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A kinetic model for concentrated active suspensions BARATH EZHILAN, DAVID SAINTILLAN, Department of Mechanical Science and Engineering, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801, USA, MICHAEL SHELLEY, Courant Institute of Mathematical Sciences, New York University, New York, New York 10012, USA — We study the dynamics in concentrated suspensions of active self-propelled particles using a kinetic model and three-dimensional continuum simulations.In a previous model for semi-dilute active suspensions (Saintillan and Shelley 2008), we have revealed the existence of hydrodynamic instabilities and complex correlated motions with pattern formation in suspensions of pushers, while suspensions of pullers undergo no such dynamics. Here, we modify this previous kinetic model by including an additional nematic alignment torque proportional to the local concentration in the equation for the rotational velocity of the particles, causing them to align locally with their neighbors (Doi and Edwards 1986). Linear stability analyses in the isotropic and aligned states show that in the presence of such a torque both pusher and puller suspensions are unstable to random fluctuations. Large-scale three-dimensional simulations of the kinetic equations are also performed and confirm the existence of these instabilities, which lead to the formation of nematic-like structures at high concentrations. Detailed measures are defined to quantify the degree and direction of alignment, and the effects of steric interactions on pattern formation are discussed in detail.

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