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A Spectral Atlas of F and G Stars *

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Abstract We present an atlas of a group of bright stars in the range of spectral classes F–G and luminosity classes I–V. The spectra were obtained with spectral resolution $R \sim 15\,000$ within spectral region 4500–6620 Å. Typical spectra of stars with different metallicity [Fe/H] are included. We also show the digital version of the spectral data in FITS format.

Key words: stars: atlas — stars: spectral class — stars: F-G type

1 INTRODUCTION

The photographic era in stellar spectroscopy has given a wealth of information, mainly in the blue wavelength region. The well-known MK two-dimensional spectral classification is just based on the stellar spectra in the blue wavelength region. The CCD era of stellar spectroscopy started observations in the red wavelength region. Early CCD spectra were obtained with classical coudé spectrographs but including only short fragments of spectra. After the realization of the echelle spectrographs combined with CCD system, it has become practicable to compile atlases of stellar spectra (e.g., the library of fiber echelle spectra developed by Montes et al. (1999)).

In the course of fulfilment of numerous observing programs at the 6-meter telescope several spectral atlases were compiled (Kipper & Klochkova 1987; Chentsov et al. 1997, 1999, 2002). In the following we present spectral atlases for a group of F-G stars.

2 OBSERVATIONS AND REDUCTION PROCEDURE

A sample of bright F–G stars with low values of projected rotation velocity ($v \sin i$) were observed with the prime focus echelle spectrograph (PFES, Panchuk et al. 1998) of the 6-meter telescope of Special Astrophysical Observatory, Russian Academy of Sciences. The spectrometer PFES provides spectral resolution of the order $R \sim 15\,000$ over a large spectral region. The signal-to-noise ratio in all the spectra taken is higher than 200. A Th-Ar lamp was used for the wavelength calibration.

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Table 1 Basic Data of the Program Stars

Star	HR	MK	$v \sin i$ (km s^{-1})
γ Vir	4825	F0V	30
ϕ Cas	382	F0Ia	27
σ Boo	5447	F2V	3
41 Cyg	7834	F5Iab	13
τ Boo	5185	F6IV	14
γ Ser	5933	F6IV	8
α UMi	424	F7:Ib-IIvar	17
99 Her	6775	F7V	3
θ Boo	5404	F7V	34
γ Cyg	7796	F8Iab	20
o Aql	7560	F8V	<6
HD 176051	7662	F9V	4
β Cam	1603	GIIb-II	19
η Boo	5235	G0IV	13
β CVn	4785	G0V	<3
α Sge	7479	G1II	0
24 Cep	8468	G7II-III	<19
μ Peg	8684	G8III	7
β Aql	7602	G8IV	<16
ξ Boo	5544	G8V	3

In Tables 1 and 2 the basic data of the program stars are listed. The successive columns of Table 1 are, the name of the star, its HR number, its spectral class Sp, and the value of the projected rotation velocity $v \sin i$ taken from Hoffleit et al. (1995); the columns of Table 2 are, the name of the star, its spectral class Sp, and its metallicity [Fe/H] given by Cayrel et al. (2001) or from our original determinations for some of the objects.

Table 2 Basic Data of the Program Stars in Figs. 1–3

Star	MK	[Fe/H]
HD176051	F9V	0.0
G27–44	F8	–0.8
G188–22	F8	–1.2
BD+36 2165	G0	–1.5
BD–15 2546	F6	–1.8
G201–5	F6	–2.0
HD140283	F3	–2.3

Two-dimensional CCD spectra were reduced in the environment of the standard MIDAS echelle package. The reduction consists of the order identification, background subtraction, removing cosmic traces, extraction of echelle orders, and linearization. Extracted echelle-orders were shifted in wavelengths in order to take into account the values of radial velocity of individual stars. It means that there is no information on radial velocities in the atlas. It should be noted here that the edges of each order were trimmed off and not used for the atlas because of the decreased signal-to-noise ratio.

3 DESCRIPTION OF THE ATLAS

The normalized portions of the 16 spectral orders for each star are presented (the interested readers can find or download the figures of the spectral atlases in FITS format at http://chjaa.bao.ac.cn). All spectral portions for each order are shifted on the ordinate by 0.75 units in the continuum level. The stars in these figures are arranged in the same order as in Tables 1 and 2. Each spectral order occupied two panels in the atlas: the panel "a" contains spectra of 10 stars from the upper part in Table 1, and the panel "b", the 10 stars from the lower one. Spectral orders with m < 36 are contaminated by rich telluric spectrum, and are not included in the atlas. Vertical arrows in the figures mark selected features.

4 EFFECTS OF THE DIFFERENT PARAMETERS

The selection of stars for the atlas was intended to include all the main factors operating in a stellar spectrum: effective temperature, luminosity, rotation and metallicity.

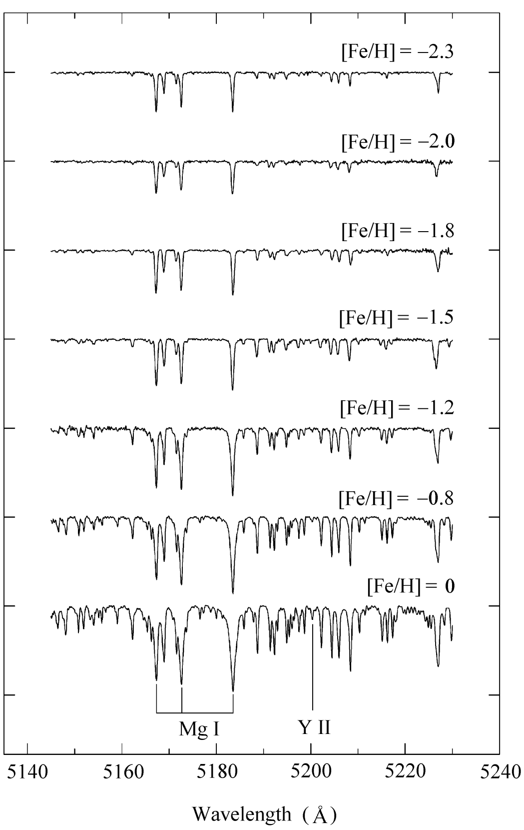

Fig. 1 A portion of the spectral atlas including Mg b triplets for selected stars with different metallicities.

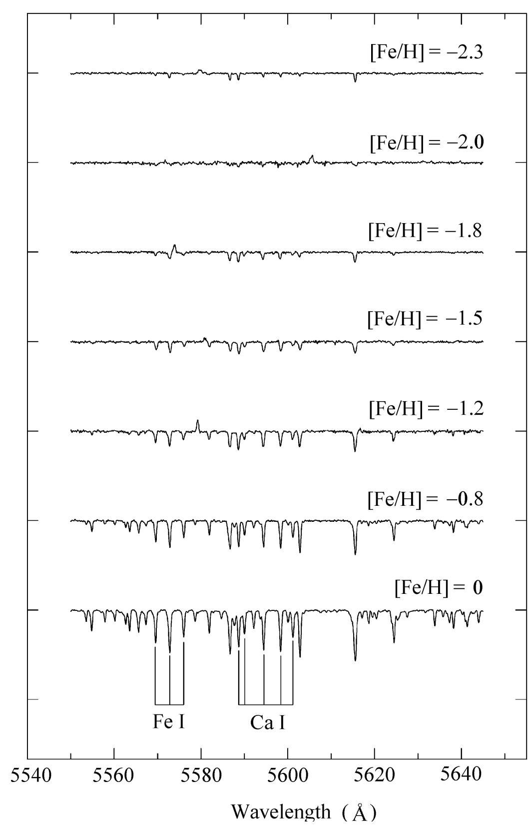

Fig. 2 A portion of the spectral atlas including some strong Ca I lines for selected stars with different metallicities.

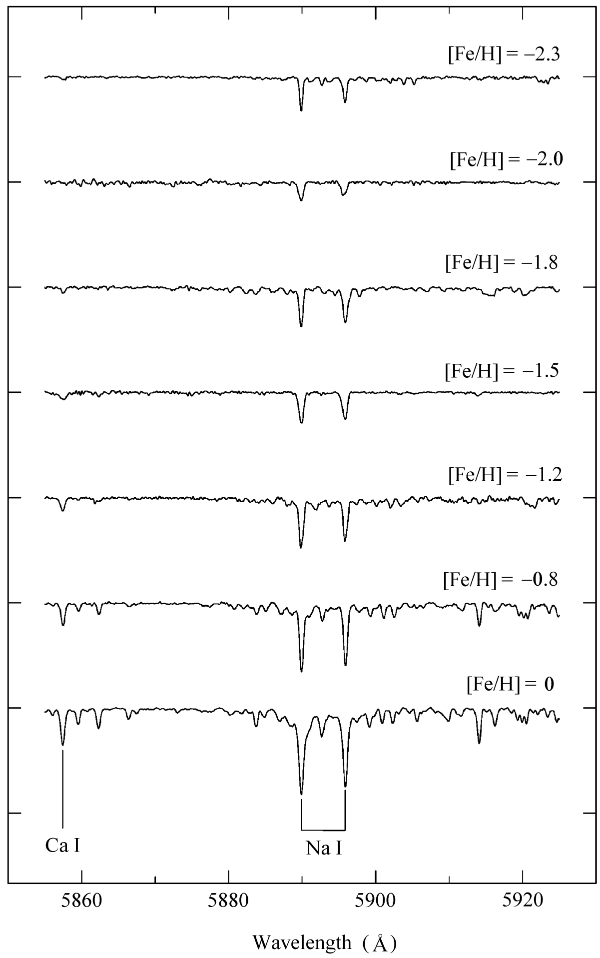

Fig. 3 A portion of the spectral atlas including Na I D lines for selected stars with different metallicities.

In order to illustrate the temperature effects we selected the four sequences of spectral classes:

FOV, F2V, F7V, F8V, F9V, G0V, G8V

F6IV, G0IV, G8IV

F7Ib-II, G0II-IIb, G1II, G7II-III, G8III

F0Ia-F5Iab-F8Iab

The luminosity effects could be considered with following five sequences of spectral classes:

F0V, F0Ia

F7V, F7Ib-II

F8V, F8Iab
G0V, G0IV, G0II-III
G8V, G8IV, G8III

The effects of rotation could be seen from comparison of the spectra of the following pairs:

F6IV, $v \sin i = 8$ and 14 km s^{-1}.
F7V, $v \sin i = 3$ and 34 km s^{-1}.

Metallicity effects are shown in Figs. 1–3 for some selected orders separately.

This homogeneous sample of stellar spectra over a large range of stellar parameters would be of benefit for the studies of the galactic and extragalactic sources. For example, it can be used as a useful tool for population and evolutionary synthesis of stellar clusters and galaxies and for the theoretical study of stellar atmospheres, as well as serving the traditional astrophysical task of spectral classification.

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References

Cayrel de Strobel G., Soubrian C., Ralite N., 2001, A&A, 373, 159
Chentsov E. L., Klochkova V. G., Mal'kova G. A., 1997, Bull. Special Astrophys. Obs., 43, 18
Chentsov E. L., Klochkova V. G., Tavolganskaya N. S., 1999, Bull. Special Astrophys. Obs., 48, 25
Chentsov E. L., Ermakov S. V., Klochkova V. G., Panchuk V. E., Bjorkman K., 2002, A&A, submitted
Hoffleit D., Jaschek W. H., 1991, The Bright Star Catalogue, 5th Revised Edition, Astronomical Data Center, NSSDC/ADC
Kipper T., Klochkova V. G., An atlas of the spectrum of Aldebaran 4000–6720Å Tallinn. Valgus. 1987
Klochkova V. G., Topilskaya G. P., 1996, Bull. Special Astrophys. Obs., 41, 52
Montes D., Ramsey L. W., Welty A. D., 1999, ApJS, 123, 283
Panchuk V. E., Najdenov I. D., Klochkova V. G. et al., 1998, Bull. Special Astrophys. Obs., 44, 127