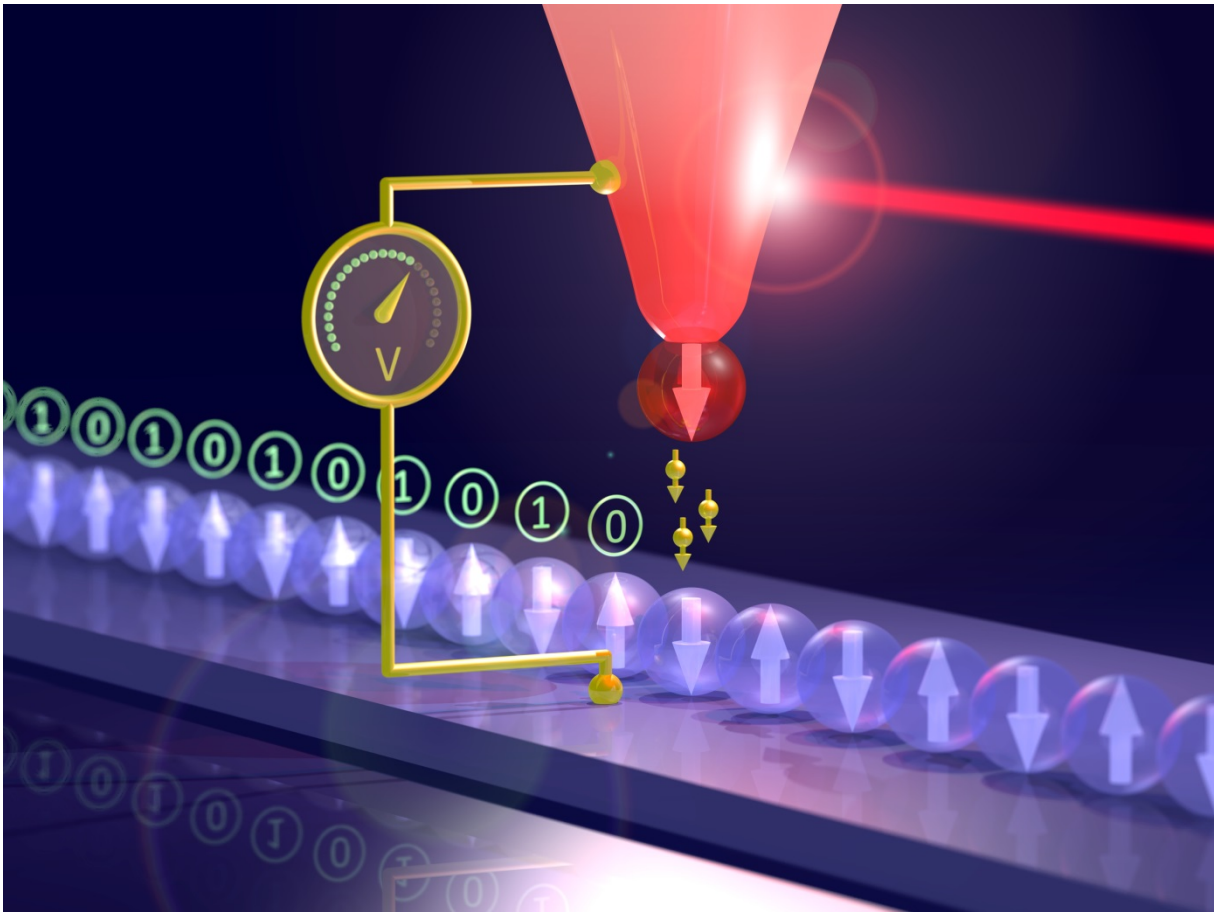
New concept for energy-efficient data processing technology

A thermo-sensor for magnetic bits



The illustration schematically depicts the experimental setup: The tip of the scanning tunneling microscope is heated using a laser beam. The temperature difference between the hot tip (red) and the cold surface atoms (blue) generates an electric voltage (yellow), which depends on the magnetic orientation of the surface atoms, acting here as magnetic bits (green). (Image: UHH/Krause)

Scientists of the Department of Physics at the University of Hamburg, Germany, detected the magnetic states of atoms on a surface using only heat. The respective study is published in the recent volume of the “Science” magazine. A magnetic needle was heated by a laser beam and approached to within close proximity of a magnetic surface, with a gap of only a few atoms width. The temperature difference between the needle and the surface generates an electric voltage. Scanning the needle across the surface, the scientists succeeded in showing that this thermovoltage depends on the magnetic orientation of the individual atom below the needle.

“With this concept we determined the surface magnetism with atomic accuracy without directly contacting or strongly interacting with the surface”, says Cody Friesen, the main author of the study. Conventional techniques need an electric current for this, which causes undesirable heating effects. In contrast, the approach from Hamburg does not depend on a current. As a consequence for future applications, miniaturized magnetic sensors in integrated circuits may operate without a power supply and without generating waste heat. Instead, process heat generated inside a device is directed towards the sensor, which thermally senses the magnetic orientation of an atom and

translates it into digital information. “Our investigations show that the process heat generated in integrated circuits can be used for very energy efficient computing”, says Dr. Stefan Krause, who supervises the project within the research group of Prof. Roland Wiesendanger.

Today, the ever increasing amount of data generation and the enhancement of processing speeds demand a constant miniaturization of devices, which leads to higher current densities and strong heat generation inside the devices. The new technique from Hamburg could make information technology more energy efficient and thus environmentally friendly. Apart from ecological aspects, it would have meaningful implications for everyday life: Our smartphones would need less frequent recharging because of their reduced power consumption.

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Magneto-Seebeck tunneling on the atomic scale,
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