

Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

DNA – peptide polyelectrolyte complexes: Phase control by hybridization JEFFREY VIEREGG, MICHAEL LUECKHEIDE, AMANDA MARCIEL, LORRAINE LEON, MATTHEW TIRRELL, University of Chicago — DNA is one of the most highly-charged molecules known, and interacts strongly with charged molecules in the cell. Condensation of long double-stranded DNA is one of the classic problems of biophysics, but the polyelectrolyte behavior of short and/or single-stranded nucleic acids has attracted far less study despite its importance for both biological and engineered systems. We report here studies of DNA oligonucleotides complexed with cationic peptides and polyamines. As seen previously for longer sequences, double-stranded oligonucleotides form solid precipitates, but single-stranded oligonucleotides instead undergo liquid-liquid phase separation to form coacervate droplets. Complexed oligonucleotides remain competent for hybridization, and display sequence-dependent environmental response. We observe similar behavior for RNA oligonucleotides, and methylphosphonate substitution of the DNA backbone indicates that nucleic acid charge density controls whether liquid or solid complexes are formed. Liquid-liquid phase separations of this type have been implicated in formation of membraneless organelles in vivo, and have been suggested as protocells in early life scenarios; oligonucleotides offer an excellent method to probe the physics controlling these phenomena.

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Date submitted: 11 Nov 2016

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