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Near-Zero-Drag Objects S. T. THORODDSEN, I. U. VAKARELSKI, KAUST, E. KLASEBOER, IHCP, A. JETLY, M. M. MANSOOR, A. A. AGUIRRE-PABLO, KAUST, D. Y. C. CHAN, Univ. Melbourne — The quest to reduce aerodynamic drag on blunt objects is driven by the need to reduce propulsive energy. Solid objects moving in an ideal fluid experience no drag. This prediction, known as the D'Alembert's paradox, is resolved by the no-slip boundary condition on the solid surface, which promotes boundary-layer separation and form drag. Here we report objects which minimizes both the form and viscous drag within a liquid, by encasing a free-falling solid sphere inside a streamlined gas cavity. The cavity-shape self-adjusts to the streamlined potential-flow solution satisfying the Bernoulli equation on the free surface, when taking into account the hydrostatic pressure gradient. The tear-drop-shaped gas cavity is originally formed around the sphere as it impacts a pool surface in a deep tank, providing that the sphere is heated above the Leidenfrost temperature. By assuming zero form-drag we can predict the separation point of the free surface from the solid. This sphere-in-cavity structure typically has a drag coefficient less than 10% that of a solid object with the same shape. This should represent the smallest possible drag. The fall velocity is uniquely predicted by sphere density and cavity volume, with larger cavities fall faster.

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