Abstract for an Invited Paper
for the MAR05 Meeting of
The American Physical Society

R-matrix Theory: Application to Atomic, Molecular and Optical Processes

PHILIP BURKE, Queen's University of Belfast

Recent developments in R-matrix theory and its application to the ab initio calculation of a wide range of atomic, molecular and optical collision processes will be reviewed. Following physical ideas originally introduced by Wigner and Eisenbud in their analysis of nuclear reactions, configuration space describing the collision process is partitioned into two or more regions. In the internal region where exchange and correlation effects dominate a configuration interaction expansion is adopted yielding the R-matrix (or derivative matrix) on the surface. In the external region represented by a local potential the R-matrix is propagated outwards to yield the S-matrix and scattering amplitudes. Results of recent calculations for electron and positron collisions with atoms, ions and molecules, photoionization of atoms and ions, dielectronic recombination and multiphoton processes will be presented. An overview of the many applications of these results will be given. Finally, future directions of research, which include electron collisions with heavy atoms and with polyatomic molecules and the interaction of super-intense lasers with atomic systems will be discussed.