

Editorial

Correlated matter in radiation fields: from femtosecond spectroscopy to the free electron laser

Many processes in natural sciences are governed by the interaction between electromagnetic radiation and matter. Its highly interdisciplinary nature ranges from fundamental questions of quantum mechanics via new possibilities for light amplification to materials modifications. The 2005 Einstein year commemorates a milestone in the development of the field. The photoeffect still serves today as the focus of numerous modern scientific investigations. New tools such as femtosecond or attosecond lasers, free electron lasers, and novel concepts in many-particle theory have recently opened far-reaching possibilities. In addition, high-level technological methods allow the development of tailored materials. With these it becomes possible to not only study the fundamentals of the interaction between radiation and matter, but also the modification of the light by the material. The mutual interactions between strongly correlated matter and radiation fields generated by highly intense and/or ultra-short lasers are therefore a topic of ongoing lively discussions.

This topical issue addresses subjects which have in common correlation effects in radiation fields. Problems of femtosecond dynamics in structured semiconductors, Coulomb explosions in clusters, and the diagnostics of dense plasmas are tackled. Special emphasis is given to studies made possible with the advent of semiconductor quantum films, with the controllability of light-matter coupling by tuning the shapes of ultra-short light pulses, and with the start of the VUV free electron laser at DESY in Hamburg. We expect that eventually there will be access to the X-ray free electron laser. Although it will be a few more years until it goes into operation, from theoretical work we can already now get a glimpse of the exciting possibilities of this new, highly brilliant light source.

The above mentioned questions constitute the working framework of the Collaborative Research Centre “Strong Correlations and Collective Effects in Radiation Fields: Coulomb Systems, Clusters and Particles” (SFB 652), recently started at the University of Rostock. Experimental and theoretical groups work very closely together, using electromagnetic radiation from the visible to the X-ray regime, with ultra-short pulses and/or ultra-high intensity. In order to prepare that project, a W.E. Heraeus Workshop highlighted the problems. Experts from the subjects reported on developments in the context of *correlation effects in radiation fields*. This topical issue gathers the best part of the original work presented by the speakers of the W.E. Heraeus Workshop. We thank them very much for their willing cooperation and the careful preparation of the ensuing contributions.

The editors of the topical issue:

Heinrich Stolz
Ronald Redmer
Karl-Heinz Meiwes-Broer