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On Global Dynamics of 3-D Irrotational Compressible Fluids

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We consider global-in-time evolution of irrotational, isentropic, compressible Euler flow in 3-D. We study a broad class of smooth Cauchy data, prescribed on an annulus and surrounded by a non-vacuum constant exterior state, without symmetry assumptions. By imposing a sufficient expansion condition on the initial data and using the nonlinear structure of the Euler equations, we show that the first-order transversal derivative of the normalized density decays as $\langle t\rangle^{-1}(\log\langle t\rangle+1)^{-1}$, provided that the perturbation arising from the tangential derivatives can be properly controlled for all t by using a bootstrap argument. This enables us to construct global exterior solutions, including a rather general subclass forming rarefaction at null infinity. Our result applies to data with a total energy of any size, as it does not require smallness of the transversal derivatives of smooth data.

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