

WHAT DOES A PHYSICIST DO?

... and why he/she is not only meant to be a scientist at universities and research institutes, but also valuable for research and development departments of companies.

THE ANSWER:

Because of his/her fundamental mathematical and scientific education and experiences the physicist can work in a manifold of areas. The physicist has not a specific ability that stands out. He/She rather has learned to quickly get familiar in any area.

His/Her special quality is to analyse situations and to come up with solutions. **He/She is an all-rounder, showing a large overview and has a number of abilities in different fields. Please read on if you caught interest.**

To understand what a physicist is capable of doing, it firstly has to be explained that physics is divided into two main parts: **theoretical physics and experimental physics.**

In the US-sitcom "The Big-Bang Theory" Sheldon Cooper and Leonard Hofstadter personify these to parts, respectively. However, the motivation for both physicist is the same. They want to understand the every days live underlying physical principles: „**Why is something happening like it does? There must be a reason.**“

To accomplish this goal, physics has a number of different disciplines: surface science physics, high energy physics, environmental physics, atomic physics, to mention a few. In any of the disciplines both physicist are active.

In detail, the disciplines are different but the underlying principles are the same.

WHAT IS THE DIFFERENCE BETWEEN A THEORETICAL & EXPERIMENTAL PHYSICIST?

THEORETICAL PHYSICIST:

Develops physical models and mathematical methods: Theoretical physicist are model-developers.

Their goal is to formulate a theoretical description and simulate physical processes.

What whether will be tomorrow?

How are atoms in specific material arranged and what is the consequence of that arrangement?

Will there be a Big-Bang again sometime?

Additionally, theoretical physicist develop mathematical methods in order to calculate these models.

EXPERIMENTAL PHYSICIST:

Conducts experiments and develops measurement methods: Experimental physicists are observers.

Where do high and low pressure areas lie?

What atoms form the material and how are they actually arranged?

Which paths do the stars follow?

To answer such questions, the experimental physicist conducts experiments and develops the appropriate methods to measure.



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„THE ULTIMATE GOAL IS TO GET THEORY & EXPERIMENT INTO ACCORDANCE.“ –

Interplay of theoretical physics & experimental physics

Although the two physicist species have different occupations their work is entangled. The observation determines the model-development. If an observation contradicts the models, the models have to be refined or rethought. On the other hand, the models instruct an experimentalist on how to measure a physical quantity.

The ultimate goal is to get theory and experiment into accordance. Finally the theory has to describe the observation. The theory, however, delivers the microscopic understanding of the underlying physical principles.

The division of physics into theoretical physics and experimental physics is the result of the increasing complexity. 500 years ago, Nikolaus Kopernikus has observed the planets orbits and developed the heliocentric system, where the planets are circling the central sun, on his own. Nowadays, the observation and model-development by one person alone is almost impossible.

THE STUDIES OF PHYSICS

The specialisation in one or the other field occurs late in the physics studies. During the first years the students are taught a broad knowledge of theoretical and experimental methods. They learn how to derive physical laws from basic principles. Concomitantly they get to know experimental methods and the art to conduct experimental test series. The important point is to understand the interplay between theory and experiment.

During their master studies the students specialise. In the end of the studies the physicists are part of a theoretical or experimental workgroup. They learn the special procedures and get a deeper insight into their specific field of choice.

During his studies Dr. Boris Krenzer gained his fascination for experimental physics and specialised in the field of surface science physics.

The purpose of surface science is to understand the physics of surfaces and to use this knowledge to manipulate and functionalize surfaces to obtain a certain characteristic. Surface science is characterised by a vast number of different experimental and theoretical techniques.

In Germany surface science is one of the most important, if not the most important, physics discipline.



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THE EXPERIMENTAL PHYSICIST

In the centre of the experimental physicist task is the transfer of a theoretical question into an experiment. The results of the experiment are used to answer the question and verify the underlying theoretical model. Experimental results can even be the starting point for the development of new theories.

The experimental physicist not only conducts and analyses test series. Starting from simple soldering, conducting simulations up to presenting experimental results he/she is doing a variety of activities. **The experimental physicist is a hybrid between a professional tinkerer and a scientist.**

THE DESIGN ENGINEER, PURCHASER, ASSEMBLER AND SOFTWARE DEVELOPER

The first step in an experimental project is to choose the methods used to answer a given theoretical question. Generally, the result of this first step is to further develop an existing apparatus or develop an apparatus from scratch. In this phase the physicist is a designing engineer and purchasing manager. He/She decides on the required components and designs prototypes. He/She has to survey the component production in workshops and external companies. Subsequently, the physicist assembles the apparatus and develops the electronics. Even more important is the development of the individual automation and data acquisition software.

THE EXPERIMENTOR

After setup, the physicist plans and conducts experimental test series. To gain results at highest quality, he/she takes special care on a precise adjustment of the apparatus and the high control on external parameters like temperature or pressure. The physicist spends particular attention to the reproducibility of the experimental results, repeating an experiment several times. This procedure is important for the data analysis and the interpretation of the experimental results. For this purpose he/she also develops software dedicated for the data analyses and interpretation.

THE SCIENTIST AND DATA ANALYST

The actual scientific task follows the data analyses and interpretation. The results are examined in the light of previous results and theories. In the case of a disagreement the reasons for the discrepancy are analysed: are the experiments comparable and should thus lead to the same results? Is the data-quality sufficient? Has the experiment to be improved? It is also possible that the applied theory does not describe the experiment correctly.

Simple models are developed and numerical simulations are conducted in order to better describe the experimental setup. **This process is the fundamental scientific task.**

These steps are often performed in collaborations with other groups. Another advantage of the collaboration with external groups is, that complementary results can be delivered, which corroborate the own results. The goal of the scientific co-work is to find agreement of theory and experiment in the answer to the initially set question.

THE AUTHOR

If the above scientific process concluded with a plausible answer, the physicist acts as an author. **The findings are published as articles in journals for a broad readership.** He/She also presents the results in talks at conferences and uses them for fund-raising.

THE PROJECT MANAGER

As implied above the analysis of experimental data may be very complex. Very often large collaborations, including scientists and technicians, are involved in research projects. Physicist thus also act as research project managers to coordinate the research project.

THE ALL-ROUNDER

From the above written, it is clear, that a physicist is not only dedicated to the pure science, but his/her work requires a variety of skills.

Based on these skills the physicist is an ideal co-worker for the industrial research and development. With his/her experiences he/she can advance development projects.



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