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Closure relations of non-uniform suspensions KENGO ICHIKI, Department of Mechanical Engineering, The Johns Hopkins University, ANDREA PROSPERETTI, Department of Mechanical Engineering, The Johns Hopkins University — The constitutive relation of the viscous stress, for example, is the key to understand suspensions. Usually one tries to write the relation intuitively, or phenomenologically. Here we are going to derive the relation by the method of closure presented by Marchioro *et al.* [Int. J. Multiphase Flow **27** (2001) 237]. This method is able to treat non-uniform suspensions. By the closure method, the symmetric viscous stress S can be characterized by three kinds of viscosity as $\mathsf{S} = 2\mu_{\mathsf{e}}\mathsf{E}_{\mathsf{m}} + 2\mu_{\Delta}\mathsf{E}_{\Delta} + 2\mu_{\nabla}\mathsf{E}_{\nabla}$, where E_{m} is the strain of the mixture, E_{Δ} is the strain related to the slip velocity between the particles and the medium, and E_{∇} is the strain related to the gradient of the volume fraction of the particles. Note that we only have the term of μ_e for only shear flows on uniform suspensions. The above closure relation is independent of the type of the problems such as sedimentation, the problems applying torque, and shear flows, so that it is the constitutive relation. We also study the anti-symmetric part of the viscous stress, which appears on non-uniform suspensions, in the same manner. [Supported by DOE grant FG02-99ER14966.]

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