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## Joint CMB and BBN Constraints for Light Dark Sectors with Dark Radiation

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We present novel constraints on sub-GeV dark matter models involving a light particle  $\chi$  and a  $U(1)'$  dark photon mediator. Using measurements of  $N_{\text{eff}}$  from the CMB and post-BBN abundances of deuterium and helium-4, we derive constraints on the mass  $m_\chi$  of the dark matter particle, assuming an MeV-scale mediator mass. Depending on the model parameters, we find that values of  $m_\chi$  below  $\sim 8$ -10 MeV produce a tension between the predicted values of these CMB and BBN parameters and their experimentally-determined values. We find that this constraint cannot be circumvented by simply adding additional degrees of freedom in the form of dark radiation. Finally, we compare these results to the sensitivities of existing and proposed direct detection experiments, and find an overlap between the regions of parameter space that many of these experiments will probe and the region of parameter space that is constrained by this analysis.

### Summary

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