Physical chemistry, particularly solution and electrochemistry, is the discipline that underpins areas ranging from molecular biology and biochemistry to nanotechnologies to chemical engineering. It was developed in the early 20th century. Developing new sciences, both biological and physical sciences, depend upon the 150-year-old venerable discipline that often ignores quantum mechanics, which is the source of key hydration, specific ion or Hofmeister effects [1]. The problem lies deep and includes all simulations of proteins and macromolecules that rely on molecular forces. Reliance on what appears a deeply flawed discipline renders prediction impotent, and progress illusory. The situation needs urgent rectification. In the middle of the 20th century, a sophisticated theory of molecular interactions due by the Russian scientist Lifshitz went some way towards a new beginning. Much progress has followed, especially in recent decades. The author has been much involved in these developments [1-7]. There are many applications open, almost any of which will turn to gold.

I will focus on a few fundamental well posed problems in the area of molecular forces that, with co-operation of colleagues, I believe are guaranteed success. The first is to expand our semi-classical theories for Yukawa-Casimir forces and plasmon lifetimes (semi-classical analogs of pions) coming out for mesons [3-5]. I will continue my work on excited state intermolecular energy transfers [7]. Together with researchers from Europe, USA, Brazil, Australia, and China, we will explore the role of such electrodynamic fluctuation forces in geophysics (e.g., ice formation on gas hydrates in the waters of the moon Enceladus determining heat conservation [6], and anomalous stabilized methane hydrates preserving natural gases in permafrost region). Similar difficulties that beset the field of molecular forces occur with molecular interactions that involve real photon (light) transfer between them. Applications from photosynthesis to pheromones to quantum computing to vision to fluorescence are numerous. The basic theory used is flawed, and wrong for long-range interactions. The reasons are known. The correct theories have been developed by myself. Its extension to a number of applications will be pursued.

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