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Mössbauer Spectroscopy under Acoustical Excitation: Thick Target Effects

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An essential modification of the Mössbauer response model for experiments using an absorption scheme and acoustical excitation regime is proposed. These corrections are stimulated by the basic theoretical principles of the Mössbauer forward scattering (FS) phenomenon in the ultrasound (US) field [1-3]: as the formation of superposition states of Mössbauer radiation and the interference of FS Raman amplitudes. The new model is the only one for correct describing US effects in the case of Mössbauer targets with large thickness. This model should be used as a tool of fitting procedure of non-typical Mössbauer experiments under US excitation, which differ from traditional ones by effective thickness of the target or its structure. The results of the fitting of two such experiments (Fe57), specially undertaken to demonstrate their new information possibilities, are presented in the report. In the first experiment stainless steel with an effective thickness of ~ 5.18 was used as a target. In the second one, an enriched $K_4Fe(CN)_6 3H_2O$ with an effective thickness of ~ 13.2, grinded in a mortar and mixed with sugar powder was used as granular sructure target.

The fitting of obtained experimental data includes also the averaging of the model spectra using the distribution function for the modulation index as it was done in previous papers [4]. We consider our model as a return to the investigation of US modulation of Mössbauer spectra based on a modified model, in order to study new possibilities of thick target experiments. The performed fitting of control experiments confirms the advisability of the model changes we have made. It also demonstrates the application possibilities of the model under consideration.

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