THE PROBLEMS OF DETERMINATION OF ABUNDANCES IN ATMOSPHERES OF K GIANT STARS

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ABSTRACT. The influence of effective temperatures, of surface gravities, of metallicities, of microturbulent velocities as well as of effects non-LTE, of starspotting, of chromosphere, corona and wind, of different nonthermal mechanisms on determination of abundances in atmospheres of cool stars have been discussed briefly.

Key words: Cool giant stars, abundances

The goal of new astrophysics is testing of theories of nucleosynthesis and stellar evolution, chemical and dynamic evolution of the Galaxy based upon data of abundances of chemical elements in diverse object of the Galaxy. In particular, it is necessary to know about abundances of chemical elements and their isotopes in the atmospheres of stars different masses which have passed through this or that stage of evolution. The evolution of abundances are passing prestar - PS, main sequence - MS, first (second etc.) red giant branch - F(S etc.)RGB, horizontal blue or red giant branch - HBGB or HRGB, asymptotic giant branch - AGB, first or second types supernova - I SN or II SN, planetary nebulae - PN and black hole - BH or white dwarf - WD.

So, there are at least four types of stars responsible for abundances of nuclides in the Galaxy (in all the Universe). Their contribution is suggested to change with the Galaxy age, and with that merely partial matter mixing can be expected due to SNI,SNII,N and AGB contribution, and therefore stars of the given metallicity can have various abundances of other elements,in particular,elements of α-process.This problem is discussed in the most perfect and detailed way by B.Edvardson et al. (1993).

It is clear if the mass loss occurs on early stage lifetime stars on MS that composition of interstar medium will be almost equal to the composition of the initial protostar material.

90% time of life the stars find in phase of MS. Then the red giant phase is last for the majority of stars in which the outer parts expand and cool, while interior slowly transforms into a hot, compact object (a future WD). On small and intermediate masses the core these stars will slowly cool and undergo no nuclear processing. The first time in their life on FBI material processed nucleosynthesis is possibly mix with the material of surface (abundance of Li, Be, B, Na in atmospheres giants and supergiants). Then they become more cool and more luminous (more little value of surface gravity) and material with new chemical composition must be get into space. Such stars have an initial mass - $M_*^i \approx$1-8$M_\odot$. The observed masses of WD are 0.55$M_\odot$. It means that 97% of all mass interstellar medium comes from low and intermediate mass stars! Only 3% comes from supernova and mass loss from high mass stars. The end such star is outburst type 1 SN. The AGB stars are little to comparison with F(S etc.)RGB stars. IT is clear importance of determination of abundances in atmospheres of G,K,M giant on stage FROG.

In last time is euphoria about accuracy in determination of abundances with using of model atmospheres.The model of star is only the model and nothing more that. The surface of real stars may significant different from model the same as of structure of their outer layers. It is caused not only simplifications by calculation of model of atmospheres:

- plane or spherical geometry;
- local thermodynamic equilibrium;
- various methods of average of coefficient of absorption by frequency
- two-stream mixing-length theory of convection;
- and so on.

but and of real active processes on surface or in outer layers (chromosphere, corona, wind).

The quality of determination of abundances in atmospheres stars must be connected with problems of possible influence of fundamental characteristics of atmospheres of stars as well as of effects:

- non-LTE;
- rotation;
- chromosphere, corona and wind;
- starspotting;
- fluorescence;
- nonthermal of transfer of energy.

The inversion temperature in outer layers of atmospheres giants (Komarov & Shevchuk, 1995) and the short-term fluctuations of emission lines such as MgII (Cuntz et al.,1995) can to support this conclusion. The influence of chromosphere activity effects on determined abundance Li can been demonstrated. The abundances derived from the 6104Å LiI and 6708Å LiI line show discrepancy in spread because they have different depth of formation. It is noted that chromospheric effect is opposite to the model predict: the abundance Li derived on line 6708Å is more than the one derived on line 6104Å. But line 6104 is formed deeper in stellar atmosphere and one is freer from chromospheric effects! It means that the abundances Li derived on line 6708Å is set too high.

The two rules of abundance analysis have:

- use weak lines, where line strength is proportional to abundance;
- work with the main stage of ionization.

These rules minimize the effects of errors in the model, in the damping treatment, in microturbulent velocity.

But often it is necessary to determinate of abundances to use one or to lines of various strength. Their equivalent width depend on microturbulent velocity and value of damping. These parameters determine very bad. The influence of effective temperature, surface gravity we shall see on example of determination of abundance of Na. The analysis of mistakes shown if $\Delta T \leq \pm 250K$, $\Delta \log g \leq \pm 0.25$, $\Delta[Fe/H] \leq \pm 0.2$ and $\Delta\xi_t \leq \pm 0.15$ then $\Delta\varepsilon(Na) \leq \pm 0.25$dex. We must emphasize that method of estimation of right determination of abundances in result non-precision knowledge of fundamental characteristic is purely formal. That characteristics cannot determine of structure of real star so as model of atmosphere of star!

The spectrum of a cool star consists of many thousands of blended lines. The blend are difficult to interpret even of infinite resolution and signal-to noise. But even the device with high signal-to noise detectors and with high resolution spectrographs have two ignored factors:

- the instrumental profile;
- scattered light.

The instrumental profile of any spectrograph give information about the degradation of the real spectra. The projected slit width is independent and instrumental profile is almost constant. But unfortunately ghosts are in strength as the square of the order and they are due to to periodic ruling errors of gratings. The interference of the different systems of ghosts can produce ghosts far from their parent lines.

Scattered light fills in absorption lines and thus produce systematic errors in the profile. The instrumental profile is measured to use a source with narrow lines (Griffin,1968). The instrumental profile width may change by 10% for various time of observing and region of spectra. The importance of accurate determination of the instrumental profile and the scattered light is very necessary especially at very high S/N.

The ~30% all lines of absorption FeI usually is threw because the abundances determined by this lines are very different from mean value. Why? On Fig.1-3 the scatter of abundances FeI from wavelength for star HD 73710, HD 95689, HD 107328 are given.

Therefore, it is necessary to carefully analyze the structure of a lower level of every absorption line, otherwise can several times overestimate the abundance of element. In the case

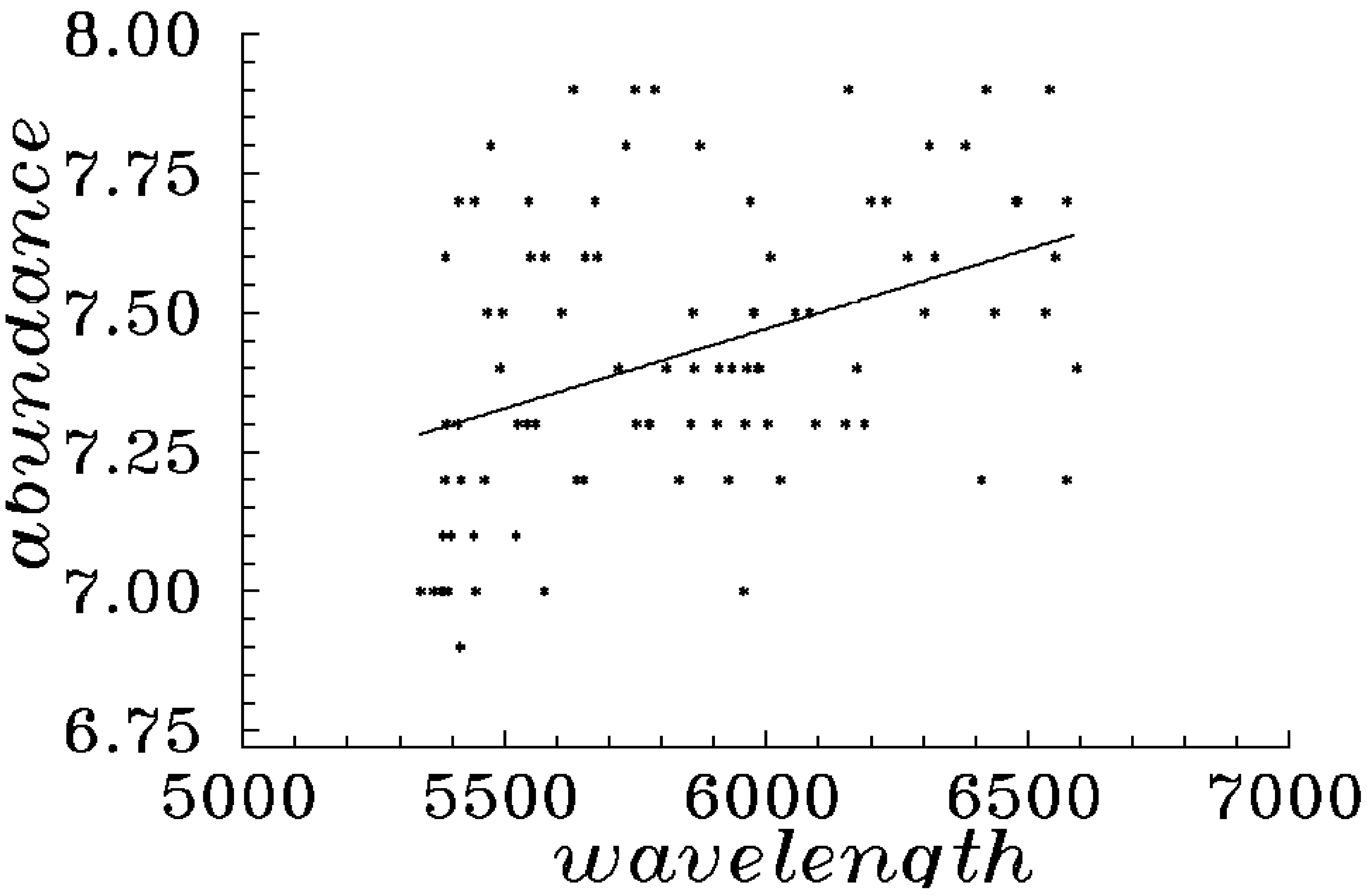

Figure 1. The dependence of abundances ε(Fe) of wavelength λ for star HD 73710.

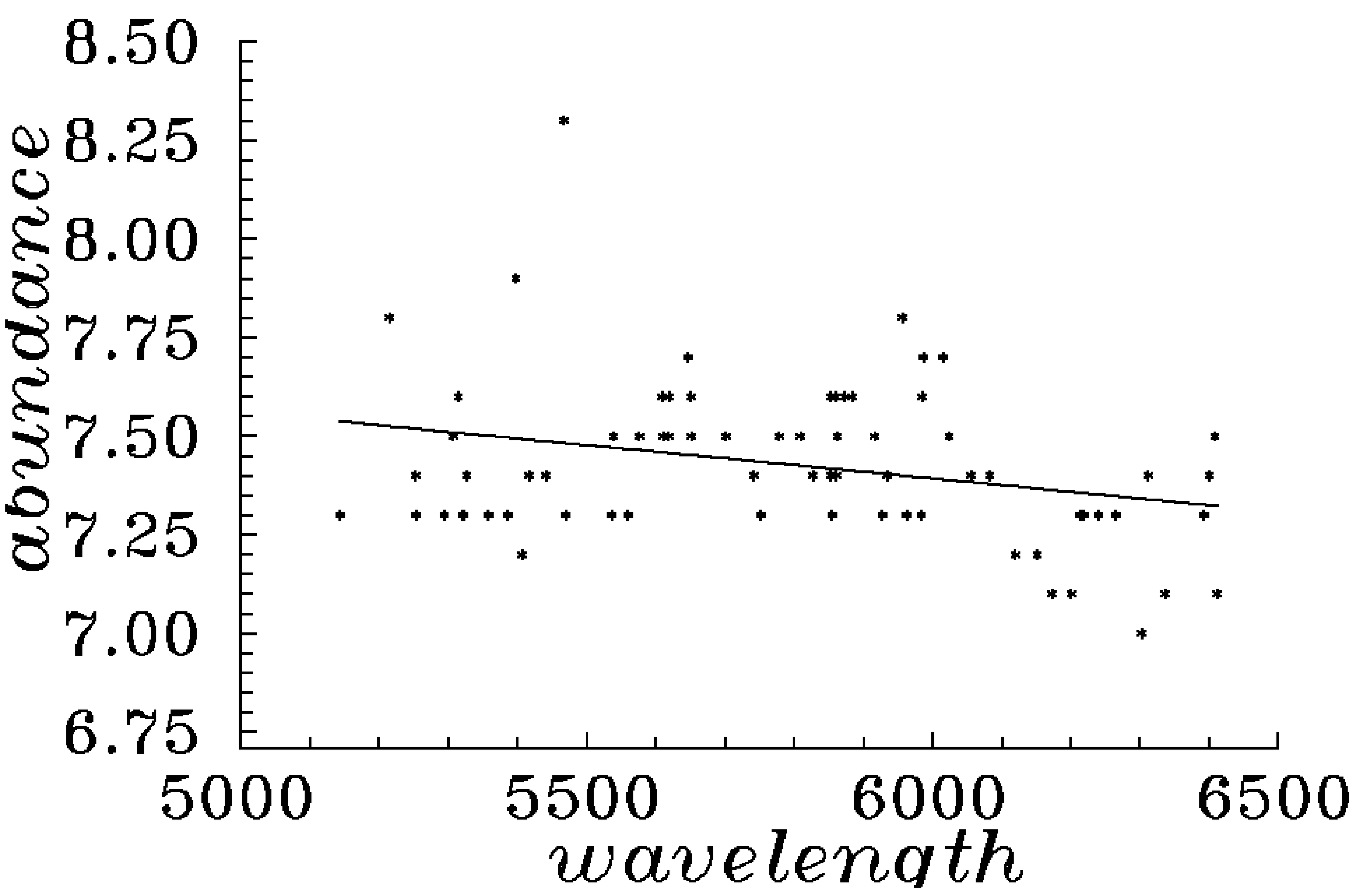

Figure 2. The dependence of abundances ε(Fe) of wavelength λ for star HD 95689.

of isotopic shift it is necessary to take account of abundance of table isotopes of a certain chemical element. For the elements of iron group the isotopic shift is occurred since isotopes of elements ^{52}Cr, ^{55}Mn, ^{56}Fe, ^{59}Co, ^{58}Ni are primarily observed.

For elements with odd Z the hyperfine structure of atomic levels is probable. Abundance ratios of isotopes of elements C, O, Ng, Al, Si, Ca, Ti, Zr can differ from those of the Earth and give information on their nuclear process resulting from the addition of α - particles and neutrons. The readers will be referred

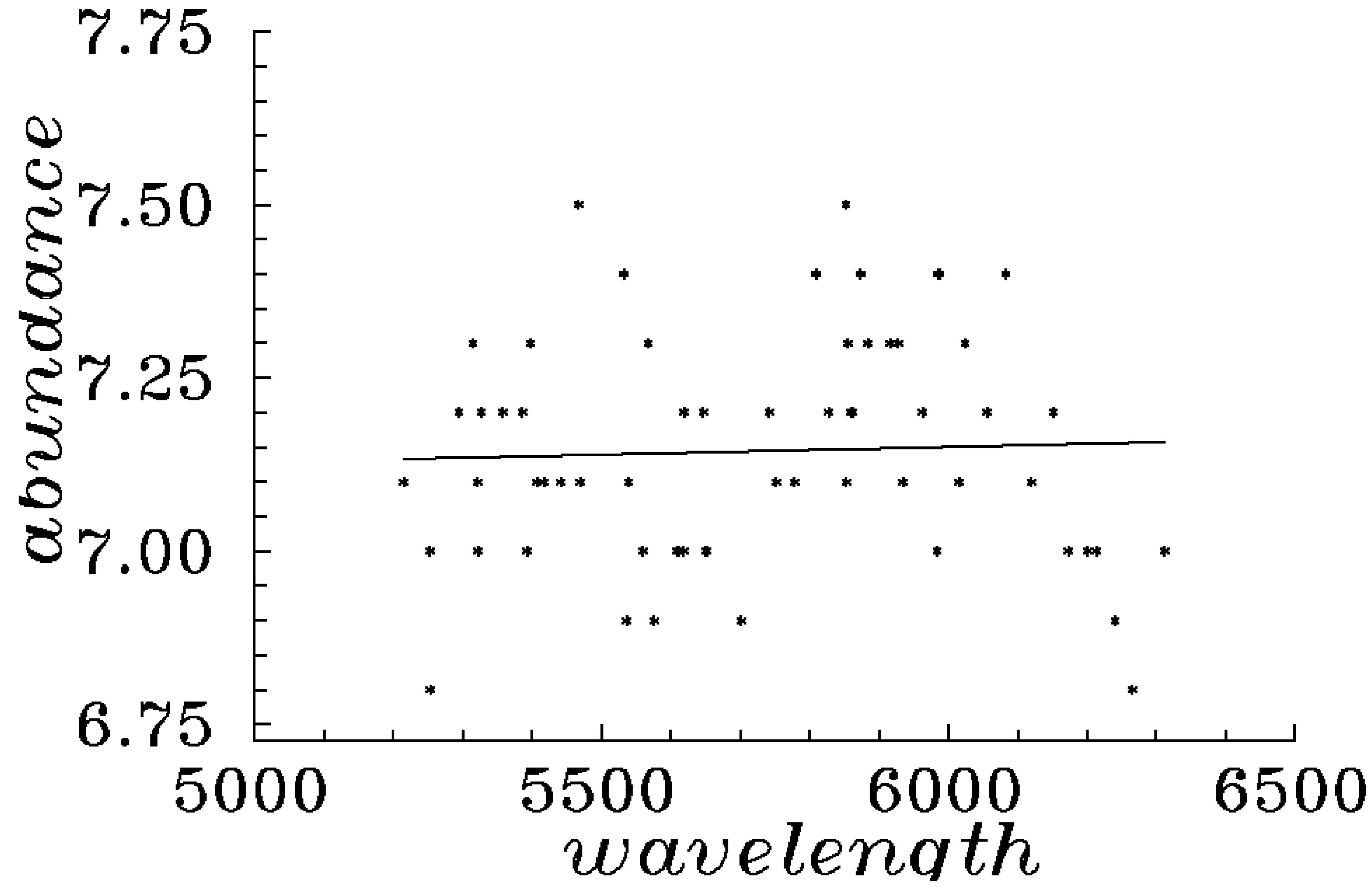

Figure 3. The dependence of abundances ε(Fe) of wavelength λ for star HD 107328.

to capital reviews by T.Gehren (1988). The mixture of all stable and unstable isotopes is in stellar matter. It means that it is only asymmetric lines in spectra of cool stars because they have all isotopic and hyperfine components. The splitting may cause the errors in results:

- the use of bisectors to determine equivalent widths, microturbulent velocities;
- the use Fourier analysis of line profiles to determine of velocity fields;
- to overestimate of damping constants;
- of mistakes to determine of wavelengths;
- to overestimate of equivalent widths.

The Doppler width and Voigt profile of each isotopes are different. We can to make of mistake to use of Gaussian in the capacity of instrumental profile.

Reference

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