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Decoupling the effects of the streamline curvature and the vorticity on the hydrodynamic forces acting on a spherical particle in rotating flows TOSHIAKI FUKADA, SHINTARO TAKEUCHI, TAKEO KAJISHIMA, Department of Mechanical Engineering, Osaka University, Japan — Understanding fluid-particle interactions in vortical flows is important for predicting and controlling particle-laden flows. In the present study, the angular velocity and the lift force on the particle in a free vortex (irrotational flow) and a forced vortex (rigidly-rotating flow) are studied by numerical simulation to see the effects of the streamline curvature and the vorticity of the background flows. Based on the non-inertial frame of reference fixed at the particle center, the streamline curvature and particle Reynolds number of the background flows are varied. An original convective boundary condition is proposed for the curved background flows. For both free and forced vortices, the angular velocity of the particle shows self-similar profile with respect to the streamline curvature of the background flow, and the angular velocity is decomposed into two independent contributions of the streamline curvature and the vorticity. As for the lift coefficient, which also exhibits self-similarity with respect to the streamline curvature, the contributions of the streamline curvature, the vorticity and the angular velocity of the particle are decoupled, and a unified correlation equation for both vortices is proposed.

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