When the direction of magnetization matters structure of multilayers revealed by nuclear magnetometry

F. Tanczikó, L. Bottyán, L. Deák, M. Major, D.L. Nagy
KFKI Research Institute for Particle and Nuclear Physics, Budapest, H-1525 P.O.B. 49 Hungary

The knowledge of the *direction* (i.e., both the *alignment* and *sign*) of the magnetization in a minute part of a sample may be of great importance. In a magnetic storage device, for example, the elemental piece of information is the direction of the film magnetization, **M**. The scattering amplitude being dependent on the angle of the wave vector **k** and the hyperfine field, $\mathbf{H}_{hf}$ (related to **M**), Mössbauer spectroscopy (MS) and nuclear resonant scattering (NRS), methods of the present study, are exquisite tools to determine the magnetization *direction* of buried layers using both conventional Mössbauer and synchrotron radiation (SR) source.

By linearly polarized -radiation (case of the transversal Zeeman effect), the alignment *may*, but the *sign* of the magnetization *cannot* be retrieved ([1] and references therein). By *circularly polarized -photons* (longitudinal Zeeman effect) in the **k**-parallel case sign sensitivity, however, can be achieved. Resonant filter techniques [2,3] may result in simpler spectra, but are rendered more difficult by the hardly avoidable granularity of the filter. Conversely, the multiline source solution [4] applied in the present study, uses the full source activity and especially combined with proper data analysis [5] also unambiguously determines the magnetization direction *via the spectrum pattern*. Principles, together with ^{57}Fe experimental results achieved by energy-domain (transmission and conversion electron Mössbauer CEM) and time-domain (NRS of SR) spectroscopies will be presented. Special attention will be paid to thin-film samples and *circular Mössbauer polarimetry*, which was combined with CEMS for the first time. Concepts are demonstrated on -Fe spectra. Coherence aspects of the scattering will also be presented.

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