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HYPERFINE FIELD DISTRIBUTION OF $Fe_{83}B_{17}$ GLASSY METAL[1])

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Convolutions of Gaussian and Lorentzian lines are proposed to fit a Mössbauer spectrum of a $Fe_{83}B_{17}$ metallic glass. The hyperfine field distribution is constructed from three Gaussian lines corresponding to the individual line pairs.

I. INTRODUCTION

The Mössbauer effect is very sensitive to local structure and chemical fluctuations resulting in distributions of hyperfine interactions. Great attention is paid to the hyperfine field distribution (HFD) which is one order of magnitude more sensitive to changes in the nearest surroundings of the resonant atoms than the isomer shift and the quadrupole interaction. Up to now several methods have been proposed for extracting HFDs from Mössbauer spectra [1] using a variety of line fittings [2]. The aim of the present paper is to propose a new way of a HFD determination based on the results of a direct experimental data lineshape analysis.

II. EXPERIMENTAL

Amorphous $Fe_{83}B_{17}$ ribbons (6 mm wide, 33 μm thick) were prepared by the method of planar flow casting at the Institute of Physics, Electro-Physical Research Centre, Slovak Academy of Sciences in Bratislava. A conventional constant acceleration Mössbauer spectrometer with $^{57}Co(Rh)$ source was used to collect data at room temperature.

III. RESULTS AND DISCUSSION

Broad and overlapped dips in a Mössbauer spectrum of a metallic glass reflect a real image among hyperfine interactions affecting the resonant atoms placed in non-equivalent sites. In order to find the proper lineshape a method

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of DISPA-PLOTs [3] was used. Its applicability for the purpose of a Mössbauer lineshape analysis including verification has been described elsewhere [4]. According to the DISPA analysis of the experimental points of a Mössbauer spectrum of the $Fe_{83}B_{17}$ metallic glass a convolution of a Gaussian and an experimental-width Lorentzian was proposed to express the line-broadening mechanism [4, 5]. Similar profiles were applied to fit the Mössbauer spectra of metallic glasses, e.g., by Lines and Ebischütz [6] but no direct connection between the experimental and the simulated lineshapes was given. Thus, the Mössbauer spectrum can be fitted by sums of Lorentzian lines weighted by Gaussian distributions in peak positions [5].

A mean value of a hyperfine magnetic field intensity is directly proportional to a separation of individual Mössbauer lines corresponding to $\pm 3/2 \rightarrow \pm 1/2$, $\pm 1/2 \rightarrow \pm 1/2$ and $\pm 1/2 \rightarrow \mp 1/2$ transmissions. Consequently, the assumed fitting profiles imply a Gaussian distribution of the field values.

Parameters of the Gaussian distribution for a $\pm 3/2 \rightarrow \pm 1/2$ transmission (i.e. for the 1st and the 6th Mössbauer lines) were achieved directly from the approximation. To obtain the parameters for the rest of the transmissions, represented by the line pairs 2—5 and 3—4, the results of the fit were scaled by the constants of 0.5787 and 0.1574, respectively, due to g-factor combinations. The HFD of $Fe_{83}B_{17}$ was constructed as a sum of such three Gaussian lines. Partial distributions were weighted with respect to the probability of the corresponding transmissions derived from the line areas.

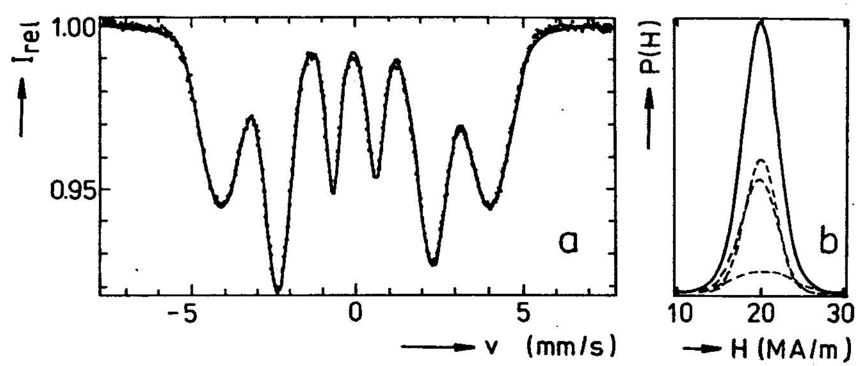

Fig. 1. a) Mössbauer spectrum (full dots) fitted by convolutions of Gaussian and Lorentzian lines (solid curve) and b) corresponding hyperfine field distribution $P(H)$ (partial distributions dashed) for $Fe_{83}B_{17}$ glassy metal.

Fig. 1 illustrates a room temperature Mössbauer spectrum of the $Fe_{83}B_{17}$ glassy metal with the corresponding HFD. The parameters of the HFD are as follows: $\bar{H} = (19.94 \pm 0.08)$ MAm^{-1}, $\Delta H = (5.03 \pm 0.08)$ MAm^{-1}, $\sigma_H =$

$= (2.48 \pm 0.08)\ \mathrm{MAm^{-1}}$, $\sigma_H/\bar{H} = 0.12$. According to [1] the $\sigma_H/\bar{H}$-ratio for Fe—B system is 0.12 and the ΔH for the $Fe_{83.8}B_{16.2}$ matellic glass was determined in [7] to be $(5.01 \pm 0.08)\ \mathrm{MAm^{-1}}$.

IV. CONCLUSION

The application of the experimental data lineshape analysis can be considered as a progressive feature of the present approach to the HFD determination. However, a further study should be carried out as far as other hyperfine parameters are concerned.

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РАСПРЕДЕЛЕНИЕ СВЕРХТОНКОГО ПОЛЯ В МЕТАЛЛИЧЕСКОМ СТЕКЛЕ $Fe_{83}B_{17}$

Три линии Гаусса, относящиеся к переходам $\Delta m_I = 0, \pm 1$ в спектре Мессбауера, образуют распределение сверхтонкого поля в металлическом стекле $Fe_{83}B_{17}$.