Quenched disorder and Coulomb interactions

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I will talk about effects of quenched fixed charge disorder on effective electrostatic interactions between charged surfaces in a one-component (counterion-only) Coulomb fluid [1,2]. Analytical results can be explicitly derived for two asymptotic and complementary cases: i) mean-field or Poisson-Boltzmann limit (including Gaussian-fluctuations correction), which is valid for small electrostatic coupling, and ii) strong-coupling limit, where electrostatic correlations mediated by counterions become significantly large as, for instance, realized in systems with high-valency counterions. In the particular case of two apposed and ideally polarizable planar surfaces with equal mean surface charge, the effect of the disorder is nil on the mean-field level and thus the plates repel. In the strong-coupling limit, however, the effect of charge disorder turns out to be additive in the free energy and leads to an enhanced long- range attraction between the two surfaces. The equilibrium interplate distance between the surfaces decreases for elevated disorder strength (i.e. for increasing mean-square deviation around the mean surface charge), and eventually tends to zero, suggesting a disorder-driven collapse transition.

[1] A. Naji and R.Podgornik, Phys. Rev. E **71** 041402 (2005).
[2] R. Podgornik and A. Naji, Europhys. Letts. **74** 712 (2006).