The Manning Transition

Suppose that an ionic polymer, such as DNA, which has N units on a length L, is placed into water at temperature T. Negatively charged ions of charge -e can enter the solution, leaving behind a highly positively charged chain. This will cause the polymer to unfold and behave like a rigid rod. Assume that a single strand of DNA is placed in a cylindrical container of height L and radius R. The radius of the DNA strand is approximately a. Assume $a \ll R$.



- (a) Calculate the partition function of the ions in solution. Assume that the ions don't interact with each other, but they do feel the strong electric field due to the charged polymer rod.
- (b) Plot the pressure P on the walls of the container. At what critical temperature T_c does the behavior radically change?
- (c) Describe physically what you think will happen above and below this critical temperature.