Grow-up rate and refined asymptotics for a two-dimensional Keller-Segel model in chemotaxis

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Abstract: We consider a special case of the Keller-Segel system in a disc, which arises in the modelling of chemotaxis phenomena. For a critical value of the total mass, the solutions are known to be global in time but with density becoming unbounded. We establish the precise grow-up rate and obtain refined asymptotic estimates of the solutions. Unlike in most of the similar, recently studied, grow-up problems, the rate is neither polynomial nor exponential. In fact, the maximum of the density behaves like $e^{\sqrt{2t}}$ for large time. In particular, our study provides a rigorous proof of a behavior suggested by Chavanis and Sire [Phys. Rev. E, 2002] on the basis of formal arguments.