Quantal toolkit for few-body and many-body theory

Chris H. Greene
Department of Physics and Astronomy, Purdue University, USA

The theoretical description of very low energy systems is controlled by quantum mechanics at very long de Broglie wavelengths. Some simplifying aspects in this limit allow for the use of specialized methods and approximations that are especially designed for this long-wavelength physical regime. These include techniques such as the zero-range Fermi pseudopotential, effective range theory, multichannel quantum defect theory, and the adiabatic/nonadiabatic methods such as Landau-Zener theory. Using a theoretical toolkit based on these ideas, we can understand remarkably detailed and complicated quantal behavior of systems such as two-body Fano-Feshbach resonances, atomic and molecular Rydberg spectroscopy, the universal Efimov effect for three neutral particles, and the large scale behavior of degenerate quantum gases. This lecture will survey the theoretical tools that are particularly effective in this area for understanding some of the most interesting and rich phenomena.