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Preface to Atomic, molecular and photon collision physics: new challenges and new opportunities. A Theme edited and compiled by K. Burnett and N. J. Mason

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Preface

The articles in this issue are a clear testament to the vitality of the field it presents. Atomic, molecular and optical physics have seen extraordinary developments in theory and experiment. These developments have, in great part, been linked to technological developments that have impinged on what scientists in the field can do. We can see, for example, how ultrashort pulse and intense lasers have enabled us to study the behaviour of atomic systems in fields of atomic strength. The impact of being able to produce atoms at microkelvin temperatures and below has opened up a wide avenue of new studies in atomic and molecular interactions at ultracold temperatures. The precision and sensitivity now available to experimenters in electron interactions are driving the study of new physics in very diverse species. These are producing new insights into the dynamics of electronic encounters with atoms and molecules and ions.

In the article by Burke *et al.*, we see how the power of the R-matrix techniques can be applied to interactions with adsorbates on surfaces. This is driving the understanding of recent experiments, which can probe adsorbates with great sensitivity.

Tennyson & Morgan have described the important advances in the treatment of electron–molecule interactions: so important in a wide range of science. Mason *et al*. review the correspondingly impressive developments in experimental studies in this field and how they may be applied to many diverse applications, in particular, environmental studies.

Matt *et al*. describe the way in which electron impact ionization of fullerenes has been used to obtain crucial insights into these fascinating systems.

Interactions of polarized electrons and polarized photons offer a distinct and powerful way of probing the dynamics of electronic encounters. Kleinpoppen & Becker show, in their review, the evolution and impact of the 'complete' scattering experiments that can now be done.

Experiments based around storage rings have produced a rich and exquisite new world of data on the interactions between electrons and ions. This new domain is described in the article by Müller.

The interactions of electrons and intense laser pulses with ions, including molecular ions is described by Williams & Newell. These new experiments are giving insights into collision dynamics as the availability of new laser sources opens up the possibilities for the field.

Exchange and annihilation processes are brought to the fore in the study of collisions using antiparticles. These exotic species are enabling experimentalists to study, and unravel, issues inaccessible to more conventional probes, as is shown in the article by Laricchia & Charlton.

The dynamics of molecules in intense laser fields is discussed in the article by McCann & Posthumus. They show how the fragments of the intense field process, both ionized and dissociated, can be used to characterize the underlying dynamics. The fruitful interaction of theory and experiment is very clear in these studies.

The time dynamics of multielectron atoms in intense laser fields presents a formidable challenge to computational theory. The article by Taylor & Dundas shows the

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impact that the recent developments in theory and computational resources is having on the field.

Atomic and molecular physics provides a wonderful context for the quantitative studies of quantum chaology. The article by Monteiro *et al.* describes the fascinating world that this work has opened up, as well as the relation to condensed matter physics.

The article from Queen's by Professor John Geddes and his colleagues (Ding *et al.*) shows what a techniques were being developed under his influence. The coincidence studies of surface interactions build on his creative use of precision techniques. His loss will be keenly felt in our community.

Near-threshold behaviour of electrons displays an exquisite blend of many-particle dynamics. The theory described by Crothers & Loughan shows what substantial progress has been made in this fascinating area.

It is now possible to produce sources of ultracold atoms, and controlling their motion is a very rapidly developing area. The development of atomic optical elements using magnetic surfaces, as described in the article by Hinds is a crucial route forward for the field.

In the final article by Butcher *et al.* the interactions between ultracold atoms is addressed. These interactions determine the properties of Bose–Einstein condensates that can now be made in the laboratory.

Thus the breadth and excitement of the fields of atomic, molecular and optical physics are described in this issue and suggest that many new exciting developments await us in the new century.

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