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Front propagation in steady cellular flows: A large-deviation approach[1] ALEXANDRA TZELLA, JACQUES VANNESTE, School of Mathematics, University of Edinburgh, UK — We examine the speed of propagation of chemical fronts modelled by the Fisher–Kolmogorov–Petrovskii–Piskunov nonlinearity in steady cellular flows. A number of predictions have been previously derived assuming small molecular diffusivity (large Péclet number) and either very slow (small Damköhler number) or very fast (large Damköhler number) chemical reactions. Here, we employ the theory of large deviations to obtain a family of eigenvalue problems from whose solution the front speed is inferred. The matched-asymptotics solution of these eigenvalue problems in the limit of large Péclet number provides approximations for the front speed for a wide range of Damköhler numbers. Two distinguished regimes are identified; in both regimes the front speed is given by a non-trivial function of the Péclet and Damköhler numbers which we determine. Earlier results, characterised by power-law dependences on these numbers, are recovered as limiting cases. The theoretical results are illustrated by a number of numerical simulations.

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