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Higgs Implications for Dark Matter

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We investigate the impact of hypothetical new neutral light particles on the tiny width of a light Higgs boson. Reviewing the possible signatures in the Higgs decay modes with missing energy, in many cases simply preventing these modes from being dominant suffices to set tight model-independent constraints on the masses and couplings of the new light states. We then apply this analysis to Higgs portal models of DM, where DM is light enough to contribute to invisible Higgs decays. Using effective field theory we show that DM can be a thermal relic only if there are additional light particles present with masses below a few 100 GeV. We give concrete examples of viable Higgs portal models of light DM, where the $\text{Br}(h \text{ to invisible})$ constraint is not too restrictive, because it is governed by different parameters than the relic abundance.

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