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Solution for time-dependent force on a sphere translating through a viscoelastic fluid MARY JOENS, JAMES SWAN, Dept. of Chemical Engineering, Massachusetts Institute of Technology — Understanding the time-dependent force exerted on a spherical particle translating through a viscoelastic fluid has the potential to aid in design of microrheology experiments. We present a method to calculate this force in a fluid described by the Johnson-Segalman constitutive model. The flow field is represented as a regular perturbation series for small values of the Weissenberg number ($U\lambda/a$), where U is the maximum flow velocity, λ is the characteristic relaxation time of the fluid, and a is the particle radius. As the solution is valid for flows with arbitrary time courses, it is valid for arbitrary values of the Deborah number ($k\lambda$), where k is the maximum rate at which the velocity changes. The governing equations for the flow field are solved analytically up to second order; these are then used to determine the force exerted on the particle at third order through application of the reciprocal theorem. Ultimately, the unsteady force is expressed as a Volterra series expansion, and material functions like those measured in MAPS rheology[1] describing the first and third order relationships between the time course of the velocity and the force are computed.

[1]K. R. Lennon, G. H. McKinley, J.W. Swan, J. Rheol., **64**, 551-579 (2020)

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