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EDITORIAL

Focus on correlation effects in radiation fields

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Abstract. Many processes in nature are governed by the interaction of electromagnetic radiation with matter. New tools such as femtosecond and free-electron lasers allow one to study the interaction in unprecedented detail with high temporal and spatial resolution. In addition, much work is devoted to the exploration of novel target systems that couple to radiation in an effective and controllable way or that could serve as efficient sources of energetic particles when being subjected to intense laser fields. The interaction between matter and radiation fields as well as their mutual modification via correlations constitutes a rich field of research that is impossible to cover exhaustively. The papers in this focus issue represent a selection that largely reflects the program of the international conference on 'Correlation Effects in Radiation Fields' held in 2011 in Rostock, Germany.

The interaction between electromagnetic radiation and matter is of paramount importance, impossible to overestimate. After all, the very existence of life itself is based on light-harvesting molecules. Our understanding of the structure of matter is largely due to spectroscopy employing coherent radiation, the dynamics of matter can be controlled by light fields, and lasers

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are nowadays commonly used to process material for, e.g. medical or engineering applications. The study of light–matter interaction is thus of wide interest, as it provides fundamental insight into light-driven many-body quantum dynamics and paves the way for future innovative applications. Indeed, whereas more than a century brought a wealth of scientific results in this area, new tools like femtosecond or attosecond lasers, free-electron lasers, non-classical light sources and novel concepts in quantum optics and many-particle theory have recently opened up, allowing for new insightful experiments and simulations undreamed of 20 years ago.

Why do we emphasize correlation in the title of this focus issue? Clearly, without correlation there would be only effective single-particle physics going on, no coupling, no transport, no structure, no life. Most physicists probably agree that correlation in fermionic systems is, by definition, whatever is not captured by a Hartree–Fock treatment. Pauli-blocking and collective effects such as plasmonic excitations *are* captured by a Hartree–Fock treatment. It is occasionally far from trivial to distinguish collective from correlation effects, let alone classical from quantum correlation. It is therefore an ambitious but exciting endeavor to investigate correlated systems *in* radiation fields and the build-up of correlations *due* to radiation fields.

At the international conference on 'Correlation Effects in Radiation Fields' (CERF2011), 150 participants from 10 countries gathered in Rostock, Germany from 12–16 September 2011, to report on and discuss recent progress in the field (http://web.physik.uni-rostock.de/sfb/cerf11/). The CERF2011 was initiated within the Collaborative Research Center (SFB) 652 'Strong Correlation and Collective Effects in Radiation Fields: Coulomb Systems, Clusters and Particles' of the German Science Foundation. It was during the organization of the CERF2011 when the idea of a *New Journal of Physics* focus issue emerged. The idea met with big positive response, most probably because the reputation and impact of a peer-reviewed *New Journal of Physics* paper is much higher and thus much more attractive than an ordinary conference proceeding. Hence, not surprisingly, most of the participants of CERF2011 appear as authors on papers in the current focus issue. More quantitatively, 26 of the 39 focus issue papers have been contributed by CERF2011 participants, 20 of them by SFB members. The other papers have been invited on the basis of renowned expertise.

The contributions to this focus issue reflect the selection of 'hot topics' that naturally emerged when the program of the CERF2011 conference was composed:

- clusters and nanoplasmas in intense radiation fields [1–8],
- exciton formation, dynamics and condensation [9–14],
- matter in intense and short-wavelength radiation [15–20],
- solid surfaces, fluids and structured material in intense laser fields [21–25],
- ionization, detachment, collision and dissociation dynamics in atoms, molecules and negative clusters [26–30],
- highly correlated effects and nonclassical radiation fields [31–34],
- spectroscopy of chemical dynamics in complex systems [35–37] and
- numerical treatment of driven quantum systems [38, 39].

Disperse as this selection may seem, it gives a flavor of the multitudinous and the diverse challenges the research field offers. We thus do hope that readers will find this focus issue useful and inspiring for their own work. In fact, the download metrics (well above an average of 300

downloads per paper) about only one year after the first paper appeared indicate that this is indeed the case.

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