Abstract: Multiferroic materials, in which spontaneous orderings (especially magnetic and electrical, in some cases elastic) jointly exist and may mutually interact, are currently in the center of attention in many fields of research due to their high application potential. They are already used in many applications, as in various sensors, microwave filters or electro / magneto-mechanical manipulators and actuators. Nevertheless, many features of microstructure and moment arrangements are not yet fully explained and understood.
The presented work is mostly experimental and focuses on the investigation of several promising multiferroic materials: $Pb_{1-x}Ba_x(Fe_{0.5}Nb_{0.5})O_3$ (x = 0 - 1) and $Pb(Fe_{0.5}Sb_{0.5})O_3$ with a perovskite structure and labeled as multiferroics of the I. type according to the Khomsky classification, BaYFeO4, which belongs to the multiferroics of the II. Khomsky class, and LiFePO4, which is a potentially multiferroic substance containing Fe^{2+} and are used in electric accumulators at present.
Mössbauer spectroscopy of the ^{57}Fe isotope was used as a key experimental method, which can provide new information about the local arrangement in the vicinity of resonantly absorbing nuclei in the investigated substances. Data evaluation and interpretation would not be possible without the using results of a number of other methods, such as X-ray or neutron structural analysis, electron microscopy, measurement of magnetic properties, nuclear magnetic resonance or X-ray absorption spectroscopy and also with the use of theoretical calculations of the electronic structure of the investigated substances. The valence and spin states of iron ions in individual lattice positions were derived from the temperature dependences of hyperfine parameters. The temperatures of phase transition and the type of magnetic arrangement in individual phases were determined on the basis of temperature dependences of hyperfine parameters and magnetic properties in wide temperature intervals. In the system Pb1 − xBax (Fe0.5Nb0.5) O3 (x = 0 - 1) this allowed the completion of the magnetic phase diagram in the whole range of mixing and Pb and Ba.