New Journal of Physics
The open access journal for physics

EDITORIAL

Focus on correlation effects in radiation fields

D Bauer[1,4], T Brabec[2], H Fehske[3], S Lochbrunner[1], K-H Meiwes-Broer[1] and R Redmer[1]

[1] Institut für Physik, Universität Rostock, D-18051 Rostock, Germany
[2] Department of Physics, University of Ottawa, Ontario K1N 6N5, Canada
[3] Institut für Physik, Ernst-Moritz-Arndt-Universität, D-17487 Greifswald, Germany
E-mail: dieter.bauer@uni-rostock.de

New Journal of Physics **15** (2013) 065015 (4pp)
Received 12 May 2013
Published 25 June 2013
Online at http://www.njp.org/
doi:10.1088/1367-2630/15/6/065015

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

[4] Author to whom any correspondence should be addressed.

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.

References

[1] Köhn J, Redmer R and Fennel T 2012 Collision-enhanced plasmonic electron acceleration in small metal clusters *New J. Phys.* **14** 055011

[2] Sayres S G, Ross M W and Castleman A W Jr 2012 Onset of Coulomb explosion in small silicon clusters exposed to strong-field laser pulses *New J. Phys.* **14** 055014

[3] Moll M, Schlanges M, Bornath T and Krainov V P 2012 Inverse bremsstrahlung heating beyond the first Born approximation for dense plasmas in laser fields *New J. Phys.* **14** 065010

[4] Peltz C, Varin C, Brabec T and Fennel T 2012 Fully microscopic analysis of laser-driven finite plasmas using the example of clusters *New J. Phys.* **14** 065011

[5] Krishnan S R *et al* 2012 Evolution of dopant-induced helium nanoplasmas *New J. Phys.* **14** 075016

[6] Heidenreich A, Infante I and Ugalde J M 2012 Ion energetics in electron-rich nanoplasmas *New J. Phys.* **14** 075017

[7] Passig J, Irsig R, Truong N X, Fennel T, Tiggesbäumker J and Meiwes-Broer K-H 2012 Nanoplasmonic electron acceleration in silver clusters studied by angular-resolved electron spectroscopy *New J. Phys.* **14** 085020

[8] Raitza T, Reinholz H, Reinhard P-G, Röpke G and Broda I 2012 Spatially resolved collective excitations of nano-plasmas via molecular dynamics simulations and fluid dynamics *New J. Phys.* **14** 115016

[9] Phan V-N and Fehske H 2012 Coulomb interaction effects in graphene bilayers: electron–hole pairing and plasmaron formation *New J. Phys.* **14** 075007

[10] Monney C, Monney G, Aebi P and Beck H 2012 Electron–hole instability in 1T-$TiSe_2$ *New J. Phys.* **14** 075026

[11] Manzke G, Semkat D and Stolz H 2012 Mott transition of excitons in GaAs–GaAlAs quantum wells *New J. Phys.* **14** 095002

[12] Yan Y and Kühn O 2012 Laser control of dissipative two-exciton dynamics in molecular aggregates *New J. Phys.* **14** 105004

[13] Stolz H, Schwartz R, Kieseling F, Som S, Kaupsch M, Sobkowiak S, Semkat D, Naka N, Koch T and Fehske H 2012 Condensation of excitons in Cu_2O at ultracold temperatures: experiment and theory *New J. Phys.* **14** 105007

[14] Wolter S, Aizezers J, Fennel F, Seidel M, Würthner F, Kühn O and Lochbrunner S 2012 Size-dependent exciton dynamics in one-dimensional perylene bisimide aggregates *New J. Phys.* **14** 105027

[15] Bauer D 2012 Modeling the core-hole screening in jellium clusters using density functional theory *New J. Phys.* **14** 055012

[16] Rupp D *et al* 2012 Identification of twinned gas phase clusters by single-shot scattering with intense soft x-ray pulses *New J. Phys.* **14** 055016

[17] Plagemann K-U, Sperling P, Thiele R, Desjarlais M P, Fortmann C, Döppner T, Lee H J, Glenzer S H and Redmer R 2012 Dynamic structure factor in warm dense beryllium *New J. Phys.* **14** 055020

[18] Bahn J *et al* 2012 Pb 4f photoelectron spectroscopy on mass-selected anionic lead clusters at FLASH *New J. Phys.* **14** 075008

[19] Junker A, Pálffy A and Keitel C H 2012 Cooperative effects in nuclear excitation with coherent x-ray light *New J. Phys.* **14** 085025

[20] Ziaja B, Chapman H N, Fäustlin R, Hau-Riege S, Jurek Z, Martin A V, Toleikis S, Wang F, Weckert E and Santra R 2012 Limitations of coherent diffractive imaging of single objects due to their damage by intense x-ray radiation *New J. Phys.* **14** 115015

[21] Bierbach J *et al* 2012 Generation of 10 μW relativistic surface high-harmonic radiation at a repetition rate of 10 Hz *New J. Phys.* **14** 065005

[22] Zherebtsov S *et al* 2012 Carrier-envelope phase-tagged imaging of the controlled electron acceleration from SiO_2 nanospheres in intense few-cycle laser fields *New J. Phys.* **14** 075010
[23] Sarpe C, Köhler J, Winkler T, Wollenhaupt M and Baumert T 2012 Real-time observation of transient electron density in water irradiated with tailored femtosecond laser pulses *New J. Phys.* **14** 075021
[24] Guay J-M, Villafranca A, Baset F, Popov K, Ramunno L and Bhardwaj V R 2012 Polarization-dependent femtosecond laser ablation of poly-methyl methacrylate *New J. Phys.* **14** 085010
[25] Krüger M, Schenk M, Hommelhoff P, Wachter G, Lemell C and Burgdörfer J 2012 Interaction of ultrashort laser pulses with metal nanotips: a model system for strong-field phenomena *New J. Phys.* **14** 085019
[26] Kull H-J 2012 Position-momentum correlations in electron–ion scattering in strong laser fields *New J. Phys.* **14** 055013
[27] Herlert A and Schweikhard L 2012 Two-electron emission after photoexcitation of metal-cluster dianions *New J. Phys.* **14** 055015
[28] Korneev P A, Popruzhenko S V, Goreslavski S P, Becker W, Paulus G G, Fetić B and Milošević D B 2012 Interference structure of above-threshold ionization versus above-threshold detachment *New J. Phys.* **14** 055019
[29] Lange M *et al* 2012 Radiative cooling of Al_4^- and Al_5^- in a cryogenic environment *New J. Phys.* **14** 065007
[30] Emmanouilidou A and Lazarou C 2012 Multiple electron trapping in the fragmentation of strongly driven molecules *New J. Phys.* **14** 115010
[31] Sperling J and Vogel W 2012 Entanglement quasiprobabilities of squeezed light *New J. Phys.* **14** 055026
[32] Zhao J and Lein M 2012 Probing Fano resonances with ultrashort pulses *New J. Phys.* **14** 065003
[33] Ngoko Djiokap J M, Hu S X, Jiang W-C, Peng L-Y and Starace A F 2012 Enhanced asymmetry in few-cycle attosecond pulse ionization of He in the vicinity of autoionizing resonances *New J. Phys.* **14** 095010
[34] Najjari B, Müller C and Voitkiv A B 2012 Resonantly enhanced photoionization in correlated three-atomic systems *New J. Phys.* **14** 105028
[35] Fingerhut B P *et al* 2012 Dynamics of ultraviolet-induced DNA lesions: Dewar formation guided by pre-tension induced by the backbone *New J. Phys.* **14** 065006
[36] Roth C, Chatzipapadopoulos S, Kerlé D, Friedriszik F, Lütgens M, Lochbrunner S, Kühn O and Ludwig R 2012 Hydrogen bonding in ionic liquids probed by linear and nonlinear vibrational spectroscopy *New J. Phys.* **14** 105026
[37] Göde S, Irsig R, Tiggesbäumker J and Meiwes-Broer K-H 2013 Time-resolved studies on the collapse of magnesium atom foam in helium nanodroplets *New J. Phys.* **15** 015026
[38] Scrinzi A 2012 t-SURFF: fully differential two-electron photo-emission spectra *New J. Phys.* **14** 085008
[39] Alvermann A, Fehske H and Littlewood P B 2012 Numerical time propagation of quantum systems in radiation fields *New J. Phys.* **14** 105008