Cosmological constraints on a coupled Multi Scalar Field Dark Matter Model

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About two decades ago, it was proposed that a scalar field can be used to describe the Dark Matter. The simplest of such models is a real, scalar field minimally coupled to baryonic matter gravitationally. There are a few motivations to extend this model to a multi field one. First, the dark matter particles can exist in multiple quantum states, giving them different effective potentials if the original mass is light. Second, the dark matter could be made of multiple species to begin with, just as the baryonic counterpart does. Moreover, a single scalar field model does fall short in describing some observations, requiring different masses on different scales.

There are quite a few variables to play with in a multi scalar field dark matter model. For example, it is interesting to see the impact of the field being real or complex, of the introduction of self interaction, of the interaction among DM species, of the form of the potentials, and of the mass hierarchy. I will derive the equations for the background and linear perturbations, and numerically calculate the DM mass power spectrum and the CMB power spectrum for the different variations. (The scope of variations permitted by the limited time frame) I will then use observational data to place constraints on the model parameters.