Project 18 2023/24: Project Plan

'Scalar Fields in Cosmology'.

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1 Aims:

In this project we aim to demonstrate that the method as given by investigating the properties of Scalar Fields in a cosmological model give rise to the Dynamical Dark Energy required to describe the observed acceleration in universal expansion. From this we aim to compare these predictions either to real data from the Euclid Space Telescope, or to generate model data. The solutions to the autonomous equations in the presence of various potentials and fields should yield results giving points of different stability, from this we can also back-track for real - observable quantities like Redshift, which can be used to compare with data.

2 Costing and Work Packages:

This is a theoretical physics project, as such the costs are limited to ink and computational simulations, but these are unnecessary to include. As yet the work packages being used are unknown.

3 Anticipated schedule:

Pre-Review:
Everyone has derived the autonomous equations as given in [1], for an exponential potential.

3.1 January 2024

Weeks 1 and 2 are not included as they are before the deadline.

Week 3:
19/01 - All submit separate Literature Reviews and Joint Plan

Week 4:
Solve the derived autonomous equations to determine existence of solutions. Compare to [1] and among various calculations to determine validity. Plot the derived equations and ensure they are consistent with [1].

3.2 February 2024

Week 1:
Introduce a second fluid (to model Matter and Radiation) into the simulations in addition to the exponential potential. This increases the number of dimensionless Friedmann constraint variables to x', y' as well as z'.

Week 2:
Perform the same analysis for fixed points and stability as was done for the autonomous equations given in [1] for the new equations.

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Week 3:
Will realise that in this case can't have tracking behaviour as well as Dark Energy domination (as required), so need more exponential potentials. This produces a system with two fluids and two potentials.

Week 4:
Derive equations for the new system then test as before.

3.3 March 2024

Week 1/2: Empty to account for delays due to Modern Cosmology projects.

Week 3:
Reconstruct physical observables $H(z), \phi(z), z(N)$. This will allow easier comparison to existing data.

Week 4:
Generate plots of ℓ_D vs z to compare to data.

3.4 April 2024

Looking at early Dark Energy, discuss early impulse which possibly contributed to the Hubble tension.

3.5 May 2024

Finalisation of Project and Write up.

References

[1] Edmund J. Copeland, Andrew R. Liddle, and David Wands. Exponential potentials and cosmological scaling solutions. *Physical Review D*, 57(8):4686–4690, April 1998.

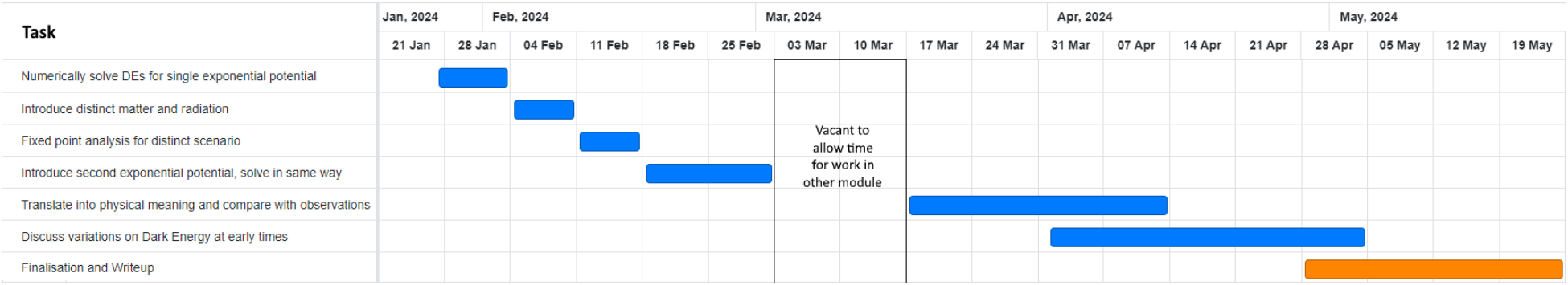

Figure 1: Gantt chart showing rough project timeline. Division of roles between project members was not relevant since we will all be contributing to every task