Nuclear Resonant Scattering

D. Bessas*, D. G. Merkel, A. Chumakov, R. Rüffer
European Synchrotron Radiation Facility, F-38043 Grenoble, France

Nuclear resonant scattering is an experimental technique which is directly related to interdisciplinary applications such as magnetism and lattice dynamics. It is comprised into the excitation of nuclei by synchrotron radiation from the nuclear ground state into a nuclear excited state. The finite energy width of the excited state corresponds to a finite lifetime. Hence, the resonantly scattered photons are delayed with respect to the non-resonantly scattered (prompt) photons. The delayed events are separated from the prompt pulse using fast electronics. Both coherently [1], Nuclear Forward Scattering and incoherently [2], Nuclear Inelastic Scattering, scattered radiation are observed simultaneously and are recorded by two sets of avalanche photo diodes.

On one hand, the Nuclear Forward Scattering of synchrotron radiation [3, 4] provides information similar to Mössbauer spectroscopy [5] (energy domain), *i.e.*, isomer shift, electric field gradient and hyperfine magnetic field, in time domain. This technique is particularly useful when preparation of the radioactive source for Mössbauer spectroscopy is difficult, when the lifetime of the radioactive source is short, or when the experimental setup requires a collimated or a small-size beam. The typical lifetime of the excited states ranges between 0.2 and 200 ns and matches the bunch structure of the current synchrotron radiation facilities. Hence, the Nuclear Forward Scattering can, in principle, be measured for any of the Mössbauer isotopes.

On the other hand, the Nuclear Inelastic Scattering [6, 7] of synchrotron radiation is an inelastic X-ray scattering technique resonant in nature. The resonant nuclei, which might/or not be included in the studied system, act as an energy analyser and the scattered radiation is purely incoherent. Thus, the measured energy distribution of the nuclear inelastic absorption is integrated over the momentum transfer and the *true* density of phonon states is extracted. This technique is particularly useful when the *true* partial or total density of phonon states, the element specific inter-atomic mean force constant, and the speed of sound, is of interest, or when sub-meV resolution along the spectrum is required.

In this poster, the experimental setup of nuclear resonant scattering will be explained, state of the art results obtained at ID18/ESRF [8] will be presented, and hints on future studies and collaborations will be given.

References

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* bessas@esrf.fr