Magnetoelastic Materials beyond Born-Oppenheimer Approximation

Nearly a century ago, the **Born–Oppenheimer approximation** simplified condensed matter physics by separating motion of nuclei and electrons. When this concept is violated, interactions between phonons and elementary excitations, such as plasmons, magnons or particle-hole pairs, lead to emergent functionalities such as multiferroic behaviour, polar order or superconductivity. These phenomena are usually rare and applicable to a limited number of compounds. In **our recent study**, we have demonstrated an abundance of magnetoelastic (ME) interactions in intermetallic cerium compound, revealing that the connection between electrons and one thousand times heavier atomic nuclei is far more common.

MaMBA aims to show that ME effects are a general property of solid-state physics and argues that the assumption of Born and Oppenheimer must be **thoroughly checked**. Due to the challenge of detecting ME modes, it was not realized before that the only direct method capable of doing so is through inelastic neutron scattering on a single crystal.

We believe that hidden ME modes are responsible for many unresolved problems, and its proper description will lead to rapid progress in the area. MaMBA seeks to experimentally exploit ME modes in a) heavy fermion materials, where unconventional superconductivity was discovered; b) Uranium ruthenium silicide with still unresolved “hidden order”, where ME correlations were proposed; and c) iron pnictides, where symmetry breaking is related to ME effects. A significant element of the project is the **development of a bespoke device, the Automatic Laue Sample Aligner (ALSA)**, for automatic single crystal alignment. We **will use our knowledge** of computer vision to drastically speed up the sample preparation process. The device will be truly revolutionary in the field of neutron spectroscopy and will have an immense impact **beyond the scope of MaMBA**.