ISSN 0031 8949
ISBN 91-87308-12-6

Proceedings of

Colloquium on Atomic Spectra and Oscillator Strengths for Astro-physics and Fusion Research

Toledo, Ohio, USA, August 11-13, 1986

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EUROPHYSICS JOURNAL

Physica Scripta

Vol. RS 5 1987

Physica Scripta, Vol. RS5, 1987

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The papers in this reprint collection were originally published in different issues of **Physica Scripta**. Please make reference to original volume and page number in order to avoid any misunderstanding.

Foreword

An International meeting entitled "Colloquium on Atomic Spectra and Oscillator Strengths for Astrophysics and Fusion Research II" was held at the Department of Physics and Astronomy of the University of Toledo during 11–13 August 1986. This meeting was the second in series. The first was held at the University of Lund in 1983, and its Proceedings were reported in Physica Scripta T8. The purpose of these meetings is to bring together a limited number of "producers and consumers" of spectroscopic data to discuss the needs for data and the possibilities to meet the demand. Professor Bengt Edlén was honorary chairman of the meeting, and the scientific committee consisted of: I. Martinson, Lund; M. J. Seaton, England; C. R. Cowley, University of Michigan; and L. J. Curtis and L. S. Anderson from the University of Toledo.

The meeting was attended by over forty participants from four countries. General reviews of the meeting topics were presented in twelve invited lectures, recent results were reported in eighteen contributed papers presented as short talks and posters, and a roundtable discussion of current problems was held.

The conference provided an opportunity to pay tribute to Professor Bengt Edlén just prior to the occasion of his 80th birthday, which occurred on 2 November 1986. The scientific contributions of Professor Edlén provide the foundation for many of the subjects discussed at this conference, and his work was reviewed in the opening ceremonies. Already in the 1920's, Professor Bengt Edlén had begun measurements that extended spectroscopic studies into new regimes of high ionisation stages at shorter wavelengths than had previously been attained. By the 1930's he had reached species 20 times ionised. Although these were pioneering studies, the accuracy of many of his measurements has not been surpassed today, and some of his work contained dramatic discoveries. In 1933 he reported systematic deviations in H-like Li and Be that constitute the first observation of quantum electrodynamic effects. In studies of Li-like atoms, carried out with Tyrén, he discovered multiply excited atoms and "satellite" lines due to spectator electrons. In 1931 he identified transitions observed in Wolf–Rayet stars as arising from highly ionised C, N, and O atoms. These identifications sets the stage for his spectacular discovery in 1941, wherein he showed that the mysterious "coronium" emission lines in the solar corona (unidentified since their discovery in 1869) were due to forbidden transitions in very highly ionised atoms. This discovery provided the first quantitative measure of the unexpectedly high temperature and low density of the environment of the solar corona that ushered in a new epoch in our understanding of the sun. Subsequently Professor Edlén identified many forbidden transitions in other stars and nebulae. In recent years, forbidden lines have also been observed and used for diagnostic purposes in fusion devices such as tokamaks, where the conditions resemble those in solar flares. Professor Edlén's classification work encompasses over 150 spectra, and are of unparalleled scope and precision. Through the use of isoelectronic extrapolation of ionisation potentials, he obtained unprecedented accuracies in the prediction of electron affinities in negative ions. His studies of the index of refraction of air resulted in the internationally adopted dispersion formula for standard air. Although his official retirement in 1973 has provided Professor Edlén and his wife Friedel with additional time to devote to gardening and to their summer house in Åsljunga, it is gratifying to note that he is still vigorously engaged in spectroscopic research, and is generously helping, encouraging and training young atomic scientists.

These proceedings contain most of the invited papers and a number of the contributed papers. In addition, a special "Symposium on Radiating Atoms in the Laboratory and Space" honoring Professor Edlén was held in Lund on 4 November 1986, which was attended by a number of participants at this conference. Two papers from that symposium are also included in these proceedings.

The Toledo conference concluded with a round table discussion, in which a number of concerns and considerations were discussed. It was generally agreed that the need for additional primary atomic structure data is acute. Numerous needs were cited, particularly in heavy and highly ionised systems. The needs were not only for applications, such as tokamak plasmas, X-ray lasers, and astrophysical models, but also in fundamental theory, for which the inclusion of the Breit interaction, the Lamb shift, relativistic correlations, etc, remain untested for highly stripped atoms.

In stellar astronomy, spectroscopic studies are indirectly revealing structure deep down in stars where one could not otherwise see. Internal structure shows up in the emergent radiation spectrum both kinematically and through abundance anomalies. Two examples of the former are the low amplitude resonant oscillations over a wide range of spherical harmonics, and the high amplitude oscillations of variable stars. In the first example, accurate line profiles are required for the diagnostic lines. In the second example, a new accurate compilation of all spectral features contributed to the opacity of stellar material is needed. This same compilation is necessary for the analyses of abundance anomalies through relative diffusion (cf. Michaud, these proceedings). While theoretical work is being done to try to address the need for a "universal" compilation (cf. Pradhan, these proceedings), laboratory work on significant entries is necessary to provide theoretical benchmarks.

Concern was expressed over the fact that young people are entering the field on the side of data consumers, but not as data producers. There are essentially no spectroscopists in U.S. universities, and the handful of spectroscopists in U.S. Government Laboratories is approaching retirement age without the opportunity to transfer their expertise to younger colleagues. This situation is somewhat better in Europe, but even there the burden falls on a small number of very vigorous senior scientists. In accelerator based studies, spectroscopy and atomic structure is on the decline, and many workers are moving toward atomic collisions research. More support for postdoctoral fellows might retain some young scientists in data and structure.

It was suggested that new types of spectroscopic light sources and new types of instrumentation are providing exciting possibilities. For example, Fourier transform spectroscopy can allow the measurement of literally millions of lines in neutral atoms. However, for the foreseeable future producers will still be required to carry out a long program of disciplined studies. Unfortunately, trendy one shot experiments are sometimes more attractive and more fundable

than lengthy data measurement programs. However, an important advance concerns the archiving and disbursal of atomic data compilations, which could be greatly facilitated by an international electronic network.

It was suggested that the scope of the next meeting might be broadened to include consumers outside the fields of astrophysics and fusion. Examples were suggested that included isotope shifts for applications in laser isotope separation, synchrotron radiation studies, and 4-photon interactions.

The Conference was jointly sponsored by the U.S. Department of Energy, Division of Chemical Sciences and the University of Toledo Program for Excellence.

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