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Higgs-portal vector dark matter at a low reheating temperature

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We study vector dark matter (DM) production with Higgs-portal type interactions in the scenarios with a low reheating temperature which can be realized by a prolonged decay of the inflaton after inflation. We take the reheating temperature to be large enough to match the observations in Standard Cosmology such as Big Bang Nucleosynthesis but small enough below the DM mass for the DM production. We analyze the impact of the model parameters including the extra gauge coupling and the reheating temperature on the DM relic density, collider bounds and DM direct and indirect detection experiments.
The decay processes are generally subdominant for the DM production but they can be important when kinematically allowed and the DM mass is close to half of the Higgses mass. The DM production with DM masses below 100 GeV is driven primarily by the scatterings of the SM fermions and Higgses decay whereas the case with higher DM masses is achieved mainly due to the Higgses scatterings. The enhanced coupling for the strong freeze-in in our framework enables potential detection prospects in direct and indirect detections and collider experiments. The parameter space of the model has already been explored partly by the current direct detection experiments and it can be explored further by future experiments such as Darwin. On the other hand, the indirect detection experiments in the current and near future are not sensitive enough to test our model.

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