UPPSALA UNIVERSITET

Colloquium

The Human Story Lurking behind the Hofstadter Butterfly

Douglas Hofstadter

Indiana University, Bloomington

Douglas Hofstadter is College of Arts and Sciences Professor of Cognitive Science, and Director of the Center for Research on Concepts and Cognition, at Indiana University in the US.

A legendary pioneer in the field of artificial intelligence, Hofstadter is best known for his Pulitzer Prize winning debut work, *Gödel, Escher, Bach: an Eternal Golden Braid*, published in 1979.

Date: Feb 5 at 15:15
Location: Siegbahnsalen

The seminar is organized by the Department of Information Technology and the Department of Physics and Astronomy.

UPPSALA UNIVERSITET

The Human Story Lurking behind the Hofstadter Butterfly

Douglas Hofstadter

Indiana University, Bloomington

From the early 1930s onwards, theoretical physicists strove to understand the behavior of electrons in a crystal when the crystal was placed in a magnetic field. While electrons in a crystal (with no magnetic field) were well understood, and while electrons in a magnetic field (with no crystal) were also well understood, the combination of these two very basic physical situations turned out to yield a strangely recalcitrant yet fundamental problem, and for a long time, insights were few and far between.

In the mid-1970s, the speaker — at the time a graduate student in physics — was given this long-standing problem by his doctoral advisor, Gregory Wannier. For almost a year he struggled with it with little success, but then something unexpected suddenly happened. Over a decade earlier, as an undergraduate mathematics student, he had spent several years passionately exploring a small area of number theory, and now, to his amazement, it turned out that the insights he had gained in those years were just what was needed to understand the crux of what was happening in this tough nut of a physics problem. Number theory to the rescue!

Thanks to this excellent luck, he (that is to say, yours truly, aka "I") soon discovered a visually riveting new type of quantum-mechanical energy spectrum — a graph made out of an infinite number of smaller copies of itself (giving rise to a dizzying infinite regress) — which revealed, among other things, that both number theory and topology, contrary to what most physicists had thought, play key roles in certain areas of physics. In the following decades, this exotic graph became well known, acquiring the nickname of "Hofstadter butterfly", and it cropped up in numerous new contexts, especially in connection with the quantum Hall effect. In recent years, certain aspects of the butterfly have just started to become empirically testable.

The lecture will recount the human story of this 40-year-old discovery, a tale rife with emotional twists and turns. In the talk there will be some technical parts (Bloch bands and Hamiltonians and wave functions and such things), but even so, much of it will be accessible to non-physicists; all that is needed is a sense of curiosity about the laws of nature and a sympathy for the idea that beauty must play a key role therein.

Date: Feb 5 at 15:15
Location: Siegbahnsalen

Organized by the Department of Information Technology and the Department of Physics and Astronomy.