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Press Release

Trapped by Light

Freiburg quantum physicist Tobias Schätz receives prestigious grant from European Research Council

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Tobias Schätz, professor of atomic and quantum physics at the University of Freiburg, has been selected to receive a Consolidator Grant from the European Research Council (ERC) for a novel approach: trapping atoms and ions with light. Together with his research group, the physicist aims to gain deeper insight into the complex quantum dynamics of many-body systems and chemical reactions at temperatures lower than one millionth of a degree above absolute zero, which is equal to -273.15 degrees Celsius. The grant is among the most prestigious awards for scientists in Europe. Schätz will receive 1.8 million euros in funding for his project TIAMO (Trapping Ions in Atoms and Molecules Optically) in the next five years.

The field of ultra-cold chemistry provides the right conditions for the experiments. Reactions between atoms and ions usually become slower and slower as temperatures decrease, until the point is reached at which all dynamics come to a standstill. However, the laws of quantum physics predict that at ultra-low temperatures quantum effects will dominate and chemistry will obey fundamentally different rules: Collisions between reactants can then no longer be described as a billiard-like impact between hard spheres but rather as interfering waves that interact at long range and can even annihilate each other. Under these ultra-cold conditions, energy barriers no longer need to be lower than the smallest available kinetic energy but can be efficiently passed by tunneling. Researchers have used laser-cooled atoms and ions for decades to study such natural quantum effects during molecule formation. This involves isolating the particles from disturbing environmental influences. Scientists use radio frequency fields to trap ions and optical fields to trap neutral particles.

Schätz and his team demonstrated a new method: The research group succeeded for the first time ever in also trapping ions by means of an interaction with light. Up to now, the fields vibrating at different frequencies led to fundamental friction, triggering heating process between the various trapped particles. This prevented them from reaching the quantum regime, the state in which it is possible to study quantum effects. Now the team wants to use optical fields exclusively to trap ions and atoms. “This approach will prevent the vibration and enable temperatures that are tens of thousands of times lower, allowing us to study the quantum effects of ultra-cold chemistry,” says Schätz. In addition, interfering laser beams will create new possibilities for using optical gratings as conveyors to control the reaction of a single ion with a single atom – the ultimate form of control at the level of individual quanta.

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