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**Illuminating RNA and Its Ion Atmosphere With Solution X-Ray Scattering.** Rhiju Das, Sebastian Doniach, Daniel Herschlag, Stanford Univ., Stanford, CA.

The biopolymer RNA is an ancient component of all living systems, whose catalytic prowess and extensive ability to form complex folds have only recently come to light. We are investigating one of the most fundamental questions about the forces underlying nucleic acid dynamics and structure: Do the basic components of RNA structure, the double helices, attract or repel each other under physiological conditions? This apparently simple question is complicated by a highly dynamic "atmosphere" of positive counterions that always surrounds the negatively charged helices but is largely hidden to standard structural techniques like NMR and x-ray crystallography. Through close collaborations with several laboratories and synchrotron sources, we have developed and implemented an arsenal of experimental approaches, including solution x-ray scattering of model RNAs, resonant x-ray scattering of counterions, and high-precision strategies for counting bound ions, to visualize the ion atmosphere and its effects on interhelical forces throughout RNA folding. This body of experimental results disfavors the existence of significant counterion-induced attraction between RNA helices and exhibit striking agreement with the simple Poisson-Boltzmann theory of the shape, composition, and energetics of the ion atmosphere. The work provides a foundation for our ultimate goal: a well-calibrated, predictive framework for how long-range electrostatic forces counterbalance the short-range chemical interactions that mediate self-assembly of RNA into compact folds.