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Manwai Yuen

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Blowup for Regular Solutions and C^1 Solutions of Euler Equations in R^N with a Free Boundary

Manwai Yuen*

Department of Mathematics and Information Technology,

The Education University of Hong Kong,

10 Lo Ping Road, Tai Po, New Territories, Hong Kong

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Abstract

The compressible Euler equations are fundamental models in the study of fluids, plasmas, condensed matter and atmospheric dynamics. In this paper, we analyze the blowup phenomena of the weakened regular solutions $(\rho, \vec{u})$ and the C^1 solutions for $\gamma \geq 2$ of the Euler equations in $\mathbf{R}^N$ in an initial bounded region $\Omega(0)$. If

$$\max_{\vec{x}_0 \in \partial\bar{\Omega}(0)} \sum_{i=1}^{N} u_i^2(0, \vec{x}_0) < \frac{\min(2, N(\gamma-1))E}{M},$$

where E is the total energy and $M > 0$ is the total mass,

then the corresponding solutions blow up in finite time. Our blowup development for the free boundary value problem partially complements the result for the fixed boundary problem. (T. Makino, S. Ukai and S. Kawashima, *Sur la Solution à Support Compact de l'équations d'Euler Compressible (French) [On the Compactly Supported Solution of the Compressible Euler Equation]*, Japan J. Appl. Math. **3** (1986), 249–257.)

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*E-mail address: nevetsyuen@hotmail.com