

WIMP DM candidate	Quntum numbers			Masses	
	$SU(2)_L$	$U(1)_Y$	Spin	m_χ/TeV	$\Delta m_\chi/\text{MeV}$
Higgsino	2	1/2	Dirac fermion	1.1	341
Wino	3	0	Majorana fermion	2.9	166
5-plet scalar	5	0	real scalar	9.4	166
5-plet fermion	5	0	Majorana fermion	10	166

Table 1: Table of properties of popular WIMP DM candidates [?, ?, ?, ?, ?, ?]. The $SU(2)_L$ electroweak charge, $U(1)_Y$ hypercharge, spin nature, mass, and mass difference compared with a charged component of the multiplet are shown. See Sec. ?? (♣ **Caution!!** ♣) for the details of the last column.

Section 1

Models with WIMPs

There are several examples of the models that contain WIMP DM candidates. In this section, two of them (♣ **Really?** ♣) are briefly reviewed. (♣ **EWIMP and WIMP??** ♣)

1.1 Minimally supersymmetric standard model

Minimally supersymmetric standard model (MSSM)

(♣ **Relationship between λ parameter above should be clearer** ♣) WIMPs with mass around or just above the electroweak scale are theoretically well-motivated in connection with problems of the SM such as the naturalness problem. For example, the minimal supersymmetric extension of the SM (the so-called MSSM) contains several WIMP DM candidate such as Higgsino and Wino.^{b1} Another example is the minimal dark matter (MDM) model [?, ?, ?], which is a simple extension of the SM with an $SU(2)_L$ electroweak multiplet such as a 5-plet scalar / fermion. In these models, the stability of the DM is ensured by the R -parity (for the MSSM case) and by high dimensionality of the operator that describes the decay of the DM (for the MDM case). The properties of these WIMP DM candidates are summarized in Table 1. The required masses to explain the DM relic abundance through the freezeout mechanism are also shown. Since the non-relativistic annihilation cross section of TeV mass particles is significantly enhanced by the Sommerfeld enhancement effect [?, ?],

^{b1} For a review of the MSSM, see for example [?].

there are deviations from the rough estimation formula Eq. (??). We will return to this point later in Sec. ??. (**♣ Caution!! ♣**) In addition, in the last column there are mass differences Δm_χ between the DM and its charged counterpart that will be explained in detail in Sec. ??. (**♣ Caution!! ♣**)

1.2 Minimal dark matter model