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Research Success Stories

SEVENTH FRAMEWORK PROGRAMME

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A new method and a dynamic team looking for the solution of nonequilibrium problems

With DYNCORSYS, Philipp Werner is contributing to a long-term effort in the field of theoretical physics: he is developing a new formalism to compute the time evolution of interacting quantum systems, with a focus on strongly correlated materials. This formalism will lead to a better understanding of nonequilibrium phenomena and to the discovery of transient states of matter with potential technological applications.

About three years ago, Prof. Philipp Werner submitted his ERC-starting grant proposal while working as a temporary assistant professor at ETH Zurich. The time, he felt, was just right for significant progress in a field of theoretical physics that had emerged a couple of years earlier and had matured to the point where the first interesting applications had been demonstrated by his collaborators. When the project got funded, he moved to a permanent position as Associate Professor at Fribourg University and more importantly, he is following up on these ideas.

Prof. Philipp Werner
Departement of Physics
University of Fribourg

A new method

Prof. Philipp Werner is the only person in Switzerland (and one of only a few in the world) doing research in nonequilibrium dynamical mean field theory; a new method that he is developing further thanks to the generous financial support offered by the ERC - starting grant. This method allows to address physical problems that were not solvable with previously existing techniques.

Establishing a group

There are two postdocs and one PhD student testing and extending the recently developed formalism, which allows to study how interacting many-particle systems (for example electrons in a solid) behave when they are perturbed by an external force such as a strong light pulse. This work has already led to interesting predictions of magnetically ordered or even superconducting states which should not exist under equilibrium conditions. Moreover, the ERC - starting grant allowed him to build up an appropriate infrastructure for this research: the existing computer cluster at Fribourg University has been upgraded to enable simulations on several hundred processors.

" I enjoy the challenge of trying to understand things which are not immediately obvious: from the formulation of the problem to the development of a method to solve it."

Full-time research

An important advantage is that Prof. Werner, when obtaining his permanent position, decided to pay part of his own salary from this ERC grant. He can therefore profit from a sabbatical semesters (free from teaching and other administrative duties) and focus full time on research. During this time Prof. Werner is also free to travel in Europe and in Japan, where he has fruitful collaborations. Very recently, together with his international collaborators, he has published a review article on nonequilibrium dynamical mean field theory in Reviews of Modern Physics, the reference journal for both fundamental and applied physics.

ABOUT THE PROJECT

Solids typically consist of periodic array of atoms which are held together by electronic bonds. When a perturbation is applied, the electrons are excited and the material is driven out of its equilibrium state. The dynamical mean field theory (DMFT) is a method which allows to determine the electronic structure of strongly correlated materials.

DYNCORSYS aims to establish a "nonequilibrium DMFT" for the investigation of excitation and relaxation processes, and the description of transient states. The ultimate goal is to identify long-lived transient states with novel, and hopefully useful properties, such as high-temperature superconductivity.

FACTS AND FIGURES

Project Name:	DYNCORSYS Real-time dynamics of correlated many-body systems
Research Area:	Condensed Matter Physics
Coordinator:	Prof. Philipp Werner
Organization:	University of Fribourg
Start Date - End Date:	2012/01/02 - 2017/31/01
Duration:	60 months
Project Cost:	1.49 million Euro
Project Funding:	1.49 million Euro
Contract Type:	ERC Starting Grant
FP7 Reference Number:	278023

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