2019 International Solvay Chair in Chemistry

Professor Gernot Frenking

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Program

Inaugural Lecture: Tuesday 12 March (4 - 5 P.M., Solvay Room)

THE CHEMICAL BOND

The historical development of the concept of the chemical bond and the physical understanding of chemical bonding is not only a fascinating chapter of chemistry as a scientific discipline. It also reflects human attempts to understand the material world and the process of conquering and changing matter at one's own discretion. It was not until 1927 that physical laws were available, which provided a basis for an understanding of the nature of the chemical bond in terms of fundamental physical forces. But even before this time heuristic bonding models had been proposed which had proved very useful as ordering principles and guidance for new experiments. The remarkable success of these models contributed to the booming development of the chemical industry as a very important part of wealth and economy. Chemistry can be seen as an example of significant progress being made in a scientific discipline without its fundamental basis being known.

The physical understanding of chemical bonding, introduced in 1927, was based on the newly developed quantum theory of Werner Heisenberg and Erwin Schrödinger. Following their work, Walter Heitler and Fritz London applied quantum theory to the nature of the chemical bond. They showed for the first time that the strong interatomic interactions leading to a chemical bond can be explained by fundamental physical forces. But the complicated mathematical formulation, which appeared intractable at a time when computers were not available, and the enormous difficulties in grasping the meaning of a quantum theoretical description of chemical bonding with a model accessible to the human mind were great obstacles to make quantum chemistry a valuable discipline competing with experiment.

In my lecture I will outline the historical development of the concept of the chemical bond and the physical understanding of chemical bonding, which is an ongoing topic of controversial – and thus fruitful – discussion.

FOR THE INAUGURAL LECTURE, COFFEE AND TEA WILL BE SERVED AT 3.45 P.M. AND DRINKS AT 5.00 P.M. IN FRONT OF THE SOLVAY ROOM

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Lecture 1: Wednesday 20 March (4 - 6 P.M., Solvay Room)

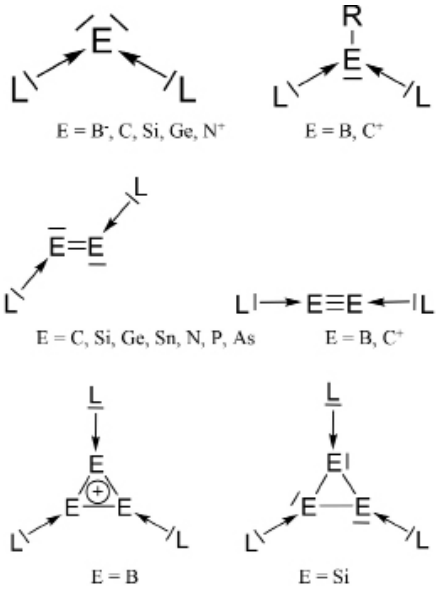
TRAVELLING IN VALENCE SPACE

Before the advent of quantum chemistry in 1927, heuristic rules were suggested which are still remarkably useful to explain and predict molecular structures and reactivities. Prominent examples are the electron-pair model for the chemical bond introduced in 1916 by Gilbert Lewis and the octet and 18- and 32-electron rules by Irving Langmuir in 1921. In my lecture I will discuss the quantum chemical underpinning of the rules and recent developments that transcend the limits of conventional understanding of the models.

Lecture 2: Friday 29 March (4 - 6 P.M., Solvay Room)

DATIVE BONDING IN MAIN GROUP COMPOUNDS

The lecture focuses on chemical bonding in one-, two- and three-centre complexes of main-group atoms E, which is described in terms of dative bonds. It is shown that the bonding model of donor-acceptor interactions provides insight and understanding for unusual geometries. It served in recent years as useful guideline for the explanation of the bonding situation and the successful prediction of novel molecules. The field of experimentally known complexes which are shown below has greatly increased in the recent past with the support of quantum chemical calculations.



The rest of Prof. Frenking's lectures will be given in November 2019.

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