# Scientists cool gas by laser bombardment

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Three decades ago, American and Finnish scientists came up with a very powerful method for cooling gases by "laser bombardment." Only now were physicists at the University of Bonn able to demonstrate that it actually works. The work of the Bonn scientists will appear in the forthcoming issue of the journal *Nature*. Fast cooling by laser bombardment could, inter alia, possibly be used for the construction of new mini fridges.

In their experiment the scientists tested a completely new principle of cooling. For this, they used the property that atoms can be stimulated by light. In this process an electron changes from its orbit around the atom's nucleus to an orbit that is further away. However, this is only successful if the incoming light has the appropriate colour. Red light has less energy than blue light. Therefore the 'push' which a red laser gives the electron may not be sufficient for lifting it to a higher orbit.

Atoms in a gas collide with each other regularly. The higher the pressure of the gas is, the more frequent the collisions are. 'In this process the electron orbits of the particles "bend",' Professor Martin Weitz from the Institute of Applied Physics explains. 'At the time of the collision, you therefore need less energy than normally in order to vault the electron into a high orbit.' After the collision the electron orbits become normal again. In order to then stay on the higher orbit, the electron has to 'borrow' the missing energy. 'To do so, it uses the kinetic energy of the atom, which becomes slower in this process,' Ulrich Vogl, a member of Weitz's team adds. Speed and temperature are two sides of the same coin - the slower the molecules in a gas move, the colder it is. So the laser

bombardment results in the gas cooling down.

This elegant method was already proposed in 1978 by researchers from New York and Helsinki. However, their idea applied to gases of a not particularly high pressure and the experiments carried out in this way were not really successful. Researchers from Bonn have now heated a mixture of argon gas with traces of rubidium to 350 degrees Celsius and increased the pressure to 230 bars. 'Under these conditions we were able to stimulate the rubidium with a laser whose energy would have normally not been sufficient,' Martin Weitz says. 'While we were doing this, the gas mixture cooled down by almost 70 degrees within several seconds.'

With their experiment the physicists from Bonn wanted to demonstrate first of all that laser cooling works in general under pressure. 'But the whole process should also work with gases below room temperature,' Martin Weitz says confidently. 'Possibly even temperatures close to absolute zero can be achieved with this method.' There are already methods of laser cooling with which gases can be cooled to such low temperatures. However, they only work at extremely low pressures. The gas mixture used in Bonn was ten billion times more dense. Moreover, the new method permits much higher refrigeration capacities. It may therefore be possible to design new kinds of mini fridges on this basis.

## High refrigeration capacity

The high refrigeration capacity is also what makes the process attractive for matter researchers. It allows gases to be brought into new, previously unexplored states of matter. As a result of the rapid refrigeration they might remain in a gaseous state at temperatures where they would normally be liquid. Similar effects are known from water, which can be cooled down to - 42 degrees Celsius without it freezing. If the cooling happens very quickly, even lower temperatures are conceivable. 'Supercooled' liquids and gases show interesting properties. Producing

them is therefore of interest to many scientists.

More information: Laser Cooling by Collisional Redistribution of Radiation, *Nature*, September 3rd

Source: University of Bonn (news : web)