

A map of the non-thermal WIMP

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We study the effect of elastic scattering on the non-thermally produced WIMP dark matter and its phenomenological consequences. The non-thermal WIMP becomes important when the reheating temperature is well below the freeze-out temperature. In the usual paradigm, the produced high energetic dark matters are quickly thermalized due to the elastic scattering with background radiations. The relic abundance is determined by the thermally averaged annihilation cross-section times velocity at the reheating temperature. In the opposite limit, the initial abundance of produced dark matters is small enough so they do not annihilate, and the relic density is determined by the branching fraction of the heavy particle. We study the regions between these two limits, and show that the relic density could be sensitive not only to the annihilation rate, but also to the elastic scattering rate. Especially, the relic abundance of p-wave annihilating dark matter crucially depends on the elastic scattering rate because the annihilation cross-section is sensitive to the dark matter velocity. We categorize the parameter space into several regions where each region has distinctive mechanism for determining the relic abundance of the dark matter at the present Universe. The consequence on the (in)direct detection is also studied.

Summary

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