Abstract

A velocity control system to operate the Mossbauer spectrometer in constant acceleration mode was designed and fabricated. The system was made operational in conjunction with the multichannel analyser used for data. The design details of the system are presented.

The thesis consists of two distinct parts, first part is related to the theoretical analysis and the second part is related to the experimental results. The theoretical portion deals with the unique properties of the nuclear multipole radiations in single crystals and the specific example being the $M_1$-multipole radiation of $^{151}$Eu. It is shown that the individual nuclear transitions can be utilised for the evaluation of nuclear hyperfine field parameters. Since these interactions admix the nuclear sub-levels, the polarization distribution of the Mossbauer radiation could be an effective tool for probing the microscopic fields.

With this aim and using the multipole theory, it is shown that the angular distribution as well as the polarization measurements of the $r$-rays in Mossbauer resonance are extremely sensitive to "orientation parameters". We have employed dematrix formulas for the transformation of the angular distribution functions from the principal axis system to the crystal fixed axis system.

It has been shown through detail calculations that the distributions of Mossbauer resonance line shapes in microcrystal are due to finite-size effects on the $f$-factor.

The Mossbauer spectra of certain organo-metallic complexes containing $^{151}$Eu have been measured and analysed for nuclear hyperfine parameters.