

PREFACE

Symposium 177 of the International Astronomical Union was held in late May of 1996 in the coastal city of Antalya, Turkey. It was attended by 142 scientists from 32 countries. The purpose of the symposium was to discuss the causes and effects of the composition changes that often occur in the atmospheres of cool, evolved stars such as the carbon stars in the course of their evolution. This volume includes the full texts of papers presented orally and one-page abstracts of the poster contributions.

The chemical composition of a star's observable surface layers depends not only upon the composition of the interstellar medium from which it formed, but in many cases also upon the star's own history. Consequently, spectroscopic studies of starlight can tell us much about a star's origin, the path it followed as it evolved, and the physical processes of the interior which brought about the composition changes and made them visible on the surface. Furthermore, evolved stars are often surrounded by detectable shells of their own making, and the compositions of these shells provide additional clues concerning the star's evolutionary history.

It was Henry Norris Russell who showed in 1934 that the gross spectroscopic differences between the molecular spectra of carbon stars and M stars could be explained as due to a simple reversal of the abundances of oxygen and carbon. It was also realized early on that the interstellar medium is nowhere carbon-rich, and that changes in chemical composition must be the result of nuclear reactions that take place in the hot interiors of stars, not in their atmospheres. The very existence of carbon stars thus showed that at least a few stars have managed to change their atmospheric compositions by mixing processed material to the surface. Until recently, however, it has been widely supposed that the atmospheric compositions of most evolved stars are unchanged since their days on the main sequence.

Recent work has shown that composition changes are far more widespread than previously thought. Stars on the asymptotic giant branch of the HR diagram (AGB stars) often show changes in a whole gamut of elements including the heavy *s*-process nuclei, and even stars on the first ascent of the red giant branch may show evidence of changes in C, N, O, and their isotopes, i.e. the nuclei affected by hydrogen-burning reactions. Some

stars have lost so much of their outer layers that all the material remaining has gone through hydrogen burning, and we see them as hydrogen-deficient. Still other stars show evidence of the composition changes associated with the AGB although they are not luminous enough to have reached that stage themselves; the mysteries of such stars are now being solved in terms of mass exchange in binaries systems, as more and more of them are found to have white-dwarf companions which must already have been through the AGB stage.

Work on these problems has seen enormous advances in recent years. Improved survey techniques are helping us discover and sort the many kinds of chemically-peculiar late-type stars, even revealing their presence in external galaxies. Advances in the modeling of stellar atmospheres, including the effects of opacity by millions of molecular lines, have made it possible to determine accurate abundances and isotope ratios for cool stars, while work on interior models has led to better understanding of energy production, mixing mechanisms, and composition changes. Infrared observations have provided data on circumstellar dust shells and have stimulated theoretical work on mass-loss mechanisms and grain formation, while radio observations reveal the composition of the molecular envelopes surrounding many cool stars. Imaging techniques are now being used to study the circumstellar environments of cool red giants and even to show the presence of spots on their surfaces. And because red giant stars return a good deal of processed material to the interstellar medium, it has become important to address the question of the effects of red giant stars on galactic evolution.

To bring together the researchers interested in these diverse problems relating to composition changes in cool, evolved stars, the IAU Working Group on Peculiar Red Giants proposed in 1994 to hold a meeting on "The Carbon Star Phenomenon." It was emphasized that the carbon stars themselves are only the most prominent manifestation of a widespread phenomenon affecting to some degree the evolution of essentially all stars of intermediate mass. The proposal was sponsored by IAU Commission 45 on Stellar Classification and co-sponsored by Commissions 27 (Variable Stars), 29 (Stellar Spectra), and 36 (Theory of Stellar Atmospheres), and we thank these Commissions and their Presidents (respectively Jack MacConnell, John Percy, David Lambert, and Wolfgang Kalkofen) for their support.

This Symposium may be considered a sequel to two others involving the same Working Group. A colloquium on "Cool Stars with Excesses of Heavy Elements" was organized by Carlos Jaschek and held in 1984 in Strasbourg, France; it was here that Jaschek proposed the formation of

a working group to maintain the momentum generated by the conference and founded its “Newsletter on Chemically–Peculiar Red Giant Stars.” This working group became the IAU–sponsored WG on Peculiar Red Giants at the General Assembly in New Delhi the following year, with Hollis Johnson as its Chairman. Johnson then organized the very successful IAU Colloquium 106 on “Evolution of Peculiar Red Giant Stars,” which was held in 1988 in Bloomington, Indiana, U.S.A. When I took over as Chair of the WG in 1991, we were already starting to think about a third meeting along similar lines. I did, however, consider that it would be advantageous to hold our next meeting somewhere other than in Western Europe or North America, which have had more than their share of astronomy conferences.

Symposium 177 was held on May 27–31, 1996, in the city of Antalya, Turkey. It was the first IAU–sponsored conference to be held in Turkey, a country with more than 50 IAU members, several major departments and institutes of Astronomy, and a new national observatory. The choice of Turkey as the meeting site was also strongly influenced by my family’s interest in that country: my daughter Sylvia had studied the Turkic languages, married a Turk, and had given me a guided tour of Istanbul during which I made the acquaintance of several Turkish astronomers. Organizing a conference far from one’s home institution has obvious difficulties and could be carried out successfully only because of the enthusiastic support of many Turkish astronomers and graduate students. The key to this success was the hard work of Zeki Aslan, Head of the Physics Department at Akdeniz University in Antalya, who served as Chair of the Local Organizing Committee and took care of all local arrangements.

The Scientific Organizing Committee for Symposium 177 consisted of Zeki Aslan (Turkey), Hollis Johnson (U.S.A.), Uffe Jørgensen (Denmark), Tom Lloyd Evans (South Africa), Mário Magalhães (Brazil), Janet Mattei (U.S.A.), Monique Querci (France), Verne Smith (U.S.A.), Takashi Tsuji (Japan), and Robert Wing (Chair, U.S.A.). With two exceptions (Aslan and Mattei), these committee members constituted the Organizing Committee of the WG on Peculiar Red Giants. Aslan was added because of his role as LOC Chair and his interest in the photometric and kinematic properties of red giants. Janet Mattei was invited to join because of her Turkish background and the committee’s desire to include a variable-star expert. Hollis Johnson resigned from the Committee shortly before the symposium when he realized he would not be able to attend, and his place was taken by John Lattanzio (Australia). All other SOC members did attend the symposium, except that Monique Querci was replaced by her husband François.

Antalya is a substantial, but relatively quiet, city on the southern coast of Turkey. It has a long and rich history, a fine archaeological museum, and a young university (Akdeniz Universitesi, named for the Mediterranean Sea, or “White Sea” in Turkish). It is the nearest city to Bakırlitepe, a mountain in the Toros range that is the site of the new Turkish National Observatory, headed by Zeki Aslan. Antalya also boasts several first-rate hotels, some with enormous conference facilities, strung out along the Mediterranean coast. As our conference site we chose the more modest Talya Hotel because of its pleasant atmosphere and central location, within easy walking distance of shops, restaurants, and the lovely ancient harbor. The hotel sits on a cliff overlooking the sea (to get to the pier from the hotel lobby, one takes an elevator down 7 flights). Most participants stayed at the Talya and will remember its excellent buffet-style breakfasts and dinners, which gave us many good opportunities to interact socially.

The Local Organizing Committee included astronomers from each of Turkey’s principal astronomy centers, as well as several of their graduate students. The original membership consisted of Zeki Aslan (Chair) and Orhan Gölbaşı from Antalya; Çetin Bolcal, Hülya Çalışkan, Levent Denizman, Dursun Koçer, Tuba Koktay, and Talat Saygıç from Istanbul; Cafer İbanoğlu and Varol Keskin from İzmir; and Osman Demircan from Ankara. Most of the above attended the symposium and provided the essential support needed for the smooth running of the meeting. In addition, several other Turkish astronomers and students offered help at the symposium, and in particular we thank Cahit Yeşilyaprak and Şerafettin Yaltkaya, both of the Physics Department of Akdeniz University, for their assistance.

The final count of participants was 142, including 113 from outside Turkey. They came from 32 countries, representing all of the world’s continents except Antarctica. In addition there were 20–25 accompanying persons from abroad, and an unknown number from the host country. A List of Participants follows this Preface. There I have given affiliations as of the time of the conference, since that is part of the symposium record, but I have given current (1999) email addresses as far as possible in order to make them more useful for communication. Many participants have changed affiliations since the symposium, as is often apparent from discrepancies between the listed affiliations and email addresses. If the reader needs the current postal address of a participant, I would suggest sending email and requesting it directly from the participant. In compiling the List of Participants, I discovered that alphabetizing the list of names was not a trivial matter. Accented letters in Turkish are considered separate letters, usually directly following their unaccented counterparts in the alphabet;

thus Çalışkan and Çay come after Cunha, Göğüş follows Gong, and so on. To be consistent, Jørgensen follows Jorissen and Joyce, since \emptyset comes at the end of the Danish alphabet. But the French letter è is *not* a separate letter, but merely an accented *e*, so Lèbre come before LeSqueren. Is everyone with me?

The conference photo on p. xxviii was taken on an interior stairway of the Talya Hotel leading to the lower level where the conference room was located.

The SOC was particularly pleased by the attendance of a substantial number of young astronomers (students and post-docs), who for the most part were relatively unknown to the organizers before the symposium but who made great contributions to its success. On the other hand, we were unable to secure the attendance of the most senior members of our field, perhaps because of the distance most of them would have had to travel.

Here I would like to mention several of the real pioneers of our discipline, whose work has greatly influenced many of the topics we discussed. Much of our knowledge of the occurrence and statistics of peculiar red giants has come from surveys of our Galaxy and the Magellanic Clouds carried out by Bengt Westerlund, Victor Blanco, Martin McCarthy, and Bruce Stephenson. The recognition and classification of the various sub-groups of peculiar stars owes much to Philip Keenan, William P. Bidelman, Y. Yamashita, and Carlos Jaschek. Abundance determinations for cool stars got their start with the work of Yoshio Fujita, and our modern understanding of the interiors and evolution of red giants is largely based on the work of Icko Iben, Jr. Philip Keenan was almost persuaded to give a talk on the classification of carbon stars, 55 years after his classic paper with Morgan on the subject, but in the end he decided against making the trip. Billy Bidelman was invited to give an historical talk to put the symposium in perspective, and although he declined on his doctor's advice, he did send a short paper which I read to open the conference. These leaders of our field were all alive at the time of the symposium (Carlos Jaschek has since died) and sufficiently active to be likely to read these proceedings. Other names could of course be added, and I certainly don't wish to offend anyone by omission, but I want at least these gentlemen to know that although they did not attend Symposium 177, they were most certainly in the thoughts of its participants.

Two Turkish pioneers of astronomy played significant roles at Symposium 177 and should be mentioned here. One of them, Nüzhet Gökdoğan, received her Ph.D. in Astronomy at Istanbul University in 1937, at a time when the only astronomers there were foreign-born; the other, Paris Pişmiş,

received her Ph.D. from the same university in the same year, but in Mathematics. Both were ground-breakers, being among the first women to study the sciences in the new Republic of Turkey at the time of Atatürk. After receiving their degrees, however, their careers diverged, at least geographically. Nüzhet Gökdoğan, an authority in solar physics, stayed in Turkey and was a leading force in the development of modern astronomy in that country; over the years she supervised the dissertations of many of today's leading Turkish astronomers, including members of our LOC. Paris Pişmiş, meanwhile, accepted an appointment as assistant at Harvard College Observatory shortly before the outbreak of World War II; at Harvard she met her husband, a Mexican graduate student, and moved with him to Mexico, where she had great impact on the development of that country's fledgling astronomy programs. We were delighted that Drs. Gökdoğan and Pişmiş both expressed great interest in Symposium 177. Dr. Gökdoğan had guided Turkey's admission to the IAU in 1961 and so was especially pleased to take part in Turkey's first IAU symposium. One of her former students, LOC member Dursun Koçer, made sure that she attended the welcoming reception in the gardens of the Antalya Archaeological Museum, giving us an opportunity to present her with a certificate of appreciation (see p. xxvi). Dr. Pişmiş had accepted our invitation to give a paper on planetary nebulae and their progenitors, but unfortunately she was prevented from traveling by a broken hip. When we reached her spot on the program, several participants spoke movingly about her influence and contributions. These Proceedings include the abstract of her intended talk, submitted just before the symposium. It is with deep sorrow that I must now add that Paris Pişmiş died in August 1999.

Several social activities were arranged for participants and their guests, and photos from these occasions will be found scattered throughout the volume. The first of these was the opening reception and cocktail, held in the gardens of the Antalya Archaeological Museum amid Roman statuary and (live) peacocks, at the end of the first day. It was attended by officials from Akdeniz University and the City of Antalya, and we were treated to a guided tour of the museum collection, an illustrated lecture by a local archaeologist, and snacks accompanied by the ever-present traditional Turkish *rakı*.

On the third day of the symposium, papers were scheduled for only half a day to allow time for a refreshing bus tour to the archaeological sites of Perge and Aspendos. Both ancient cities had been visited by Alexander the Great, although most of what one sees today is from a later (Roman) period. The large amphitheater at Aspendos is said to be the best-preserved

theater of the classical world.

The conference banquet was held at a marina west of the city, outdoors but under cover. We were treated to drinks, a sumptuous spread of food, and belly-dancing lessons.

On the Saturday following the conclusion of the Symposium, participants were invited to a full-day excursion to Bakırlitepe, the site of the new Turkish National Observatory. This peak, located about 50 km west of Antalya, had been selected by a site-survey team led by our LOC Chair Zeki Aslan (see p. 507), who continues as Head of the Observatory Project. Several photos from this excursion, including one of the mountain itself (p. 12), are included in this volume. At the time of our visit, construction was well along on the dormitory and the building for the smaller of two telescopes, and was about to begin on the building for the larger telescope. The smaller telescope, a 0.4-m photometric telescope installed in collaboration with the University of Utrecht, has now been in operation for some time. The larger facility, the 1.5-m Kazan University telescope employing a Russian-made mirror, is now in place and has recently seen first light at the Cassegrain focus. A description of the high-resolution spectrometer designed for the coudé focus is given on p. 569. The Observatory was officially opened on September 5, 1997, with Turkey's President in attendance.

It is my sad duty to report that two contributors to these Proceedings, in addition to Paris Pişmiş, have died since the symposium was held. Chris Skinner, an observer of circumstellar shells who did not attend the symposium but co-authored two of its posters, passed away tragically in October 1997 just as his career was starting to blossom. Then in July 1998 the Latvian theoretician Jurij Frantsman died suddenly while returning from a conference in Canada. The full text of his paper is included here.

Death has also struck the editor's family, not once but twice while work on this volume was in progress. My mother, Charlotte Wing, died in March 1997 at the age of 88. On behalf of the SOC, I would like to thank her for her support of the Symposium and for her financial assistance, which allowed us to provide small but important subsistence grants to 30 of the participants, many of whom would not otherwise have been able to attend. As my family was getting over that loss, my wife Ingrid — whom many participants met in Antalya — learned that her cancer had returned, this time in a more aggressive form. A two-year barrage of radiation and chemotherapy, including several experimental varieties, may have slowed the progress of the disease but did not change the inevitable outcome, which occurred in October 1999.

To say that these circumstances have interfered with the editorial work on this volume would be an understatement. But it would also be misleading to imply that these were the only factors that slowed the work. Of the many other contributors, I should mention my own serious miscalculation of the amount of work involved, and my pedantic insistence on uniformity of style throughout the volume. Perhaps unfortunately, I tried to referee as well as edit each paper and entered into email discussions with nearly every author about details that weren't clear to me. Although I believe this process has resolved ambiguities and brought about many small improvements, it has also caused unacceptable delays. I apologize to all authors for taking so long to get their papers into print, and I thank them for their patience and understanding.

The papers in these Proceedings are grouped into broad topics and, with minor exceptions, appear in the order in which they were presented in Antalya. Abstracts of posters appear at the end of the volume, arranged alphabetically by first author.

I thank Michael Feast and Jeffrey Linsky for sharing with SOC members the task of chairing the paper sessions. All SOC members deserve thanks for their numerous communications and ideas during the planning stages, and for their active participation in Antalya.

The discussion that followed most of the talks was recorded by Turkish student volunteers who handed sheets of paper to each discussant. I hope that my subsequent editing has not cleansed the comments of too much of their original flavor.

Although I won't mention them by name, I want to acknowledge that many authors of papers in this volume provided important assistance by email. Most of what I know about L^AT_EX I learned while editing these proceedings, and the authors were my teachers. I also thank the undergraduate students at Ohio State University who helped at different times: Melissa Holdren mounted several of the figures that required manual intervention, and Sarah Rayburn carried out various sorting and proof-reading tasks.

The photos appearing on many of the blank pages are mostly from my own camera (as digitally remastered in black & white at the Ohio State University Cop-Ēz center), and I apologize for the perhaps too frequent appearance of family members in them. I also thank Sunetra Giridhar, Kunio Noguchi, Irene Little, Janet Mattei, and Jeff Linsky for kindly sending photos, some of which are included on these pages.

The artistic talents of astronomers may not be sufficiently appreciated. Bengt Gustafsson sent his visualization (p. 480) of the traditional Turkish

Hoca story of “Duck Soup,” which he told at the end of his talk. And quite recently Pierre North kindly sent to me, as a *souvenir* of the symposium, the sketches of participants that appear on pp. 140, 206, and 302 . I thank him for allowing their inclusion in the proceedings. Pierre points out that they are not portraits, since they were done from memory in his hotel room — he calls them *impressions visuelles* — and he hopes that none of his unwitting subjects will take offense!

A grant from TÜBİTAK, the Science and Technical Research Council of Turkey, allowed us to waive the registration fees of Turkish participants. It also provided bus transportation for the excursion to Bakırlitepe (with box lunches), as well as computer support.

We thank Akdeniz University for the use of poster boards and other materials, and for the services of computer systems manager Yavuz Kömür, who helped us set up terminals with an Internet connection in the Talya Hotel for the use of participants.

Many participants have told me how pleased they were with their stay at the Talya Hotel. I would like to thank the management and staff of the hotel for maintaining such an excellent facility and for their courteous service, which contributed greatly to the pleasant atmosphere of the Symposium.

Participants and their guests were given Turkish shoulder-bags (*heybeler*) made of kilim material, each one different. I thank Hülya Çalışkan for shopping for these in Istanbul. She was able to get a very good price, simply by agreeing to buy every *heybe* in the store!

I thank Sylvia and Muammer Önder for their help and encouragement, both before and during the symposium. Many participants enjoyed Sylvia’s evening workshop on Turkish customs and language, and several of them appreciated her help with shopping (as did the local shopkeepers).

Most of all, I am grateful to Zeki Aslan for his enormous efforts on behalf of the Symposium. On his shoulders fell the tasks of securing the conference rooms, hotel accommodations, and transportation, making arrangements for tours and the banquet, making hotel reservations for everyone, dealing with agents, and making sure that everything was paid for. He also organized the LOC, enlisted the help of numerous Turkish astronomers, students, and secretaries, and obtained the financial support of TÜBİTAK. Zeki, it was a pleasure working with you — *teşekkür ederim*, and may the Turkish National Observatory have clear skies!

Columbus, Ohio
November 1999

Robert F. Wing