Structure evolution during phase separation in colloids under microgravity

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A series of microgravity experiments was carried out over the last several decades in the International Space Station (ISS) to study phase transitions in colloids and colloid-polymer mixtures without masking gravity effects, such as buoyancy-driven convection and particle sedimentation. The main goal of the proposed research project is to develop phase-field models for structuring in colloids consistent with ISS experiments. These models will be built upon the previous work in the field and will consider phase separation due to spinodal decomposition, as well as crystal growth. Mathematically, the process will be formulated in terms of nonlinear time dependent partial differential equations describing temporal and spatial evolution of the colloid concentration. These equations will be then considered by both analytical and computational methods. Analytical approaches include asymptotics, as well as linear and weakly nonlinear analysis. The computational methods will be built upon already developed computational schemes established in the context of simulating thin fluid films, and will include development of CPU and GPU based simulations in serial and parallel computing environment. It is expected that the models and simulations will provide a benchmark for comparison and evaluation of existing theories for phase transformations that were developed based on terrestrial experiments influenced by gravity effects, and will help improve Earth-based production of advanced materials.