EDITORIAL

As a tribute to the winners of the Nobel Prize in Physics 2016, the editorial board of Momento Revista de Física decided to reproduce a small part of their work for which they were deserving of this recognition. Our readers interested in the subject can see the link *https:www.nobelprize.orgnobel_prizesphysicslaureates2016advanced-physicsprize2016.pdf*

"**Strange phenomena in matter's flatlands**

This year's Laureates opened the door on an unknown world where matter exists in strange states. The Nobel Prize in Physics 2016 is awarded with one half to David J. Thouless, University of Washington, Seattle, and the other half to F. Duncan M. Haldane, Princeton University, and J. Michael Kosterlitz, Brown University, Providence. Their discoveries have brought about breakthroughs in the theoretical understanding of matter's mysteries and created new perspectives on the development of innovative materials.

The mysterious quantum leaps

Experimental developments eventually brought about a number of new states of matter that required explanation. In the 1980s, both David Thouless and Duncan Haldane presented ground-breaking new theoretical work that challenged previous theories, of which one was the quantum mechanical theory for determining which materials conduct electricity. This had initially been developed in the 1930s and, a few decades later, this area of physics was considered to be well understood. It was therefore a great surprise when, in 1983, David Thouless proved that the previous picture was incomplete and, at low temperatures and in strong magnetic fields, a new type of theory was necessary, one where topological concepts were vital. At around the same time, Duncan Haldane also arrived at a similar, and similarly unexpected, conclusion while analysing magnetic atomic chains. Their work has been instrumental in the subsequent dramatic developments to the theory of new phases of matter. The mysterious phenomenon that David Thouless described theoretically, using topology, is the quantum Hall effect. This was discovered in 1980 by the German physicist Klaus von Klitzing, who was rewarded with the Nobel Prize in 1985. He studied a thin conducting layer between two semi-conductors, where the electrons were cooled to a few degrees above absolute zero and subjected to a strong magnetic field. In physics, it is not uncommon for drastic things to happen when the temperature is lowered; for example, many materials become magnetic. This happens because all the small atomic magnets in the material suddenly point in the same direction, giving rise to a strong magnetic field, which can also be measured.

Answered by topology

Topology describes the properties that remain intact when an object is stretched, twisted or defor-med, but not if it is torn apart. Topologically, a sphere and a bowl belong to the same category, because a spherical lump of clay can be transformed into a bowl. However, a bagel with a hole in the middle and a coffee cup with a hole in the handle belong to another category; they can also be remodeled to form each other's shapes. Topological objects can thus contain one hole, or two, or three, or four... but this number has to be an integer. This turned out to be useful in describing the electrical conductance found in the quantum Hall effect, which only changes in steps that are exact multiples of an integer. In the quantum Hall effect, electrons move relatively freely in the layer between the semi-conductors and form something called a topological quantum fluid. In the same way as new properties often appear when many particles come together, electrons in the topological quantum fluid also display surprising characteristics. Just as it can't be ascertained whether there is a hole in a coffee cup by only looking at a small part of it, it is impossible to determine whether electrons have formed a topological quantum fluid if you only observe what is happening to some of them. However, conductance describes the electrons'collective motion and, because of topology, it varies in steps; it is quantized. Another characteristic of the topological quantum fluid is that its borders have unusual properties. These were predicted by the theory and were later confirmed experimentally. Another milestone occurred in 1988, when Duncan Haldane discovered that topological quantum fluids, like the one in the quantum Hall effect, can form in thin semiconductor layers even when there is no magnetic field. He said hed never dreamed of his theoretical model being realized experimentally but, as recently as 2014, this model was validated in an experiment using atoms that were cooled to almost absolute zero."

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Editor