PAPERS PRESENTED AT THE SCIENTIFIC MEETINGS OF COMMISSION 29 DURING THE I. A. U. GENERAL ASSEMBLY, PRAGUE 1967

From Prof. J. Sahade, the President of Commission 29, we have received on 15 April 1968 ten following papers for publishing in our Bulletin.

REMARKS AND RECOLLECTIONS OF A STELLAR SPECTROSCOPIST

Заметки и воспоминания о звездных спектроскопистах

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I feel strongly bound to Commission 29 for a number of sentimental reasons. I have had the privilege of attending all the I.A.U. meetings of this Commission since 1935, at the time of the Paris General Assembly. As a matter of fact the Paris sessions were the most thrilling to me, because one of the greatest astrophysicists of this century, Henry Norris Russell, who was chairman of Commission 29 gave me an exciting mark of friendship and confidence which filled me with pride: he appointed me secretary of the sessions, and he entrusted me with the responsibility of writing the report on these sessions which had been most interesting, especially because we discussed and adopted Beals' classification of the Wolf-Rayet stars. There were only 19 members in Commission 29 in 1935, and unfortunately very few of these 19 stellar spectroscopists are still alive.*) This sad reason gives me an excuse for a few historical comments on Commission 29.

There had been only one president of Commission 29 before Henry Norris Russell: at the Rome 1922, Cambridge (U.K.) 1925 and Leiden 1928 General Assemblies the chairman of Commission 29 was Walter S. Adams. At the Cambridge (Mass.) 1932, Paris 1935 and Stockholm 1938 General Assemblies H. N. Russell was the chairman of Commission 29; incidentally the membership of Commission 29 was still only 22 in 1938. Of course there were fewer stellar spectroscopists thirty years ago, but in addition it was also fairly difficult to be accepted as a member of the rather exclusive Club 29!

At the Zürich 1948 meeting Otto Struve was chairman; he had accepted the chairmanship under two conditions: (i) that I should be secretary of the Commission during his term of presidency and that the draft report should be written in collaboration; (ii) that I should become the chairman at the following Rome Assembly of 1952, with the understanding that he, Struve, would be the secretary of the Commision during my term as chairman. The members of the Commission 29 who know how close were our collaboration and friendship may have forgotten about this arrangement, but are certainly not surprised.

My successors have been three eminent stellar spectroscopists, Drs. Jesse L. Greenstein, Lawrence H. Aller and Jorge Sahade. Their task has become heavier and heavier, on account of the tremendous increase in membership of Commission 29, which now exceeds the 100-mark. I wish to compliment my three colleagues for a job well done, worthy of the departed chairmen Adams, Russell and Struve. The future chairmen of Commission 29 will be faced with the difficult necessity to summarize drastically the reports which are becoming terribly long, hence expensive to our Union.

In the general remarks which will follow I shall avoid to refer to the closely related fields of the spectroscopy of the sun, planets, comets, planetary nebulae and interstellar matter, despite the tremendous temptation to relate the corresponding spectroscopic problems to those of the stars proper. I shall not indulge in theoretical discussions either. I am not afraid to stress the importance of the pure identification problem in stellar spectra. I recognize that to a few members of Commission 29 including myself the pure identification work is lots of fun in itself. Of course I know that this point of view has been violently criticized; unfavourable comments have even been expressed against Struve's work which was said to be too descriptive and to enter into too many observational details. This, I feel, is entirely wrong and I want to defend energetically Struve's memory, especially since I share his views. Our progress in the theoretical understanding of the stellar and other atmospheres could not have gone very far if we

*) Three are still members of Commission 29: D. Chalonge, W. W. Morgan and I.

had not had pure identifications and detailed descriptions as a sound and solid basis. To take two extreme cases: where would Astrophysics be without the identification of the nebular lines by I. S. Bowen and his successors and of the coronal lines by B. Edlén? Let us take a much more modest case. Bengt Edlén and I devoted two full years of hard steady work to the laboratory analysis of the Fe III-spectrum. Thirty years later we both still feel that our endeavors paid excellent dividends later on, when it turned out that the forbidden as well as the permitted lines of Fe III explained many features in novae, peculiar bright line stars, and even normal hot stars, including dilution effects in shell stars and other mechanisms affecting the stellar atmospheres. Of course pure identification work must be accompanied by studies on intensities and profiles. I do not want to miss this opportunity to thank and compliment our colleagues who computed transition probabilities (even of very complicated spectra, such as the forbidden transitions of Fe II, Ni II, Fe III, etc.) or collisional cross sections. I have especially in mind Dr. Garstang and Dr. Seaton, but a good many other names should be added. Reference to their work will certainly be given in other commissions, especially Nos 14, 36 and 44.

However my plea in favor of the identification and intensity measurements of the spectral lines of stars should not be misunderstood. I fully recognize that spectroscopy is only a tool, providing precious informations to the theoretical astrophysicists, and that it should be combined with photometry and other observational techniques. For example, if we want to make headway in our understanding of symbiotic stars, we should obtain accurate monochromatic lightcurves in H_α, in specific forbidden lines, in the red and ultraviolet continua. Similar considerations should be applied to Of-stars, novae, etc. Such observational data may now be secured without too great difficulties, on account of the recent progress in electronics.

Are there still many important unidentified features in stellar spectra? Indeed there are, in practically all spectral types. To take first just one simple example, Struve and I found two unassigned emission lines in Of-stars, at $4485{\cdot}7 \pm 0{\cdot}2$ and $4503{\cdot}7 \pm 0{\cdot}2$ Å. These were confirmed by R. J. Wolff (1963) who found that these two features were strong in various Of-stars; they are the only remaining strong unidentified bright lines in these stars which, as you all know, contain only very few emission lines. The two lines must belong to light elements, such as N III or C III. Identification attempts have been made without success by several spectroscopists, including B. Edlén, L. Goldberg, R. J. Wolff, A. Underhill and myself. If these two lines belong to the same element — which is likely — and have one common level the wavenumber separation between the other two levels should be between 87 and 91 cm^{-1}. We have found no convincing assignment in searching for levels of separation 87 to 91 cm^{-1} in CI to IV, NI to V, OI to IV, Si I to IV. But we should not become discouraged: L. Goldberg's group and others have found peculiar types of transitions*). I do think that the identification of $\lambda\,4485{\cdot}7$ and $\lambda\,4503{\cdot}7$ will prove of great interest.

A look at the excellent reproductions of the spectrograms of η Carinae published by A. D. Thackeray reveals unidentified lines, some of them quite strong. We also know that there are still strong unassigned lines in Wolf-Rayet stars, in symbiotic objects, etc., especially in the photographic infrared region. The Fe II-spectrum behaves in a queer fashion in the P Cygni stars. The $a^6S - z^6P^\circ$ multiplet ($\lambda\lambda\,4923{\cdot}92$; $5018{\cdot}43$; $5169{\cdot}03$) differs strongly from the $b^4P - z^4D^\circ$ ($\lambda\lambda\,4233{\cdot}7$; $4351{\cdot}76$; $4385{\cdot}36$), the sextet being much stronger than the quartet and having very different profiles.

In recent years astronomical spectroscopy has lost a great deal of the glamor which it used to have. Many young astronomers prefer to go into photometry, radio-astronomy, semi-theoretical investigations in nucleogenesis, plasma problems, shock waves, etc. This is all right, but many spectroscopic problems remain unsolved. Young research men should be made aware of this fact, and encouraged to undertake spectroscopic observations, since these are still as essential to the progress of astronomy now, as they were 30 or 40 years ago. These young research people should extend the covered spectral range, toward the infrared as well as toward the ultraviolet. Incidentally the spectrographic observations already made in the far ultraviolet-and X ray-regions from space vehicles are of tremendous interest, and we may expect an extremely exciting crop of results in the short wavelength region when adequate orbiting telescopes go into operation. But this we should leave to Commission 44.

Another progress which may be expected in the relatively near future is the increase in spectral resolution, which becomes possible thanks to the electronic camera, and the improvement in photographic emulsions. If I had to start my astrophysical career all over again I would still want to be a spectroscopist, and I would try to contribute spectroscopically to our still very limited knowledge of the following matters**)

*) Of-stars reveal queer selectivities in NIII and other ions they have not yet been quite convincingly interpreted.

**) It is unnecessary to insist on the desirability of the extension in spectral range and resolution.

among others which do not belong to Commission 29: the magnitude, masses and binary nature of peculiar objects such as the Wolf-Rayet stars (this would include the evolutionary stage, the spectroscopic study of the near infrared region, etc.), the real nature of symbiotic objects and their location (as well as that of the nuclei of planetary nebulae) in the Hertzsprung-Russell diagram; the relative importances of the different excitation mechanisms in hot bright line stars (example: the relative role of the dilution effect and of the fluorescence by Lyman β in the excitation of the OI-emission at λ 8446 in various shells*); the relative importance of the excitation mechanisms of the singlets and triplets of He I; etc.); the abundance "anomalies" which exist in the cool stars as well as in the hot objects (including the isotopic abundances, especially on the basis of high resolution spectra of cool stars, including those with strong Merrill-Sanford bands); the high resolution study of a few stars of types T Tauri, RV Tauri and W Virginis representing very different stages of evolution; the stars of R Coronae Borealis type; all bright novae, especially those of the recurrent type.

*) λ 8446 belongs to the OI-triplets, while λ 7772 belongs to the quintets.

I would try to convince good "photometrists" of the need for "monochromatic light curves", and to find theoretical colleagues interested in the detailed study of time lags.

Probably I would not be able to resist the temptation to participate in the study of the stellar spectra which will be obtained with orbiting telescopes or high flying balloons (Swings 1964, 1965).

This big program, I know, would be too heavy for a single observer! And anyway I am unfortunately in the last part of my career, instead of the beginning... I do hope that a sufficient fraction of my young colleagues of Commission 29 will continue the exciting work of their predecessors.

REFERENCES

Swings P., 1964, AnnAp 27, 283.
—, 1965, AnnAp 28, 212.
Wolff R. J., 1963, PASP 75, 485.

SOME PROBLEMS CONCERNING THE He I LINES IN B TYPE SPECTRA

Некоторые проблемы, касающиеся линий He I в спектре звезд типа B

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Introduction

Spectral type B was originally assigned to stars whose spectrum at low dispersion (100 to 200 Å/mm) showed lines of He I as well as lines of H. A few lines of the second spectra of C, N, O, Si and Mg might also be present. When photoelectric photometry became established it was found that the stars of class B have $(B-V)_0$ lying in the range 0·00 to −0·32. Series of model atmospheres which represent the formation of the continuous spectrum well and which allow rather successful prediction of the Hγ and Hδ profiles have been made for the B stars. This theoretical work has generated confidence in our understanding of the formation of stellar spectra. One consequence has been that spectral classification by means of photometry has been believed to be equivalent to the original classification by means of spectra. Stars with $(B-V)_0$ in the range 0·00 to −0·32 have been expected to have the same spectra as B stars.

Within the last 5 to 7 years spectra of some of the faint blue stars, in particular some of the horizontal branch stars in globular clusters, have been obtained. It has been disconcerting to find that the He I lines are very often weak or absent. Even some galactic blue stars which have many of the spectral characteristics of normal B stars are found to have weaker than normal He I lines. What is the meaning of this variation in the strength of the He I lines among stars which appear to be on or close to the main sequence?

The original spectral classification criteria are based on the relative intensities of empirically selected absorption lines in the blue-violet part of the spectrum. This empirical selection represents some monotonic change in the process of line formation. The action of classifying stellar spectra does not tell us what the process is nor whether the process is simple or complex. It has been rather generally believed that the hypothesis of line formation under conditions of local thermodynamic equilibrium will permit one to predict the observed classification lines and that an increasing electron temperature as one goes up the main sequence is the monotonically changing factor which governs the appearance of the well-known spectral sequence.