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Sommario/riassunto	In Bose-Einstein condensates from physics and competing species system from population dynamics, it is observed that different condensates (or species) tend to be separated. This is known as the phase separation phenomena. These pose a new class of free boundary problems of nonlinear partial differential equations. Besides its great difficulty in mathematics, the study of this problem will help us get a better understanding of the phase separation phenomena. This thesis is devoted to the study of the asymptotic behavior of singularly perturbed partial differential equations and some related free boundary problems arising from Bose-Einstein condensation theory and competing species model. We study the free boundary problems in the singular limit and give some characterizations, and use this to study the dynamical behavior of competing species when the competition is strong. These results have many applications in physics and biology. It was nominated by the Graduate University of Chinese Academy of Sciences as an outstanding PhD thesis.