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Rayleigh-Taylor Instabilities and the Buoyancy-Drag Equation

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The buoyancy-drag equation (BDE) is a non-linear second order differential equation (SODE) arising in the study of Rayleigh - Taylor instabilities which develop when two fluids with different densities are superposed in a external acceleration field g. In this paper, the integrability of the buoyancy-drag equation is examined. For either a constant acceleration g0 or a time-dependent g(t) given by a power law of time t, the BDE is shown to be invariant under the homothetic Lie point symmetry and for both cases a non-linear FODE (first order differential equation) is obtained. For g=g0, the FODE is separable and its general solution can be derived and written in terms of quadratures. The time-dependent situation does not lead to the general solution, however a one-parameter solution can be found. Finally, the asymptotic (t goes to infinity) behaviors of these solutions are studied and "attractor" properties are eveidenced.