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Stochastic and deterministic models of chemotaxis

In this talk, we shall discusses a Langevin type stochastic chemotaxis model which assumes that the statistical increment of cell motion results from the fluctuation of cell velocity. Our main goal is to derive the well-known Keller-Segel model of population chemotaxis from the proposed stochastic model and establish the connection between the stochastic and deterministic chemotaxis model. We first derive the mean field chemotaxis model (i.e. Fokker-Planck equation) corresponding to the Langevin stochastic chemotaxis model by means of the mean field theory. Then based on the mean-field chemotaxis model, we derive the classical Keller-Segel model by using the minimization principle, moment closure approach, approximation technique and scaling argument. The relationship between microscopic and macroscopic parameters is explicitly identified. Moreover an analytical approximation of the probability density function of the Langevin stochastic chemotaxis model is found by minimizing the free energy of the mean-field model. The biological implications will be discussed.