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It's dispersion, not diffusion: An exact transport equation for active swimmer suspension from the Smoluchowski equation.[1] LLOYD FUNG, Imperial College London, RACHEL BEARON, University of Liverpool, YONGYUN HWANG, Imperial College London — A dilute suspension of micro-swimmers can be modelled with the Smoluchowski (a.k.a. Fokker-Planck) equation for the probability density function of swimmers' location and orientation. However, in most applications, we are only concerned with the locational distribution of swimmers, while the direct numerical simulation of both the orientation and location of swimmers is too computational costly. Therefore, there have been several models to coarse-grain the Smoluckowski equation into a transport equation for the swimmer density. The generalised Taylor dispersion theory (GTDT) has, by far, been shown to be the superior model among others, but its application is strictly limited to pure shear flow. In this presentation, we will present a novel way to derive a transport equation via a transformation of the Smoluchowski equation. The resulting model is less restrictive and exact, which also implies that it is more accurate than GTDT. We will use the gyrotactic swimmer as an example to show that the imposition of positive-definiteness to the diffusivity tensor causes the GTDT model to lose accuracy. The result demonstrates that the biased random walk of swimmers is better described as dispersion rather than diffusion.

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