Abstract: This thesis if focused on the study of magnetic properties of three different uranium-based $5f$-electron compounds ($U_4Ru_7Ge_6$, UAu_2Si_2 and UIrGe). High quality single crystals of these systems were grown by various methods as a part of this work. Properties of these compounds were studied by multiple bulk methods (magnetization, specific heat, thermal expansion, electrical transport) and by neutron and x-ray diffraction under various external conditions (low temperature, high magnetic field, high pressure). Combination of these methods revealed complex behaviors of the systems and helped to construct their magnetic phase diagrams.

The first studied compound, $U_4Ru_7Ge_6$ is ferromagnet, that exhibits an extremely low magentocrystalline anisotropy, which is unexpected for uranium-based system. It is evidenced by very isotropic dependence of almost all measured physical quantities. It was found, that the magnetic easy axis is changed in the ordered state and such an effect is connected with anomalies in thermal expansion, pointing to a possible rhombohedral distortion. It leads to the creation of two different U sites with unequal magnetic moments. This prediction was confirmed by theoretical calculations and by polarized neutron diffraction. The difference of magnetic moments on two distinct U sites is caused by a small change in their local symmetry.

The second case investigated in this thesis is UAu_2Si_2. The first single crystals of this compound ever grown allowed us to shed more light on the previous inconsistent reports about its properties. Magnetization and magnetostriction measurements combined with neutron-diffraction experiments clearly confirm the uncompensated antiferromagnetic ground state together with the weak ferromagnetic component. High-field studies traced the phase boundary of the ground-state phase towards the tricritical point, where the transition changes from the first- towards the second-order type. Detailed thermal-expansion measurements revealed volume collapse in the ordered state together with the possible basal-plane distortion of the former tetragonal structure.

The last part is focused on the orthorhombic uranium-based antiferromagnet UIrGe. Thermal-expansion studies of this compound revealed strongly anisotropic lattice changes of all three principal axes of the unit cell below the Néel temperature. Its almost zero volume-change leads to very weak pressure dependence of the ordering temperature. An external magnetic field applied along the c axis has a strong effect on the antiferromagnetic ground-state structure and causes a metamagnetic transition. The Néel temperature of the compound is rapidly suppressed by higher fields, and signs for the presence of a tricritical point were also observed.