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Revisiting the approximations on the cosmological solutions of ultra-light axions

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Ultra-light axions are promising dark matter candidates, but the computation of their cosmological observables is challenging because of the rapid oscillations of the axion field around the minimum of its potential. Different approaches have been discussed in the literature to avoid such difficulty, mainly by using approximated formulas for the axion equation of state and sound speed. Here, we revisit an alternative method that makes a change of variables and which allows to spot more easily the rapidly oscillating terms in the equations of motion. Such terms can be cut-off directly in the differential equations without spoiling the accuracy of the final output, and without manipulating the equation of state and the sound speed. A comparison between numerical and semi-analytical is shown to assess the appropriateness of the method to solve the original axion equations.

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