

## Alexey Ustinov of KIT Wins a Russian "Megagrant"

November 16, 2011 (HE63). Alexey Ustinov of the Physics Institute at the Karlsruhe Institute of Technology (KIT), Germany, and of KIT's Center for Functional Nanostructures (CFN), won one of the prestigious competitive "megagrants" awarded by the Russian Government. For the next two years he'll obtain 150 million rubles (about EUR 3.5 millions) for a project on "Superconducting Metamaterials".

Ustinov will use these funds to equip a laboratory at the Russian [National University of Science and Technology \(MISiS\)](#) in Moscow<sup>1</sup> and conduct research into his topic in parallel at KIT and MISiS. The grant can be extended for two more years.

Metamaterials are typically constructed of artificial "atoms" that have engineered electromagnetic response not found in nature. These atoms could be very small electronic devices and elements, such as wires, resonators, junctions, *etc.* The properties of the artificial atoms are often engineered to produce non-trivial values for the effective permittivity and effective permeability of a lattice of identical atoms. However, major limitation of small electronic objects are their large losses which increase inversely proportional to the square of their linear size or radius. In contrast to ordinary metallic structures, superconducting metamaterial components can be miniaturized while still maintaining their low-loss properties. The design flexibility of superconducting meta-atoms with, *e.g.*, Josephson junctions allows for utilizing small sizes down to the nano-scale while maintaining very low losses and frequency tunability. Moreover, superconductors offer an intriguing and unique possibility of exploring quantum effects in metamaterials. Superconducting qubits based on Josephson junctions have all characteristic properties of macroscopic artificial 'atoms' that behave as quantum two-level systems. The quantum behavior of such superconducting metamaterials will be the long-term research goal of Ustinov's group at MISiS, in cooperation with KIT.

Overall, 500 applications from the whole world were evaluated and 39 megagrants awarded. Among the 2011 awardees are two Nobel Prize laureates, 10 scientists from the US, 6 from France and 4 from Germany.

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<sup>1</sup> Following Russian Federal Policy in Engineering and Innovations, the University is working to develop research and development projects in prioritized areas of the economy, as identified by the Presidential Administration. MISiS's goal is to create energy-effective technologies and environmentally-friendly methods of industrial production, as well as to produce new materials for use in energy-effective technologies.