MAGIC

Science of the Cosmos

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Cosmological effect of coherent oscillation of ultralight scalar fields in a multicomponent universe

The idea that coherent oscillations of a scalar field, oscillating over a time period that is much shorter than the cosmological timescale, can exhibit cold dark matter (CDM) like behavior was previously established. In our work we first show that this equivalence between the oscillating scalar field model and the CDM sector is exact only in a flat Friedmann-Lemaitre-Robertson-Walker (FLRW) spacetime in the absence of cosmological constant and any other possible matter components in the universe when the mass of the scalar field is very large compared to the Hubble parameter. Then we show how to generalize the equivalence between the coherently oscillating scalar field model and the CDM sector in a spatially curved universe with multiple matter components. Using our general method, we will show how a coherently oscillating scalar field model can represent the CDM sector in the presence of non-minimal coupling of the CDM sector with radiation. Our method is powerful enough to work out the dynamics of gravitational collapse in a closed FLRW spacetime where the coherently oscillating scalar field model represents the CDM sector. We have, for the first time, presented a consistent method which specifies how a coherently oscillating scalar field model, where the scalar field is ultralight, acts like the CDM sector in a multicomponent universe.

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