DESCRIPTION FOR THE GENERAL PUBLIC

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Critical behaviour in the Lifshitz point in UT_2M_2 phases, where *T* is a *d*-electron transition metal atom and *M* stands for Si or Ge atom

Uranium, the actinide metal, is the element with the highest atomic number that may be found on Earth (not taking into account traces of neptunium and plutonium). It is poorly radioactive. The best known application of the element is to use the ^{235}U isotope in the nuclear reactions. Nevertheless, the electronic properties of uranium are not less interesting. The partly filled 5*f*-electron shell is localized close to the Fermi energy and thus is less or more hybridized with the conduction band. That is the reason why U-based compounds exhibit wide range of physical properties. Since the discovery of ferromagnetism in uranium hydride by Włodzimierz Trzebiatowski in 1950s, the amazing properties of uranium have attracted lot of attention. In the U-based phases, there were observed different kinds of magnetic ordering (ferromagnetism, antiferromagnetism, ferrimagnetism etc.), unconventional superconductivity, coexistence of magnetic ordering and superconducting state, or dual nature of 5*f*- electronic states (both localized and itinerant).

In this project, it is planned to investigate intriguing hypothesis of occurrence of a Lifshitz point in the phase diagrams of selected U-based intermetallic compounds. The Lifshitz point is a multicritical point (on the phase diagram plotted as a function of the temperature and external magnetic field – *B*-*T*, or temperature and external pressure – *p*-*T*) , in which the magnetically disordered paramagnetic phase meets with two ordered phases – commensurately and incommensurately modulated. However, it is not the sufficient condition, because not every triple point on the phase diagram is the Lifshitz point. It is essential that phase transition between disordered and two ordered phases is a continuous phase transition. It is also indispensable, that the modulation vector of the inncomensurate phase changes continuously along the transition line. The critical behaviour in the vicinity of Lifshitz point diverges from that observed for ordinary critical points. The magnetic Lifshitz point was up to now observed in the only one compound, namely MnP.

The object of the investigations undertaken within the project is the family of compounds with composition UT_2M_2, where *T* denotes the *d*-electron transition metal and *M* is Si or Ge atom. These compounds, crystallizing with tetragonal crystal structure, exhibit wide range of physical properties. There were observed different kinds of magnetic ordering among them. The existence of Lifshitz point was put forward for one compound from the family – UPd_2Si_2. It is known that also the other UT_2M_2 compounds show points, where three magnetic phases meet one another. However, further investigation of these phases is indispensable in order to confirm the type of multicritical point and study critical behaviour around hypothetical Lifshitz point. Furthermore, some of the phases from the family has been studied only briefly, and one may expect rich phase diagrams for them. A good example of such phase is UPd_2Ge_2. In zero field, there were observed occurrence of magnetically ordered incommensurately and commensurately phases. However, properties of the compound in magnetic fields are still unknown.

It is planned, in the framework of the project, to perform syntheses of the selected phases in monocrystalline form in the laboratory adapted to work with radioactive materials. Later, the magnetic, transport and thermal properties of the obtained specimens will be measured in wide ranges of temperatures, magnetic field strength and external pressure. It is planned to perform neutron experiments for selected phases. The acquired results will be analysed using theoretical models available in the scientific literature. The outcomes will be published in the scientific magazines and presented on scientific conferences.