The interplay of dancing electrons

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Negative ions play an important role in everything from how our bodies function to the structure of the universe. Scientists from the University of Gothenburg, Sweden, have now developed a new method that makes it possible to study how the electrons in negative ions interact in, which is important in, for example, superconductors and in radiocarbon dating.

"By studying atoms with a negative charge, 'negative ions', we can learn how electrons coordinate their motion in what can be compared to a tightly choreographed dance. Such knowledge is important in understanding phenomena in which the interaction between electrons is important, such as in superconductors", says Anton Lindahl of the Department of Physics at the University of Gothenburg.

A negative ion is an atom that has captured an extra electron, giving it a negative charge. Negative ions are formed, for example, when salt dissolves in water. We have many different types of negative ion in our bodies of which the most common is chloride ions. These are important in the fluid balance of the cells and the function of nervous system, among other processes.

Increased knowledge about negative ions may lead to a better understanding of our origin. This is because negative ions play an important role in the chemical reactions that take place in space, being highly significant in such processes as the formation of molecules from free atoms. These molecules may have been important building blocks in the origin of life.

"I have worked with ions in a vacuum, not in water as in the body. In order to be able to study the properties of individual ions, we isolate them in a vacuum chamber at extremely low pressure. This pressure is even lower than the pressure outside of the International Space Station, ISS."

Anton Lindahl's doctoral thesis describes studies in which he used laser spectroscopy to study how the electrons in negative ions interact.

"In order to be able to carry out these studies, I have had to develop measurement methods and build experimental equipment. The measurements that the new equipment makes possible will increase our understanding of the dance-like interplay."

The new measurement methods that Anton has developed are important in a number of applications. One example is the measurement of trace substances in a technique known as 'accelerator mass spectrometry' or AMS. The technology and knowledge from Gothenburg are being used in a collaborative project between scientists in Gothenburg, Vienna (Austria) and Oak Ridge (USA) to increase the sensitivity of AMS measurements. One application of AMS is radiocarbon dating, which determines the age of organic matter. Another application is measurements on ice cores drilled from polar ice, which can be used to investigate the climate hundreds of thousands of years into the past.

Provided by University of Gothenburg