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Self-similar thermals in Stokes flow JOHN LISTER, ROBERT WHITTAKER, ITG, DAMTP, University of Cambridge, UK — Similarity solutions are obtained for the rise of a buoyant thermal in Stokes flow (i.e. infinite Prandtl number), in which all lengths scale like $t^{1/2}$ and velocities like $t^{-1/2}$. The dimensionless problem depends only on the Rayleigh number $Ra = B/(\nu\kappa)$, where B is the (conserved) total buoyancy. For small Ra there are only slight deformations to a spherically symmetric Gaussian temperature distribution. For large Ra the temperature distribution is greatly elongated in the vertical direction, with a long 'wake', which contains most of the buoyancy and dominates the flow, and a small 'head', which is asymptotically unimportant. This structure contrasts with the usual view of mantle plumes and laboratory experiments. The large-Ra behaviour is explained using a simple analytic model based on slender-body theory. The width of the thermal increases like $(\kappa t)^{1/2}$ while the wake length and rise height both increase like $(Ra \ln Ra)^{1/2}(\kappa t)^{1/2}$.

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