Stuttgarter Physikalisches Kolloquium

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Dienstag, 6. Dezember 2016 | **17.15 Uhr** | **Hörsaal 2 D5**

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Oxitronics: taming transition metal oxides interfaces

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Abstract

Personal electronic devices, from laptops to smartphones from tablets and e-readers to connected objects (watches, appliances, homes), are definitely part of our daily life and scores of new e-gadgets hit the consumer market every year. Such technological revolution could not have taken place without the masterful engineering of metal-oxide-semiconductor field effect transistors (MOSFET) which are currently the core constituents of every electronic device. But the surging demand for more connectivity, more multimedia multitasking at ever higher speed comes with a taxing energetic cost. The current strategy – packing larger numbers of smaller size transistors on a tiny chip – is reaching a limit (M. Waldrope, *Nature* **530**, 144, (2016)). This fate had been foreseen a while ago by engineers and fundamental science researchers who are actively exploring alternatives to the silicon-based technology. In this respect, oxide electronics (we coined it "oxitronics") appears to be a promising lead in the quest to design new types of components. Impressive advances in materials science have allowed the community to engineer heterostructures in a Lego-like fashion. It was found that these interfaces are not only conducting but that they also exhibit ferroelectricity, superconductivity, gate tunable transport, large thermoelectric effect, large spin-orbit contributions, possibly ferromagnetism as well. This multi-functionality paves the way for an oxitronics technology.

We shall focus on a particular oxide based heterostructure, $LaAlO_3$-$SrTiO_3$ (LAO-STO). Experiments reveal that a quasi two-dimensional metallic sheet that evolves at low temperature into a superconducting state may form on the STO side, close to the interface. Charge transport can be controlled by applying gate voltages such that one may write user-defined conducting channels on the interface. This has deep implications for the engineering of nano circuits. Strain and spin also control the transport of charge; the possibility to tune the strength of the interfacial spin-orbit interaction (Rashba) is promising for spintronic developments. Lastly, I shall hint to the putative existence of a topological state in this system.