

# What is DM?

Eg. PBH

$$10^{-22} \text{eV} < m < 10^{19} \text{GeV}$$

$$10^{-22} \text{eV} < m < 10^{40} \text{g}$$

**Particle**

**Non-particle**

$$10^{-2} \text{GeV} < m < 10^5 \text{GeV}$$

Eg. Axion,  $\nu_R$ , Fuzzy DM, ...

**Thermal**

**Non-thermal**

**Freeze-out**

**Asymmetric**

...

**WIMP-like**

**SIMP-like**

**Semi-ann.**

...

**DM candidates**

**Motivation**

**Signal @ Lepton Collides**

✓ CPV H-funnel DM

Anti-p excess

Invisible Higgs decay

✓ Leptophilic DM

$g_\mu - 2$

Mono- $\gamma$  process

✓ Light DM

Small scale crisis

Exotic Higgs decay

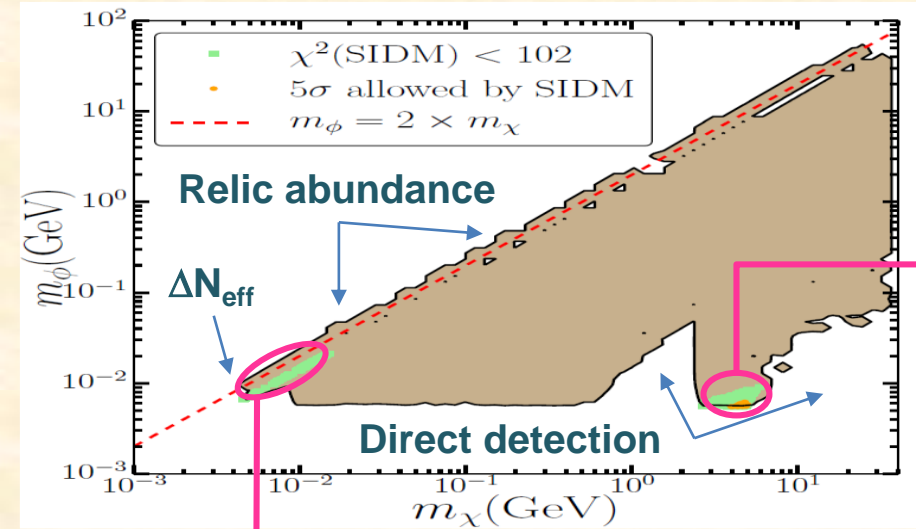
✓  $SU(2)_L$  doublet DM

SUSY naturalness

Direct prod. ( $\chi^+ \chi^-$ ,  $\chi^0_1 \chi^0_2$ )

Oblique correction, etc.

$$\mathcal{L} = \mathcal{L}_{\text{SM}} + \frac{1}{2} \bar{\chi} (i \not{\partial} - m_\chi) \chi + \frac{1}{2} (\partial \phi)^2 - \frac{c_s}{2} \phi \bar{\chi} \chi - V(\phi, H)$$



**Light mediator region ( $m_\phi \ll m_\chi$ )**

✓ **Annihilation mode:**  $\chi\chi \rightarrow \phi\phi$

✓ **Scattering mode:**  $\phi$  exchange

**DM mass is required to be  $O(1)$  GeV to have a  $v$ -dependent  $X$ -section.**

**$\phi$  couples to SM sector via  $\Phi^2/H^2$ . ( $\phi$ - $h$  mixing is very suppressed.)**

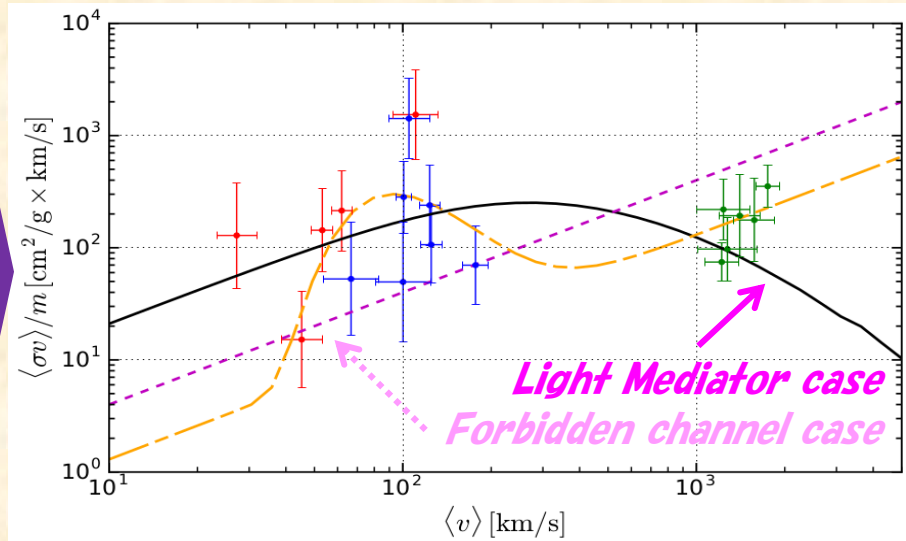
**Forbidden channel region ( $m_\phi \sim m_\chi$ )**

✓ **Annihilation mode:**  $\chi\chi \rightarrow \phi\phi$

✓ **Scattering mode:**  $\phi$  exchange

**DM mass is required to be smaller than  $O(10)$  MeV due to the channel.**

**$\phi$  couples to SM sector by  $\Phi/H^2$  int. (The level of  $\phi$ - $h$  mixing is  $\sim 10^{-3}$ ).**



$$\mathcal{L} = \mathcal{L}_{\text{SM}} + \frac{1}{2} \bar{\chi} (i \not{\partial} - m_\chi) \chi + \frac{1}{2} (\partial \phi)^2 - \frac{c_s}{2} \phi \bar{\chi} \chi - V(\phi, H)$$

*In the light mediator region, the branching fraction  $Br(h \rightarrow \phi\phi)$  is well above  $O(0.1)\%$ , so it is tested by the invisible H decay search.*

*Simple extension of the minimal model will offer the third region (the resonant region) for SSC, which leads to the exotic H decay.*

