subject of stellar populations and was followed by a panel session on questions of classification and terminology of populations. It was concluded by a conference summary.

In addition to the 34 invited review papers, the panel discussion and the summary, participants were invited to submit poster papers. The SOC decided that review talks should in principle be allotted 45 minutes including discussion in order to give the review speakers a chance to present their area in depth. We feel that this has resulted in more comprehensive reviews and in a general sense of adequate time for in–depth presentations indeed. As a result we have not accepted short, contributed papers as oral presentations. Before the meeting somewhat over 140 posters were accepted and a few more during the meeting. Although most abstracts were published as part of the abstract book of the General Assembly, we have felt it important to allocate one page to each poster in the proceedings (provided it was actually presented at the meeting) in order to give authors a chance to update their abstract as these were submitted well before the meeting. We were fortunate to have the posters immediately outside the meeting room. A review by A. Wolfe on quasar absorption lines had unfortunately to be withdrawn due to illness and instead we turned that time into a poster session.

The meeting was held in the Van Gogh Room at the Nederlands Congressgebouw in Den Haag (The Hague), the Netherlands. The attendance was, as a result of the coinciding of the meeting with the General Assembly, more numerous than during a regular IAU Symposium and, due to the fact that two more Symposia were being held at the same time and during the second part also Joint Discussions, Commission meetings, etc., also more varied. We estimated that all sessions were attended by more than 200 persons, but often well over 300.

There is an interesting correlation that we found. Of the more than 2000 registration numbers that were allocated at the General Assembly, the 12 members present of the SOC had a mean number of 743, while for the invited review speakers it was 885. This means that the SOC

members registered somewhat earlier than the average speaker. But the mean registration number of the speakers correlated with their session number with a correlation coefficient $r = 0.86$ as $\langle registration\ number \rangle = (327 \pm 160) + (128 \pm 32) session\ number$. The larger the distance of the objects to be reviewed became, the later the invited speakers registered. A full paper with all the data and a discussion on the interpretation of this correlation is in preparation.

We wish to record our thanks to all that helped to make this Symposium so successful. In the first place the members of the SOC (most of whom also acted as session chairpersons) and the review speakers, authors of poster papers and the participants. Once again we thank the Executive Committee of the IAU for approving our proposal and I. Appenzeller, Assistant General Secretary of the IAU, for his support and help. Also many others were helpful, in particular the members of the National Committee (chaired by H. Van Woerden) and the Local Organizing Committee (chaired by E. Raimond) of the General Assembly and the IAU Secretariat in Paris for all logistic matters and solutions to problems concerning grants, visas, etc. Finally we thank Michiel Kolman of Kluwer Academic Publishers for assistance in the editing process of these proceedings.

P.C. van der Kruit and G. Gilmore