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Cosmological Bounds on Non-Abelian Dark Forces

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Non-Abelian dark gauge forces that do not couple directly to ordinary matter may be realized in nature. If the dark sector is reheated in the early universe, it will be realized as a set of dark gluons at high temperatures and as a collection of dark glueballs at lower temperatures, with a cosmological phase transition from one form to the other. These glueballs can be, if left alone, the cosmological dark matter. We explore the parameter space needed to satisfy present day densities.

However, despite being dark, these new glueball states can also connect indirectly to the Standard Model through various operators. These interactions will transfer energy between the dark and visible sectors, and they allow some or all of the dark glueballs to decay. We investigate the cosmological evolution and decays of dark glueballs in the presence of connector operators to the Standard Model.

Dark glueball decays can modify cosmological and astrophysical observables, and we use these considerations to put very strong limits on the existence of pure non-Abelian dark forces. On the other hand, if one or more of the dark glueballs are stable, we find that they can potentially make up the dark matter of the universe.

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