Coherent Inelastic Moessbauer Scattering of Synchrotron Radiation

V. A. Belyakov

L. D. Landau Institute for Theoretical Physics, Kosygin str.2, 117334 Moscow, Russia

Recent success of coherent elastic [1] and incoherent inelastic [2] Moessbauer scattering of synchrotron radiation (SR) in investigations of very delicate properties of the condensed matter makes also urgent performing of experiments on coherent inelastic Moessbauer scattering (CIMS) of synchrotron radiation (Common meaning of the term CIMS is coherent inelastic Moessbauer scattering accompanied by creation or annihilation of phonons in the crystal lattice, i.e. by very low energy losses of SR quanta). However up to now there were no publications on experimental observation of CIMS so there is a need in theoretical investigations revealing most favorable conditions for CIMS observation. The theory of CIMS is presented below and applied to specific processes of CIMS such as forward scattering, scattering at grazing incidence angles, scattering via a cascade of Moessbauer transitions. It is shown that the phase matching (between the incident and scattered beam) is very important for the angular and frequency distribution in CIMS and processes where phase-matching can be reached are the best candidates for CIMS experimental investigations. The performed analysis shows that because of the phase-matching demands the forward CIMS is suppressed significantly in comparison with the coherent elastic Moessbauer scattering [3] and more favorable for observation is CIMS at nonzero scattering angle. Some examples of CIMS specific geometries are discussed. In particular, it is shown that for the grazing CIMS at isotope interface (a plane interface between regions with different abundance of the Moessbauer isotope) there is enhancement of CIMS at the critical angle of total reflection and suppression of CIMS at angles below the critical one [4]. Another possibility of CIMS in more general meaning of the term is Moessbauer scattering of SR via a cascade of Moessbauer transitions (CIMC) which is connected with huge losses of energy by SR quanta in the process [5]. Analysis of CIMC for the two transitions cascade in Fe57 and the corresponding calculations are presented. Optimal conditions of experimental observation for various cases of CIMS are discussed.

References

[2] ibid, chapt. 5.

Submitting author: V. A. Belyakov, e-mail: bel@landau.ac.ru