ble polyelectrolyte conformations: stretched with a reduced charge and compacted with nearly zero charge.[2] The renormalized or effective charge of chains with N charged monomers due to counterion condensation strongly depends on the chain conformation. Mean-field models, including Poisson–Boltzmann of ion penetrable spheres, give a reduced effective charge proportional to the size of a charged sphere R. If the stretched chain ($R \sim N$) collapses into a dense sphere ($R \sim N^{1/3}$), its reduced charge is much less than the effective charge of the stretched conformation, $N \ln N$. If the correlations between the condensed ions and the monomers are included, the dense sphere is nearly neutral.[2,3]

Chain precipitation occurs if the entropy decrease of the counterions neutralizing the sphere's charge is overcompensated by the gain in short-range electrostatic attractions per monomer in the sphere.[3] These attractions cause the chains to compact: to a toroid in semiflexible chains or a sphere in flexible chains. Consequently, monomolecular DNA condensation occurs because finite, stretched, rodlike chains of charged monomers have higher effective charge, and therefore higher energy, than chains collapsed to their smallest possible size. Gelbart and coauthors mention that isolated spheres have higher effective charge than isolated rods. But this is only true if the finite rods have no short-range cutoffs, as in a continuous zero-width line of charge with zero-size counterions,[2] and if the concentration of chains is identically zero, which is physically impossible.

The size of the multivalent ions is also important in determining the possibility of charge inversion (see Gelbart et al., ref. 11), and the re-dissolution of the precipitate at large salt concentrations.[3] These phenomena are determined by the relation of the chemical potential of the multivalent ions in the solution and the inverse screening length. Large multivalent particles do not contribute to screening; they readily overcharge a polyelectrolyte such as DNA wrapped around histones. Small multivalent salts, however, have complex thermodynamics in concentrated ionic solutions, and do not necessarily lead to polyelectrolyte charge inversion.

In summary, contrary to our intuition, short length scales strongly influence the physics of large charged systems.

References

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Gelbart, Bruinsma, Pincus, and Parsegian reply: We thank Francisco Solis and Monica Olvera de la Cruz for calling attention to the novel statistical mechanical properties that arise with flexible polyelectrolytes. We also agree that the line- and point-charge condensation behaviors we describe do not occur except in the ideal limit of infinite dilution (as we did specify in our text). At the levels of both mean-field and correlation approaches, physical issues arise with flexible chains that are related to—but different from—those treated in our article. Because of space constraints we focused primarily on rigid polyelectrolytes, and omitted many other interesting aspects of recent studies on molecular and colloidal electrostatics.

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The Trouble with Superlatives

The title of the book reviewed in the October 2000 issue of Physics Today (page 81) boldly states *The Discovery of Anti-matter: The Autobiography of Carl David Anderson, the Youngest Man to Win the Nobel Prize.* But it's just not so. William Lawrence Bragg was born in Australia in March 1890. Together with his father, William H. Bragg, he was awarded the Nobel Prize in physics in 1915 for their joint work on x-ray diffraction, beating Anderson by a good six years.

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[Editor's Note: This is one of several letters we received on this subject. We contacted the publisher, World Scientific Publishing Co, whose editor-in-chief sent us the following response.]

K. K. Phua replies: After consulting the series editor of the book *The Discovery of Anti-matter,* we admit that we erred. Indeed, William Lawrence Bragg was the youngest to win the Nobel Prize in Physics. We will insert an erratum in the book to the effect that Carl Anderson was the second youngest. Two professors in the history of physics missed this point when they reviewed the book for us.

Thank you for bringing this matter to our attention.

K. K. Phua
World Scientific Publishing Co
River Edge, New Jersey

India, Pakistan, NPT

I mistakenly identified Iran and Iraq (Physics Today, December 2000, page 25) as two of the four nonsignatories of the Non-Proliferation Treaty. The two other nonsigning countries were India and Pakistan.

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Corrections

October 2000, page 98—Emily Shuk-Chi Ching winner of the Overseas Chinese Physics Association's Achievement in Asia Award, is affiliated with the Chinese University of Hong Kong and not the University of Hong Kong as reported.

December 2000, page 60—Mike Lazardis's gift of Can$100 million for the Perimeter Institute for Theoretical Physics in Waterloo, Canada, is about US$64 million, not $78 million as reported.

December 2000, page 61—In several places, the printer mistakenly replaced the Japanese yen symbol, ¥, with a bullet. ■