# THE BONNER SPECTRAL ATLAS AND THREE-DIMENSIONAL CLASSIFICATION AT LOW DISPERSIONS

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**Abstract.** Work on the third part of the *Bonner Spectral Atlas: Peculiar Stars* has well progressed during the past year. Observations of the more than 200 stars – photographed with a dispersion of 240 Å $mm^{-1}$ at Hγ on *I-N* plates – is nearing completion.

The arrangement of the spectra will be as follows:

1. WR-stars
2. O-stars Of sequence
3. Peculiar B-type stars
   emission-line objects
4. Ap-stars
   with various sequences:
   Cr-Mn-Hg-rare earths
5. Asi-stars
6. Am-stars
7. Late-type peculiar stars Ba II, CH
8. C-stars
9. Late M-type stars
10. S-stars
11. Composite spectra
12. Spectra with large rotational broadening

The 12 groups are displayed on 40 plates, each with 6–8 objects. Stars of groups 8 to 10 will be presented with different exposures in order to facilitate the discovery of faint objects.

Sample plates will be shown and discussed.

## 1. Introduction to the Bonner Spectral Atlas

*The Bonner Spectral Atlas – Atlas for Objective Prism Spectra* – consists of the published or projected parts as shown in Table I.

## 2. Visibility of Classification Features on Low-Dispersion Spectrograms

While planning the various parts of the atlas it came, of course, to our minds, whether it was at all sensible to reproduce spectra of a large variety of spectral types at low dispersions when it might not be possible to differentiate between them. We thus looked for an empirical rule to predict the visibility to certain classification features and found the following: *The equivalent width of the faintest visible feature in mÅ is approximately equal to the dispersion in Å $mm^{-1}$.*

This heuristic rule is derived from observations over a wide range of dispersions

*B. Hauck and P. C. Keenan (eds.), Abundance Effects in Classification*, 129–133. 

TABLE I
Published and projected parts of the Bonner Spectral Atlas

| No. | Volume | Stellar Types | Dispersions | Publication Date |
|---|---|---|---|---|
| 1 | Part I | MK standards | 240 Å mm$^{-1}$ | 1970 |
| 2 | Part II | MK standards | 645, 1280 Å mm$^{-1}$ | 1975 |
| 3 | Supplement I | MK standards text only | 240, 645, 1280 Å mm$^{-1}$ | 1976 |
| 4 | Part III | 'peculiar' stars | 240 Å mm$^{-1}$ | (1977) |
| 5 | Part IV | 'peculiar' stars | 645, 1280 Å mm$^{-1}$ | (1979) |
| 6 | Supplement II | 'peculiar' stars text only | 240, 645, 1280 Å mm$^{-1}$ | (1979) |
| 7 | Part V | Nova Delphini | 240 Å mm$^{-1}$ | (1976) |

The term 'peculiar' refers to all types not included in the MK system of 1953, including such normal objects as M-type stars later than M2 and Population II objects.

(0.5 Å mm$^{-1}$ – 1280 Å mm$^{-1}$) and seems to hold reasonably well for both absorption and emission lines, provided that the line width is not much larger than the resolution of the spectrogram. Exposure effects, small fluctuations in resolution and line width and uncontrolled influences set the limits between which this holds true to roughly ± 0.3.

One requirement is essential in all cases of high (relative to the dispersion) accuracy classification: sufficient broadening of the spectra. Regardless of dispersion, the widening should not go below 0.5 mm. Best results are obtained for widening values between 0.7 and 1.5 mm.

In order to compare the results obtained with a variety of instruments equipped with objective prisms to those obtained with the Bonn Schmidt telescope, which has the fairly short focal length 1375 mm and thus – with seeing values of no more than 2″ – a high resolution, one has to apply the following conversion factor for telescope $X$:

$$\frac{\beta_X \cdot T_X}{\beta_{\mathrm{Bonn}} \cdot T_{\mathrm{Bonn}}}$$

where $\beta$ = seeing, and $T$ = focal length of the telescope.

Figures 1 and 2 show the predicted visibility of certain features on the basis of their equivalent widths according to the above cited rule.

The ordinates represent equivalent widths in mÅ as well as dispersions in Å mm$^{-1}$. The three Bonn dispersions are indicated by long lines. The abscissae represent spectral types. Figure 1 shows the equivalent widths of a certain silicon and europium blend in different types of stars. It is immediately apparent that the two higher dispersions should easily reveal Si II and Eu II stars on the basis of the line strengths around λ 4130.

Figure 2 shows the absorption strengths around λ 4180 indicating that the feature separates Am stars from normal stars at all three dispersions of the Bonn Schmidt telescope. All symbols are explained in the diagrams.

The results of both diagrams have been checked on objective prism plates and are found to hold true.

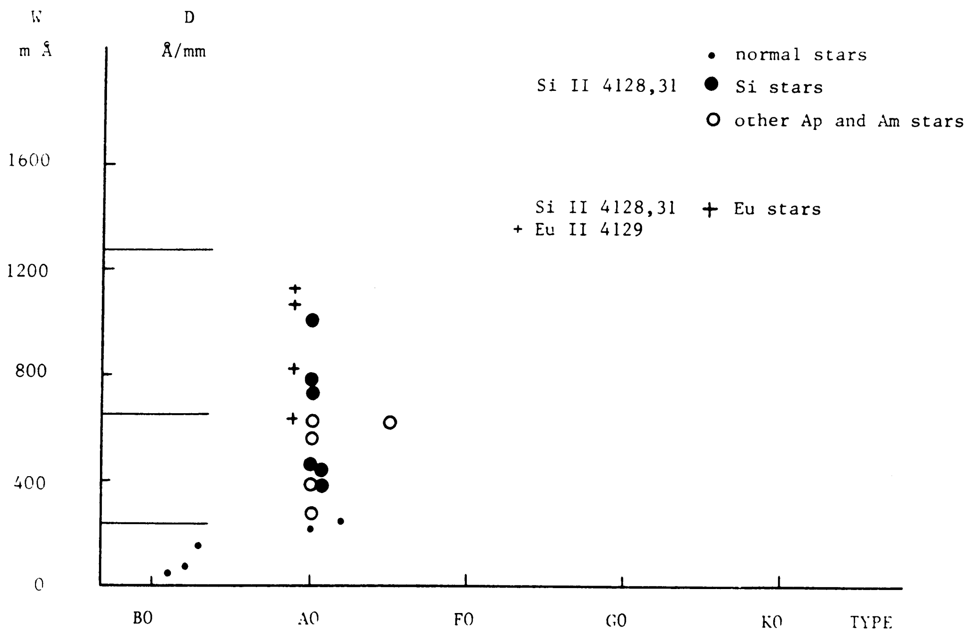


Fig. 1. Visibility of abnormal Si II line strengths at different dispersons.

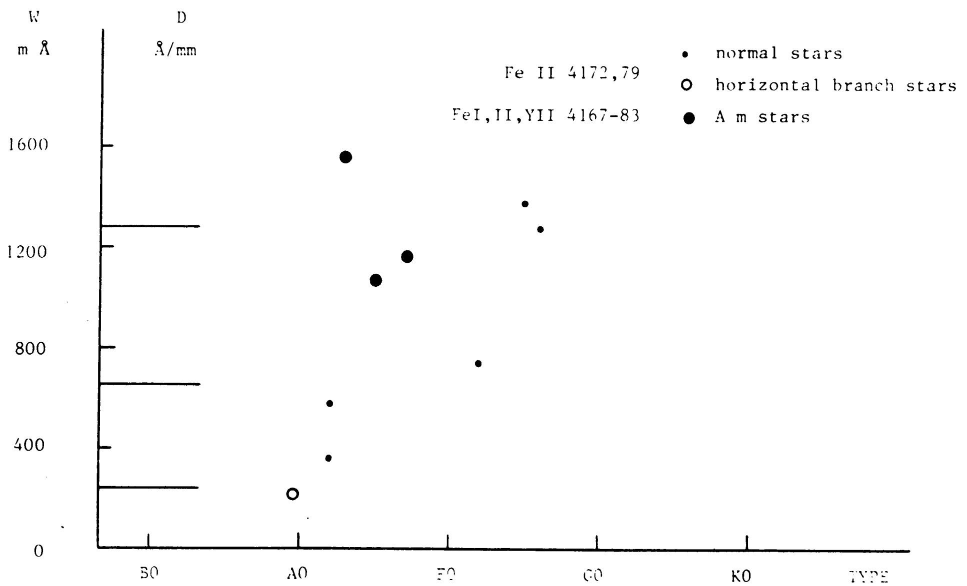


Fig. 2. Visibility of metallic star characteristics at different dispersions.

## 3. Sample Spectra of Different Peculiar Spectral Types at Low Dispersions

A variety of spectra including Ap stars of the Si, Cr and Sr groups, Am stars, late M-type stars, C-stars, S-stars and emission-line objects at all three Bonn dispersions are shown on slides and in an exhibit in order to give the audience the opportunity to judge for themselves the visibility of features at the different dispersions.

The detectibilities of peculiarities of some major types are summarized in Table II.

TABLE II

Recognition of spectral peculiarities at different dispersions

| Stellar Type | Dispersion in Å $mm^{-1}$ 240 | 645 | 1280 |
|---|---|---|---|
| Of | + | + | (+) |
| Be | + | + | [+] |
| He-weak | + | [+] | [+] |
| A Si | + | + | [*] |
| A Cr | + | + | (*) |
| A Sr | + | [+] | – |
| A Eu | + | [+] | – |
| A Mn | [+] | [*] | [*] |
| A m | + | + | * |
| λ Boo | [+] | – | – |
| R CrB | + | + | + |
| Ba II | * | [*] | [*] |
| CH | + | * | (*) |
| CN weak | + | + | + |
| CN strong | + | * | * |
| C | + | + | + |
| S | + | – | – |
| composite | [+] | [+] | [+] |

Characteristic features

+ clearly recognized
* seen – but frequently confused with other peculiarities
– not seen
() expected to show – not yet tested
[ ] only seen in exceptional cases

The above results are preliminary.

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## DISCUSSION

*Morgan:* What are the categories of 'normal' spectra most easy to recognize on your two lowest dispersions?

*Seitter:* At all spectral types the Ia stars are easily detected. These and other groups profit from the fact that at low dispersions new criteria appear in the form of characteristic blends and (quasi)-continuum features replacing the lines which are lost at low resolutions. An example is the broad blend of the Si IV 4089 4116 lines with Hδ, which constitutes an excellent luminosity criterion for hot stars at lowest dispersion. H-line strengths in O-F stars are very good combined spectral type-luminosity criteria.

The problem at low dispersions is not the ***absence*** of criteria, but the ***ambiguity*** of the criteria which are present. The use of as many criteria as possible helps to separate the different parameters $T$, $g$ and abundances for more types than expected.

*Walborn:* I wonder if you can really resolve all of the two-dimensional categories of the MK system with this observational system, and if not, whether this classification should be called 'MK'.

*Seitter:* The problem of assigning MK types at low dispersions is comparable to the problem of assigning MK types at very high dispersions – in the latter case you have too much, in the former too little information. For the sake of uniformity I would vote for assigning MK types irrespective of dispersion. For the low dispersions this seems justified in view of the fact that there is ***no break*** in accuracy around dispersion 100 Å mm$^{-1}$. There is rather a linear decline between about 50 and 1500 Å mm$^{-1}$ with $[\sigma]$ increasing by 0.012 spectral subtypes per 100 Å mm$^{-1}$ progress in dispersion and 0.08 luminosity classes per 100 Å mm$^{-1}$ progress in dispersion as derived from Bonn spectra. Thus, if an MK type is given together with the dispersion used, the reliability of the type is immediately apparent.