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A "reciprocal" theorem for the prediction of loads on a body moving in an inhomogeneous flow at arbitrary Reynolds number JACQUES MAGNAUDET — We derive a theorem paralleling Lorentz's reciprocal theorem and providing general expressions for the force and torque acting on a rigid body of arbitrary shape moving in an inhomogeneous incompressible flow at arbitrary Reynolds number. This theorem follows the approach initiated by Quartapelle and Napolitano (1983) by making use of auxiliary solenoidal irrotational velocity fields. It allows any component of the force and torque to be evaluated solely in terms of velocity and vorticity, irrespective of its orientation with respect to the relative velocity between the body and fluid. When the body moves in a time-dependent linear flow, this theorem reveals the various couplings between the body translation and rotation and the strain rate and vorticity of the carrying flow. We show that the predictions obtained with this approach encompass all those previously obtained in the inviscid limit. We also show how it can be used to evaluate explicitly the drag and lift components of the force acting on high-Reynolds-number bubbles moving in inhomogeneous flows.

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