

NASSP Project 2024

Gauging the Chaplygin Dark Universe (Dr Gary Tupper)

At present, we understand only about 5% of the universe we inhabit – that made up of particles described within the standard model of particle physics. The standard model of cosmology, in contrast, consists of an ad hoc mixture of cold dark matter (a legacy of low energy supersymmetric particle models, now refuted by the large hadron collider) and a unrelated cosmological constant. Yet the history of physics, from Maxwell on down, has taught that advance often comes by recognising that what appear to be disparate phenomena are just different manifestations.

The first attempt at a unified dark sector model (with 880 INSPIRE citations), based upon the perfect fluid “Chaplygin gas”, fails due to frustrated structure formation. Such a fluid has a *global* shift symmetry for its velocity potential, in conflict with notions of relativity. As reported at ‘Beyond the Concordance Model II’ (<https://www.youtube.com/watch?v=7THFRgoJ-J8&t=7s>) the result of making this symmetry *local* is a new model which is similar to electrodynamics but with a “source current” that is a function of the gauge potential.

The purpose of the project is to investigate numerical solutions of the nonlinear equations in the “gauged Chaplygin gas” with an aim of modelling dark matter halos. It is suitable for students having good mathematical and computational skills.