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On Thermodynamic Stability of the Variable Generalised Chaplygin gas

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A cosmological model with a new variant of Chaplygin gas obeying an equation of state(EoS), $p = -\frac{B}{}$ where $B = B_0 a^n$[1], is investigated in the context of its thermodynamical behaviour. Here B_0 and n are constants and a is scale factor. We show that the equation of state of this 'Variable Chaplygin gas'(VGCG) can describe the current accelerated expansion of the universe. Following standard thermodynamical criteria we mainly discuss the classical thermodynamical stability of the model and find that the new parameter, n introduced in VGCG plays a crucial role in determining the stability considerations and should always be negative[2]. Moreover the positivity of thermal capacity at constant volume c_V as also the validity of the third law of thermodynamics are ensured in this case. For the particular case $n = 0$ the effective equation of state reduces to CDM model in the late stage of the universe while for $n < 0$ it mimics a phantom-like cosmology which is in broad agreement with the present SNe Ia constraints like VGCG model.The thermal equation of state is discussed and the EoS parameter is found to be an explicit function of temperature only. Further for large volume the thermal equation of state parameter is identical with the caloric equation of state parameter when T $\longrightarrow$0.
We further observe that although the earlier model of Lu[3] explains many of the current observational findings of different probes it fails the desirable tests of thermodynamical stability. Our model is very general in the sense that many of earlier works in this field may be obtained as a special case of our solution.

References:
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