Public Abstract
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Title:A free boundary gas dynamic model as a two-body field theory problem

Motivated by the two-body problem in the classical field theories of electrodynamics and gravitation, in which finite propagation speeds lead to radiation reaction and runaway solutions, we develop a free boundary problem in gas dynamics to explore the motion of sources in a medium whose dynamics are governed by wave-like equations arising from physical conservation laws. In our linearized acoustic model, the fields can be eliminated to yield functional differential equations for the motion of the sources---delay equations with an infinite dimensional state space. Expansion and truncation gives rise to runaway solutions, just as in the classical field theories. We illustrate a scheme for eliminating runaway solutions by reducing to a finite dimensional, globally attracting, invariant manifold on which effective equations of motion for the sources can be obtained. The effective equations of motion approximate the asymptotic behavior of solutions in the full space as they approach the manifold. The results obtained suggest further research on the interaction of fluids coupled to vibrating sources. Furthermore, our acoustic field theory model provides some evidence that the two-body problems of the more complicated electrodynamic and gravitational field theories might yield effective dynamics by similar methods. We also treat the full nonlinear gas dynamic free boundary problem and show that unique classical solutions exist locally, for initial fields close enough to their constant steady state.