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Stability of an array of bottom-heavy, upswimming, spherical squirmers TIMOTHY PEDLEY, DOUGLAS BRUMLEY, University of Cambridge — Numerical simulations by Ishikawa & Pedley (Phys Rev Lett. 100:088103,2008; IP) of identical, bottom-heavy, spherical squirmers swimming in a vertical planar monolayer reveal a configuration in which many equally-spaced spheres swim upwards in a hexagonal array. This occurs for sufficiently large values of the bottom-heaviness parameter G. Here we perform an instability analysis in which the forces and torques on individual spheres are calculated using lubrication theory for the gaps between neighbouring squirmers. The results show that stability is impossible in the absence of the repulsive force which IP introduced to save computer time whenever two squirmers were less than 0.00001 radii apart. When the force is present, there is a critical value of G above which stability is assured. An unexpected finding is the existence of another equilibrium configuration in which the spheres' orientations are not vertical and columns of spheres are not equally spaced; in this case, however, perturbation leads to limit-cycle oscillations, not to static stability. The above results are qualitatively unaffected if the monolayer is confined between vertical walls.

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