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**Nonlinear polarization of ionic liquids: theory, simulations, experiments**

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Room temperature ionic liquids (RTILs) composed of large, often asymmetric, organic cations and simple or complex inorganic or organic anions do not freeze at ambient temperatures. Their rediscovery some 15 years ago is widely accepted as a "green revolution" in chemistry, offering an unlimited number of "designer" solvents for chemical and photochemical reactions, homogeneous catalysis, lubrication, and solvent-free electrolytes for energy generation and storage. As electrolytes they are non-volatile, some can sustain without decomposition up to 6 times higher voltages than aqueous electrolytes, and many are environmentally friendly. The studies of RTILs and their applications have reached a critical stage. So many of them can be synthesized - about a thousand are known already - their mixtures can further provide "unlimited" number of combinations! Thus, establishing some general laws that could direct the best choice of a RTIL for a given application became crucial; guidance is expected from theory and modelling. But for a physical theory, RTILs comprise a peculiar and complex class of media, the description of which lies at the frontier line of condensed matter theoretical physics: dense room temperature ionic plasmas with "super-strong" Coulomb correlations, which behave like glasses at short time-scale, but like viscous liquids at long-time scale. This talk will introduce RTILs to physicists and overview the current understanding of the nonlinear response of RTILs to electric field. It will focus on the theory, simulations, and experimental characterisation of the structure and nonlinear capacitance of the electrical double layer at a charged electrode. It will also discuss pros and contras of supercapacitor applications of RTILs.