Nuclear Resonance Scattering of Synchrotron Radiation at the ^{193}Ir Resonance and Fast Detectors

In this presentation we will give an overview on the recently established nuclear resonance scattering of synchrotron radiation at the ^{193}Ir resonance at an x-ray energy of 72.9 keV. This research was triggered by the ongoing interest on electronic properties in strontium iridates, especially the arrangement of local magnetic moments. The 72.9 keV transition of the ^{193}Ir nucleus is a mixed M1/E2 transition, which can give valuable additional information on the arrangement of hyperfine fields as compared to the pure M1 transition.

In order to perform NFS experiments at 72.9 keV we developed two medium resolution monochromators adapted to the asymmetric Si (3 1 1) reflection of the cryogenically cooled high heat load monochromator: A two-crystal monochromator (asymmetrically cut Si(4 4 0) and Si(6 4 2) crystals) and a four-crystal monochromator arranged as two nested channel cut crystals (asymmetrically cut Si(4 2 2) and Si(8 0 0) crystals). In both cases we achieved an energy resolution of about 150 … 170 meV.

After proof of principle by measuring NFS time spectra of pure magnetic and electric hyperfine interaction, as well as relative isomer shift, we investigated magnetic properties of Sr_2IrO_4 and electronic properties of iridium-chlorine bioinorganic materials. Most experiments were performed at low temperature < 10 K, in order to increase the Lamb-Mössbauer factor.

One key requirement was the availability of a fast (500 ps time resolution) and reasonably efficient detector for this energy. We followed an earlier development at the ESRF – ID18, i.e., a multi-element avalanche photo diode (APD) detector consisting of 16 Hamamatsu S5443 APDs, illuminated in grazing incidence. We achieved an efficiency of approx. 10 … 15% and could adapt to the vertical beam size by careful angular alignment.