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Large-scale pattern formation in active particles suspensions: from interacting microtubules to swimming bacteria[1]

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We consider two biological systems of active particles exhibiting large-scale collective behavior: microtubules interacting with molecular motors and hydrodynamically entrained swimming bacteria. Starting from a generic stochastic microscopic model of inelastically colliding polar rods with an anisotropic interaction kernel, we derive set of equations for the local rods concentration and orientation. Above certain critical density of rods the model exhibits orientational instability and onset of large-scale coherence. For the microtubules and molecular motors system we demonstrate that the orientational instability leads to the formation of vortices and asters seen in recent experiments. Similar approach is applied to colonies of swimming bacteria *Bacillus subtilis* confined in thin fluid film. The model is formulated in term of two-dimensional equations for local density and orientation of bacteria coupled to the low Reynolds number Navier-Stokes equation for the fluid flow velocity. The collective swimming of bacteria is represented by additional source term in the Navier-Stokes equation. We demonstrate that this system exhibits formation of dynamic large-scale patterns with the typical scale determined by the density of bacteria.

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