Symposium Quantum Physics in Strong Fields (SYSF)

Holger Gies
Friedrich Schiller University Jena
Fröbelstieg 1
07743 Jena, Germany
holger.gies@uni-jena.de

Ralf Schützhold
Helmholtz-Zentrum Dresden-Rossendorf
Bautzner Landstraße 400
01328 Dresden, Germany
r.schuetzhold@hzdr.de

Ultra-strong electromagnetic fields offer a new regime for studying novel fundamental quantum phenomena. They give access to an as yet unexplored territory of physics in addition to the high-energy frontier. The symposium "Strong-field physics" will review recent theoretical and experimental developments in this fascinating area.

Overview of Invited Talks and Sessions

(Lecture hall ZHG104)

Invited Talks

SYSF 1.1	Tue	10:45–11:25	ZHG104	**Nuclear physics with strong electromagnetic fields** — •Adriana Pálffy
SYSF 1.2	Tue	11:25–12:05	ZHG104	**Strong fields and fundamental physics** — •Anton Ilderton
SYSF 1.3	Tue	12:05–12:45	ZHG104	**Weakly coupled new physics in strong fields** — •Babette Döbrich

Sessions

SYSF 1.1–1.3	Tue	10:45–12:45	ZHG104	**Quantum Physics in Strong Fields**

SYSF 1: Quantum Physics in Strong Fields

Time: Tuesday 10:45–12:45 Location: ZHG104

Invited Talk SYSF 1.1 Tue 10:45 ZHG104

Nuclear physics with strong electromagnetic fields — •Adriana Pálffy — University of Würzburg, Institute for Theoretical Physics and Astrophysics, 97074 Würzburg

Strong laser-matter interaction traditionally deals with the response of atoms, molecules, and plasmas to external electromagnetic fields. Atomic nuclei have very small dipole moments and show limited response to even the strongest available optical fields. However, progress towards laser sources with increasingly high intensities and higher frequencies opens new opportunities for direct or indirect laser-nucleus interactions.

The talk will review some recent achievements in direct nuclear excitation using laser sources in the vacuum ultraviolet [1] and x-ray regimes [2]. The question on whether strong electromagnetic fields can influence nuclear processes such as alpha decay [3] or fusion [4,5] will be also addressed. Considering indirect and plasma-mediated effects, the prospects of laser-induced secondary reactions or excitation in nuclei and possible future developments will be discussed.

[1] C. Zhang *et al.*, Nature **636**, 603 (2024)
[2] Y. Shvyd'ko *et al.*, Nature **622**, 471 (2023)
[3] A. Pálffy and S. V. Popruzhenko, Phys. Rev. Lett. **124**, 212505 (2020)
[4] F. Queisser and R. Schützhold, Phys. Rev. C **100**, 041601(R) (2019)
[5] N. Thomson, L. Moschini and A. Diaz-Torres, Phys. Rev. C **110**, 034614 (2024)

Invited Talk SYSF 1.2 Tue 11:25 ZHG104

Strong fields and fundamental physics — •Anton Ilderton — Higgs Centre, University of Edinburgh, UK

Strong electromagnetic fields are produced by modern intense laser systems, are found in astrophysical environments, and can be created in collisions of dense particle bunches.

Such strong fields are essentially classical, yet they can be used to probe quantum physics, including properties of the quantum vacuum itself, through processes such as vacuum birefringence. There are even hints that in sufficiently strong fields, quantum electrodynamics may behave very differently compared to how we understand it today.

In this talk I will give an overview of some current activities in the use of strong fields to study fundamental physics, both in electrodynamics and in gravity, where strong-field methods can be applied to the scattering of black holes in the extreme-mass-ratio regime.

Invited Talk SYSF 1.3 Tue 12:05 ZHG104

Weakly coupled new physics in strong fields — •Babette Döbrich — Max Planck Institute for Physics

Strong electromagnetic fields are an exquisite ingredient in searches for weakly coupled physics. Such physics is proposed to extend the Standard Model of particle physics, among else to help to explain Dark Matter. In my talk, I will exemplify this statement and will highlight how axions over a wide set of mass scales can be searched exploiting their coupling to two photons: From laboratory set-ups to the use of large-scale accelerator infrastructure.