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Chiral Symmetry Breaking and Elastic Response of Frustrated Polyelectrolyte Bundles GREGORY GRASON, Department of Physics and Astronomy, University of California, Los Angeles, ROBIJN BRUINSMA, Department of Physics and Astronomy, University of California, Los Angeles — We present a model for hexagonal aggregates of charged, cylindrical macromolecules (DNA, microtubules, F-actin, *etc.*) in the presence of multivalent counterions at low temperature. Using the Wigner crystal picture of the neutralizing charge condensed onto the rod-like macromolecules, we establish a one-to-one mapping between the statistical mechanics of the charged bundle system and those governing the $T = 0$ properties of a two-dimensional, frustrated Josephson junction array. We find that the superconducting phase of the *quantum* system corresponds to the low-temperature phase of our *classical* bundle system, where the condensed counterions are ordered in three dimensions, while the insulating phase corresponds to the phase where one-dimensional phonon fluctuations destroy long-range order of the condensed charge. Remarkably, the mapping makes the prediction that the transition to the charge-ordered state should be accompanied by a spontaneous breaking of chiral symmetry (even in the absence of any molecular chirality). Finally, we exploit the well-studied critical properties of the electromagnetic response of the two-dimensional *quantum* system to deduce the elastic response of the *classical* charged-rod bundle system.

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