On The Thermodynamic Stability Of The Variable Chaplygin Gas

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Abstract

The thermodynamical behaviour of the Variable Chaplygin gas (VCG) model is studied, using an equation of state like $P = -\frac{B}{\rho}$, where $B = B_0 V^{-\frac{n}{3}}$. Here B_0 is a positive universal constant and n is a constant. From the consideration of thermodynamic stability, it is seen that only for the negative values of n, $\left(\frac{\partial P}{\partial V}\right)_S < 0$ throughout the evolution. Again thermal capacity at constant volume c_V shows positive expression. Using the best fit value of $n = -3.4$ as previously found by Guo et al [Z K Guo and Y Z Zhang , *Phys. Lett.* ***B645***, 326 (2007)] gives that the fluid is thermodynamically stable throughout the evolution. The effective equation of state for the special case of, $n = 0$ goes to ΛCDM model. Again for $n < 0$ it favours phantom-like cosmology which is in agreement with the current SNe Ia constraints like VCG model. The deceleration parameter is also studied in the context of thermodynamics and the analysis shows that the *flip* occurs for the value of $n < 4$. Finally the thermal equation of state is discussed which is an explicit function of temperature only. It is also observed that the third law of thermodynamics is satisfied in this model. As expected the volume increases as temperature falls during adiabatic expansions. In this case, for $T \to 0$, the thermal equation of state reduces to $\left(-1 + \frac{n}{6}\right)$ which is identical with the equation of state for the case of large volume.