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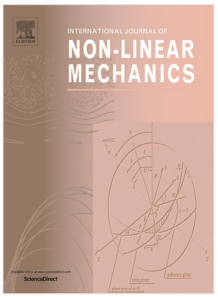

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Yicheng Pang, Yu Zhang, Yongsong Wen

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Delta shock wave to the compressible fluid flow with the generalized Chaplygin gas*

Yicheng Pang[a], Yu Zhang[b], Yongsong Wen[a]

a. School of Mathematics and Statistics, Guizhou University of Finance and Economics, Guiyang 550025, China

b. Department of Mathematics, Yunnan Normal University, Kunming 650500, China

Abstract: We concern with the Riemann problem the compressible fluid flow with the generalized Chaplygin gas. With the analysis on the phase plane, we rigorously confirm the occurrence of delta shock wave with Dirac delta function in density. Then the formation mechanism, generalized Rankine-Hugoniot relation and entropy condition for the delta shock wave are clarified. Based on these preparations, five kinds of exact solutions are obtained. Finally, the corresponding numerical results are also presented to illustrate our analysis.

Keywords: Delta shock wave; Generalized Chaplygin gas; Compressible fluid flow; Riemann problem.

1 Introduction

We consider the one-dimensional compressible fluid flow of the form

$$\begin{cases} \rho_t + (\rho u)_x = 0, \\ u_t + \left(\frac{u^2}{2} + \int^{\rho} \frac{p'(s)}{s}\mathrm{d}s\right)_x = 0, \end{cases} \tag{1.1}$$

where the variables ρ, u, p denote density, velocity and pressure. System (1.1) was first given by Earnshaw [1], and is called as the one-dimensional compressible fluid flow [2]. Besides, this system is also a hydrodynamic limit for the Vlasov equation [3],

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