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Janco's Disciples in Coulombland

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As an introduction to the following two papers, we first give an explanation of the above general title. Both authors met Bernard Jancovici as a professor, and he was such an enthusiastic teacher that we felt like doing a thesis with him. This proved to be a very good idea! Indeed, Jancovici treated each of us both as a student who had much to learn and as a true collaborator from the start. Thus, we can say that we were born to scientific research thanks to him. Moreover, "Janco" also taught us skiing, hiking, wine tasting, etc. As he provided us with such a complete education, he deserves the title of our "spiritual father," a title which he himself recognizes. In these papers, we would like to give an idea of the scientific approach which Janco taught us, and which is based on the first principles of statistical mechanics. We have chosen to exemplify this point of view through two nice problems of classical and quantum Coulomb systems which we studied after Janco addressed them alone or with us. "Coulombland" refers to systems of particles with Coulomb interactions at large distances. The Coulomb potential is defined as the solution of the Poisson equation in D dimensions. In three dimensions, it is the usual $1/r$ interaction, while in two dimensions, it takes a logarithmic form. The long range and the harmonicity of the Coulomb potential are responsible for a basic phenomenon called screening. A charged particle in a plasma is surrounded by a polarization cloud, whose total charge exactly compensates the charge of the particle it surrounds. Subsequently, the total effective potential created by a charge and its cloud at large distances is no longer the bare Coulomb potential, and the correlations are expected to decay faster. We review exact analytical results for the large-distance behavior of the correlations in two different situations, namely in the Kosterlitz–Thouless phase of the 2D classical Coulomb gas (Part I), and in the 3D quantum plasmas (Part II). Solvable models and systematic expansions starting from first principles exemplify Janco's rigorous approach.

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