

# DYNAMICS OF DOUBLE-SEMIDILUTE LIQUID COACERVATES FORMED BY OPPOSITELY CHARGED POLYELECTROLYTES

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Dynamics. Coacervates. Polyelectrolytes. Dynamics.

Mixtures of oppositely charged polyelectrolytes can undergo a phase separation to form a polymer rich phase, typically called a coacervate, and a polymer depleted phase<sup>1</sup>. The polymer rich phase can be a soft, viscous liquid, or a solid like complex. Both types have drawn much attention in the literature due to their applications in the food<sup>2</sup>, pharmaceutical<sup>3,4</sup>, and other industries as well as their role in many biological systems<sup>1</sup>. Studies have focused on the formation of the coacervate phase<sup>5</sup>, and models have been developed to predict phase separation and static properties<sup>6</sup>. However, much less attention has been given to the dynamic properties of coacervates, and how these can be predicted and controlled through the experimentally controllable parameters of the system. In this work, we develop a scaling theory for the dynamic behavior of asymmetric liquid-like coacervates formed from oppositely charged polyelectrolyte solutions. We consider asymmetric coacervates, characterized by having a different number density of charges in the polyanion and polycation. Depending on the degree of polymerization, the asymmetric liquid coacervate can form either an interpenetrating double-semidilute structure, wherein both polyanion and polycation are found above their overlap concentration, or a dilute-semidilute structure, where only one of the polyelectrolytes is found above their overlap concentration<sup>6</sup>. We will discuss a scaling theory for the unentangled dynamics of double-semidilute and dilute-semidilute coacervates, providing scaling predictions for the relaxation modulus and steady state shear viscosity of the coacervate, and the diffusivity of the polyelectrolyte chains. The scaling theory will highlight the different dynamical regimes of the system, and how the dynamic properties depend on experimentally controllable parameters such as the degree of polymerization, the number density of charges of the polyanion and polycation, and the strength of electrostatic interactions throughout different regimes. This scaling theory should provide useful guidelines for the tuning of dynamic and rheological properties for future application in the cosmetics, food, and other industries.

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