Despite more than one century of observational stellar spectroscopy, the resulting data are not available in an easily accessible format. The necessity of such basic information is greater than ever, because new wavelength regions (ultraviolet, infrared) are now accessible and because modern receivers can only analyze short stretches of spectra, so that a careful pre-selection of strategic elements is mandatory.

This book presents a summary of our knowledge of the behavior of all chemical elements identified in stars, based on observations rather than on their interpretations. Whenever possible, the behavior is described quantitatively, with the help of equivalent widths in different types of stars, or different ionization stages, for both absorption and emission features. It will provide an authoritative reference book for the astrophysical community.

The behavior of chemical elements in stars

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Preface

The purpose of this book is to provide an outline of our knowledge about the behavior of the chemical elements in stars. As every observational spectroscopist knows, one is often confronted with essentially simple questions of the following kinds. What is the behavior of a given element in a given group of stars, for example, europium in metallic line stars or in S-type stars? Are the neutral lines of this element visible, are they strengthened or weakened with regard to those of normal dwarfs? Questions like these are often difficult to answer even for specialists and we have thus thought that it would be useful to collect the available information and to present it in such a way as to be useful for others.

We have reviewed the literature for both normal and non-normal stars, in the classical wavelength region (3800–4800 Å) as well as in the ultraviolet and the infrared (when available) for both absorption and emission lines. We have tried to stick as closely as possible to observations and to refrain from interpretation; this means for instance that we quote equivalent widths rather than abundances, whenever possible. The separation of observations from interpretation is especially useful in fields that are in a constant state of flux. This alludes for instance to interpretations of observed abundances in terms of the thermonuclear processes going on in the stars, or to interpretations involving physical processes like diffusion in stellar atmospheres or mechanisms for heating of the corona.

For completeness and for reasons detailed in the introduction to that chapter, we have also summarized our knowledge about the behavior of molecules in stars.

In order to keep this book down to a reasonable size we have avoided discussing individual objects like zeta Aurigae or eta Carinae. We have preferred instead to deal with the main characteristics of stellar groups and of groups of variable stars.

There exists, however, one important exception to our rule that no individual stars are discussed, namely the sun. In fact the sun is the cornerstone of stellar spectroscopy. On the other hand, many things that can be studied in great detail in the sun (like the chromosphere and the corona) can only be seen in a global and cursory way in other stars. We have thus retained only that part of our knowledge of the sun that can be applied to stellar studies.

We excluded from the book non-stellar objects such as nebular objects (planetary nebulae, nebulae, HII regions) and interstellar features (such as star clouds).

Stellar spectroscopy has existed for more than a century and produces an ever

increasing flow of papers, which at present is of the order of several hundred per year. A complete coverage of the literature is thus impossible, the more so since we do not want to write the history of the subject. The bibliographic coverage is thus limited to essentials – whatever that means – providing usually (but not always) only the first and the latest paper on the subject. The selection of what we felt important leads unavoidably to a strong personal bias and we ask the pardon of authors who have not been quoted.

The book is divided into four parts. Part one constitutes the main body of the book. It starts with a content description followed by a separate section for each chemical element and finishes with a figure providing the general behavior of the elements in stars of different types. Part two contains in the first chapter a summary of our knowledge of molecules in stellar atmospheres and circumstellar envelopes. It finishes with a table providing the general behavior of molecules in stars. The second chapter deals with groups of elements, namely metals and rare earths. The third chapter deals with stellar chromospheres and coronas. Part three contains five short chapters on major topics such as the terminology of spectral lines, the selection of stars included in the book, line identification, equivalent widths and abundances and a last section called 'afterthoughts'. These sections do not provide a complete treatment of the subject, but provide only information necessary for a better understanding of the book. Part four contains auxiliary tables to aid use of the book. The bibliographic references are given at the end of the volume ordered by (first) author and year of publication.

This book can be regarded as a late successor to Merrill's book on the *Lines of the Chemical Elements in Astronomical Spectra* published in 1956. The book is a complement to our book on *The Classification of Stars*. In the latter the reader can find a general discussion of spectral types, stellar groups and other matters, which is not repeated in this book. For instance the uses of certain lines of certain elements for stellar classification purposes are discussed in our earlier book.

The book is the result of a long-standing involvement of the authors with the subject, which started at the La Plata Observatory with Professor L. Gratton, forty years ago, and continued at Córdoba, Lick, Mt Wilson, Leuschner, Yerkes, Ohio State, Geneva, Lausanne and Strasbourg observatories. Over the years we have had the privilege to know personally many of the astronomers who produced the results contained in this book and to work with some of them.

We would like to thank all the colleagues who have read and commented critically on parts of this book and/or have provided bibliography. These were Y. Andrillat, W. Balfour (Chemistry Department of the University of Victoria), H. Behrens, W. P. Bidelman, G. Cayrel de Strobel, R. Cayrel, Ch. Cowley, R. Freire Ferrero, N. Grevesse, M. Holtzer, L. Houziaux, P. C. Keenan, J. Koeppen, A. Maeder, A. Slettebak, V. Trimble, J. B. Tatum, A. J. Sauval and Mme Thierry (Chemistry Department of the University of Strasbourg). We also thank Dr M. Creze, director of the Strasbourg Observatory, and the staff of the Strasbourg Observatory for their help. Our special gratitude goes to Mr J. Marcout, who made all the drawings, Mrs M. J. Wagner, who helped with the

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