Eighth International Conference on
Geometry, Integrability and Quantization
June 9–14, 2006, Varna, Bulgaria
Ivaïlo M. Mladenov and Manuel de León, Editors
SOFTEX, Sofia 2007, pp 279–291

CHAPLYGIN GAS AND BRANE

NAOHISA OGAWA

Department of Liberal Arts, Hokkaido Institute of Technology
006-8585 Sapporo, Japan

Abstract. We review the theory of Chaplygin gas. This theory arises from the non-relativistic fluid mechanics with exotic state equation. This condition actually admits that the fluid theory reduces to the simple relativistic geometrical objects. This means that the non-relativistic fluid theory has hidden Poincare symmetry. We will show that the geometrical object is the brane described by the Nambu–Goto action. The application of this Chaplygin gas to the universe model is also briefly reviewed.

1. Introduction

We consider the non-relativistic fluid dynamics without viscosity. In this case the dynamical equation reduces to the usual Euler equation. We further give the exotic state equation to this theory such as

$$P = -2\frac{\lambda}{\rho} \tag{1}$$

with pressure P, density ρ, and some constant λ.

Such a fluid is called a **Chaplygin gas** which turns out to be a special effective theory of the gas fluid. Despites that it seems to be a trivial classical problem, this theory contains marvellous symmetries and beautiful geometrical contents. The symmetry is one-dimensional higher that the Poincare symmetry, and the related geometrical object is the brane with less extrinsic mean curvature. This means that the theory of Chaplygin gas is equivalent to the relativistic brane theory [10–13].

In this paper, we briefly sketch the relation to brane picture, then we find many types of solutions, and we show the symmetries of this theory. According to the relation to relativistic brane, we find the equivalence to the Born–Infeld theory. From this picture, we find different types of solutions. In the final section, we