How long does it take an electron to travel from an atom to the next atom?

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Scientists say they have discovered how long it takes electrons to hop between atoms: about 320 quintillionths of a second.

The journal *Nature* publishes this week a study of electronic dynamics ("Direct observation of electron dynamics in the attosecond domain"). The participants of this study, together with other researchers, have been professors Daniel Sánchez-Portal and Pedro Miguel Etxenike from the Donostia International Physics Center (DIPC).

A researcher group of various German laboratories has done the experimental part of the study, and the theoretical explanation based on quantum physics of what has been observed has been done in DIPC (San Sebastian).

This work answers the following question: How long does it take an electron to travel from an atom to the next atom? The main conclusion is that the time required is much shorter than the time it could be measured until now. This study analyses the dynamics of electrons in the case of sulphur atoms laid on metal surfaces (ruthenium). Electrons jump from the sulphur to the metallic surface in 320 attoseconds approximately (1 attosecond is equivalent to 0,000000000000000001 seconds). In order to have an idea how small this number is, we could say that one attosecond at one second would be what a second would be at the age of the universe (about 14,000 millions of years).

The main innovation of this work consists on the possibility to measure a

charge transference time between an atom and a surface at attoseconds, and at the same time, two theory physicists of the University of the Basque Country (EHU) have worked out details of the process by means of quantum mechanics. This phenomenon is one of the fastest ever seen directly in the solid state physics, and it shows it is possible to obtain information about the dynamics of electrons with great resolution. In order to achieve such resolution it is necessary to use a precise measurement "device", in this case, a clock that provides electronic transitions within the same atom.

The question about the time electrons require to travel between different atomic centres is very important for several phenomena. It is important to optimise the design of materials that will constitute future electronic devices (areas of nanoelectronic and molecular electronic). Particularly, the technique used allows to distinguish among different values of the electronic “spin” (giromagnetic ratio), and this opens new areas of study in the field of “spintronic”, a new electronics in which the key factor is not the electron charge as in the conventional electronics, but the spin. Charge transference processes are also essential for life (photosynthesis), energy production (photovoltaic cells) and, in general, for the photochemistry and electrochemistry.

Source: Elhuyar Fundazioa