

IUE LOW-DISPERSION REFERENCE ATLAS

A. Heck^{1,2}, D. Egret², M. Jaschek², C. Jaschek²

¹ - IUE Observatory, Astronomy Division, ESA, Madrid, Spain

² - Observatoire Astronomique, Strasbourg, France

ABSTRACT

This atlas, published by ESA and essentially devoted to normal stars, presents 229 graphic spectra together with the corresponding fluxes and an ultraviolet spectral type. The preparation of this publication has indeed confirmed that MK classifications cannot simply be transferred to the ultraviolet range. A set of transparencies are illustrating the reference sequences constructed from the ultraviolet data. A magnetic-tape copy of all the spectra pertaining to this atlas is available from the Stellar Data Center in Strasbourg.

INTRODUCTION

The programme of ultraviolet spectral classification was initiated in 1978 with the specific goal of building up a set a representative IUE low-dispersion spectra from which a classification scheme could be constructed in the UV. This undertaking was strongly supported by the participants to the VILSPA workshop on "UV Stellar Classification" held in October 1981 who stressed in their final resolution its basic importance not only for stellar and extragalactic astronomy, but also for the preparation of spectroscopic programmes on future space missions.

From a previous study in the ultraviolet range based on data from the S2/68 experiment on board the ESRO/ESA's TDI satellite (see i.a. Cucchiaro et al., 1978 and the references quoted therein), it was found that about 90% of the spectra fit a two-dimensional frame whose parameters are correlated with the temperature and luminosity, and which parallels that of the MK classification in the visible range (Jaschek & Jaschek, 1982). The remaining 10% of the stars did not fit in such a scheme, in the sense that they were abnormal in one wevalength region and normal in the other.

Similar conclusions have been reached with the present work, namely that one cannot simply transfer MK spectral classifications to the ultraviolet, the order in the MK system being not identical to that which can be established in the ultraviolet spectral range.

THE MATERIAL

Compared with the previous work on TDI data, the present programme represents a significant improvement because the spectra cover a larger wavelength range at a higher resolution. Moreover IUE has observed a much broader range of stellar types than TDI and has also reached significantly fainter magnitudes.

Table 1 : Designations used for the UV spectral classifications

| Designation | Name | Rough MK equivalent |
|-------------|-------------------|---------------------|
| d | dwarf | V |
| g- | subgiant | IV |
| g | giant | III |
| g+ | bright giant | II |
| s- | supergiant | Ib |
| s+ | bright supergiant | Ia |

Table 2 : Stars appearing in the atlas

| Identifier | IUE Sp.T. | MK Sp.T. | Identifier | IUE Sp.T. | MK Sp.T. |
|------------|-----------|-----------------|------------|-----------|--------------|
| HD 698 | B3 pec | B5 III e | HD 36673 | s F0 | F0 Ib |
| 2905 | s+B1 | B1 Ia | 36824 | d B2.5 | B2.5 V |
| 3360 | d+B1.5 | B2 IV | 36879 | 07 p | O7.5 III |
| 4142 | d B4 | B5 V SB | 37042 | d B0.5 | B0.5 V |
| 4727 | d+B4 | B5 V SB | 37061 | d+B0.5 | B0.5 V |
| 5448 | d A4 | A5 V | 37129 | d+B2.5 | B2.5 Vs |
| 6619 | d A5 | A1 V, Am | 37367 | d+B2.5 | B2 IV-V |
| 8890 | s F8 | F7:Ib-II SB,V | 37744 | d B1.5 | B1.5 V |
| 9132 | d A1 | A1 V | 37776 | d B2 | B2 V |
| 10250 | d B9 | B9 V | 37903 | d B1.5 | B1.5 V |
| 10307 | d G1.5 | G1.5 V | 38206 | d A0 | A0 Vs |
| 11031 | d A2 | A3 V | 38666 | d O9 | O9 V |
| 11636 | d A5 | A5 V SB, A5m | 40136 | d F2 | F2 V |
| 12301 | s-B8 | B8 Ib | 40893 | g O9.5 | B0 IV: |
| 12311 | g F0 | F0 V | 40932 | d A4 | Am SB, VB |
| 15570 | s O4 | O4 If | 41117 | s+B2 | B2 Ia |
| 15629 | d O5 | O5 V ((f)) | 42690 | d B2 | B2 V |
| 17138 | d A3 | A3 V | 46056 | d O8 | O8 V |
| 20346 | g:A2 | A2 IV | 46149 | d+O8 | O8.5 V |
| 20630 | d G5 | G5 V var | 46150 | d O5 | O5 V ((f)) |
| 20902 | s F5 | F5 Ib | 46202 | d+O9 | O9 V |
| 21071 | d B7 | B7 V | 46223 | d O4 | O4 V ((f)) |
| 21291 | s B9 | B9 Ia | 46769 | d B6 | B8 Ib |
| 21389 | s A0 | A0 Ia SB: | 47054 | d B8 | B8 V |
| 22049 | d K | K2 V | 47129 | g+O7 | O7.5 III (f) |
| 22928 | g B5 | B5 III SB | 47240 | s+B1 | B1 Ib |
| 23302 | g B6 | B6 III | 47432 | s+O9 | O9.5 I |
| 23324 | d B8 | B8 V | 47755 | d B3 | B9 |
| 23408 | g B6 | B7 III | 48250 | d A2 | A3 V |
| 23432 | d B8 | B8 V | 48329 | s G8 | G8 Ib var |
| 23480 | d B6 | B6 IV (e) | 48434 | B0.5: | B0 III |
| 23630 | g B7 | B7 III (e) | 50138 | B9 pec | B6 III |
| 23753 | g B8 | B8 Vn | 51283 | g B2 | B2 III |
| 23850 | g B8 | B8 III | 51309 | g+B3 | B3 II |
| 25340 | d B5 | B5 V | 52266 | g O9 | O9.5 V |
| 27176 | d F0 | F0 V | 52721 | d B2: | B2 Vne |
| 27290 | d F1 | F4 III | 52918 | d+B1 | B1.5 III |
| 27396 | d B4 | B4 IV | 52942 | d B1.5 | B3n |
| 27962 | d A2 | A2 IV | 53138 | s+B3 | B3 Iab |
| 28319 | g A7 | A7 III | 53367 | g B0 | B0 III |
| 29335 | d B6 | B7 V | 53974 | g B0.5 | B0.5 III |
| 29365 | d B8 | B8 V | 54306 | d B1 | B2 V |
| 29646 | d A1 | A2 V | 54439 | d:B1.5 | B2 IIIIn |
| 30614 | s+O9 | O9.5 Ia | 55857 | d B0.5 | B0.5 V |
| 31295 | d A2 p | A0 V lambda Boo | 57061 | g+O9.5 | O9 II |
| 31726 | d B2 | B1 V | 57682 | d O9.5 | O9 V |
| 32630 | d B3 | B3 V | 58142 | d+A1 | A1 V |
| 34078 | d+O9.5 | O9.5 V | 58350 | s+B5 | B5 Ia |
| 34759 | d B4 | B3 V | 58946 | d F2 | F2-3 Vas |
| 34816 | d B0.5 | B0.5 IV | 59612 | s A5 | A5 Ib |
| 36512 | d B0 | B0 V | 60753 | d B3 | B3 V |
| 36629 | d B2 | B2.5 IV | 61429 | d B7 | B8 IV |

| Identifrier | IUE Sp.T. | MK Sp.T. | Identifrier | IUE Sp.T. | MK Sp.T. |
|-------------|-----------|-----------------|-------------|-----------|---------------|
| HD 61831 | d B2.5 | B2.5 V | HD 152247 | g+09 | 09 II |
| 63922 | d+B0 | B0 III | 152248 | s 07 | 07 Ib: (f) p |
| 64760 | s-B0.5 | B0.5 Ib | 152249 | s-09 | 09 Ib |
| 64802 | d B2.5 | B2.5 IV | 152667 | s+B0.5 | B0.5 Ia |
| 65456 | d A5 | A2 V var | 156208 | g A1 | A2 V |
| 74180 | s F2 | F3 Ia | 159561 | g A5 | A5 III |
| 74273 | d B1.5 | B1.5 V | 159876 | F2 p | Delta Del |
| 75821 | g B0 | B0 III | 161817 | d:A3 p | A2 VI |
| 76644 | d A7 | A7 IV | 162374 | d B6 | B6 V |
| 76756 | d:A5 | A5m | 162978 | g+07 | 07.5 II ((f)) |
| 77370 | d F4 | F3 V | 163181 | s B1 | B1 Ia pe |
| 77581 | s+B0.5 | B0.5 Ia | 164353 | s-B5 | B5 Ib |
| 78362 | g F3 | F3 III-IVm, vs | 164402 | s-B0 | B0 Ib |
| 79439 | d A5 | A5 V | 164794 | d 03 | 04:V ((f)) |
| 79447 | d+B3 | B3 III | 165024 | g+B1 | B2 Ib |
| 80081 | d A2 | A1 V | 165052 | d 07 | 06.5 V |
| 83183 | g+B6 | B5 II | 166205 | d A2 | A1 Vn |
| 83754 | d B5 | B5 V | 166937 | s+B8 | B8 Ia |
| 85504 | d+A0 | A0 Vs | 167264 | s+B0 | B0 Ia |
| 86360 | d+B9 | B9 IV | 167756 | s-B0.5 | B0.5 Ia |
| 86440 | s-B5 | B5 Ib | 167838 | s+B5 | B5 Ia |
| 87696 | d A7 | A7 V | 168076 | d 04 | 04 f |
| 87737 | s A0 | A0 Ib | 168905 | d B2.5 | B2.5 Vn |
| 87901 | d B7 | B7 V | 170153 | d F6 | F8 Vb, vw |
| 89025 | g F2 | F0 III | 173502 | g B1 | B1 II |
| 90589 | d F3 | F2 IV | 173667 | d F6 | F6 V |
| 90772 | s A5 | A6 Ia | 177724 | d A0 | A0 Vn |
| 90994 | d B6 | B6 V | 183143 | s+B7 | B7 Ia |
| 91316 | s-B1 | B1 Ib SB | 183914 | d B8 | B8 Ve |
| 92741 | g+B1 | B1 II | 188209 | s-09.5 | 09.5 Iab |
| 93028 | d+09.5 | 09 V | 189849 | g A5 | A4 III |
| 93130 | g 05 | 06 III (f) | 190603 | s B2 | B1.5 Ia |
| 93204 | d:03 | 05 V | 190993 | d B2.5 | B3 V |
| 93205 | d 03 | 03 V | 192281 | d 04 | 05 V ((f)) p |
| 93250 | d 03 | 03 V ((f)) | 192685 | d B2.5 | B3 V |
| 93403 | g 05 | 05 III (f) | 193682 | g:04 | 05 |
| 95418 | d A1 | A1 V | 197345 | s A2 | A2 Ia |
| 99028 | g F3 | F3 III SB | 197392 | g B8 | B8 II-III |
| 100600 | d B2.5 | B4 V | 198478 | s+B3 | B3 Ia |
| 102870 | d F9 | F9 V | 199478 | s+B8 | B8 Ia |
| 103287 | d A0 | A0 V SB | 200120 | d B0.5 | B1 Ve |
| 104035 | s A2 | A3 Ib | 200310 | d B1 | B1 Ve |
| 107832 | d+B8 | B8-B9 V | 201908 | d B8 | B8 Vn |
| 108767 | d B9 | B9 Vn | 202444 | d:F3 | F1 IV |
| 109387 | d+B7 | B6 IIIp | 206165 | s-B2 | B2 Ib |
| 111775 | d+A0 | A0 IV | 206901 | d F4 | F4 IV SB |
| 116842 | d A5 | A5 V SB | 207260 | s+A pec | A2 Ia var |
| 120315 | d B3 | B3 V SB | 207330 | g B2.5 | B2.5 III |
| 122879 | s+B0 | B0 Ia | 209481 | g 09 | 08.5 III |
| 123008 | s+09 | ON9 Ia | 210221 | s A3 | A3 Ib |
| 125162 | d A2 p | A0 p lambda Boo | 210424 | d B7 | B7 III |
| 128167 | d F3 | F3 Vvw | 210839 | s 05 | 06 If |
| 137422 | g+A2 | A3 II-III | 212571 | d B1 | B1 III-IVe |
| 144470 | d B1 | B1 V | 214680 | d 09 | 09 V |
| 147394 | d B5 | B5 IV | 215835 | d 05 | 05.5 |
| 147547 | g FO | A9 III | 216701 | d A5 | A7 III |
| 148379 | s+B2 | B1.5 Ia | 216956 | d A3 | A3 V |
| 148605 | d B2 | B2 V | 219188 | g B0.5 | B0.5 II-IIIIn |
| 148743 | s A7 | A7 Ib | HDE 242908 | d 04 p | 05 |
| 149212 | g B9 | A0 III | 303308 | d 03 | 03 V |
| 149881 | g:B0.5 | B0.5 III | BD +60°497 | d 07 | 07 V |
| 150898 | g+B0: | B0.5 Ia | +60°2522 | s 07 | 06.5 IIIef |
| 152233 | g 05 | 06 III (f) p | | | |

TD1 data have, however, the advantage of resulting from a survey and thus represent a magnitude-limited unbiased sample of bright stars whereas IUE is pointed only to preselected targets from accepted proposals, thereby providing

a highly biased sample, mainly towards earlier spectral types.

Most of the spectra we used have been retrieved from the low-dispersion IUE data base with preference given to trailed spectra. The existing gaps in the data were bridged as far as possible via observations performed during the very limited number of shifts allocated to this programme. The absolute flux calibration applied has been that of Bohlin & Holm (1980). The short- and long-wavelength spectra have been combined into a single file and the instrumental peaks around $\lambda 2200$ have been truncated. The geo-coronal Ly α lines have not been removed, since some contain a stellar component.

THE ULTRAVIOLET SPECTRAL TYPE

We tried to produce natural sequences of standard stars in which the features transit smoothly from one standard to the next, staying however as far as possible within the general MK frame. This has been done essentially by a morphological approach described in the atlas introduction (see also Jaschek & Jaschek, 1984) and confirmed by an independent statistical process (Egret et al., 1984). To avoid confusion with the MK system, a set of designations gathered in Table 1 have been introduced. To illustrate the differences which may appear between MK and UV spectral sequences, we are listing in Table 2 the stars catalogued in the atlas with both classifications.

THE ATLAS

The body of the atlas consists of the presentation of flux tables (left-hand pages) and the corresponding composite graphs (right-hand pages) for 229 stars, most of them exhibiting a normal behavior in the ultraviolet range. A few peculiar stars have, however, been included to illustrate typical abnormalities. Adjacent to the graphs are the identifications of the IUE images used, as well as basic astronomical data retrieved from the SIMBAD data base at the Strasbourg Stellar Data Center. A set of 34 transparencies are also provided for the most representative standard stars, to allow direct comparison with the spectra and easy illustration of the spectral sequences.

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Note: The atlas can be ordered (ref. ESA SP-1052) from the Scientific and Technical Publications Branch, ESTEC, Postbus 299, NL-2200 AG Noordwijk, The Netherlands. A magnetic-tape copy of all the spectra pertaining to the atlas is available (ref. 3083) from the Centre de Données Stellaires, Observatoire Astronomique, 11 rue de l'Université, F-67000 Strasbourg, France.