Low Scale Gauge Mediation at Early LHC

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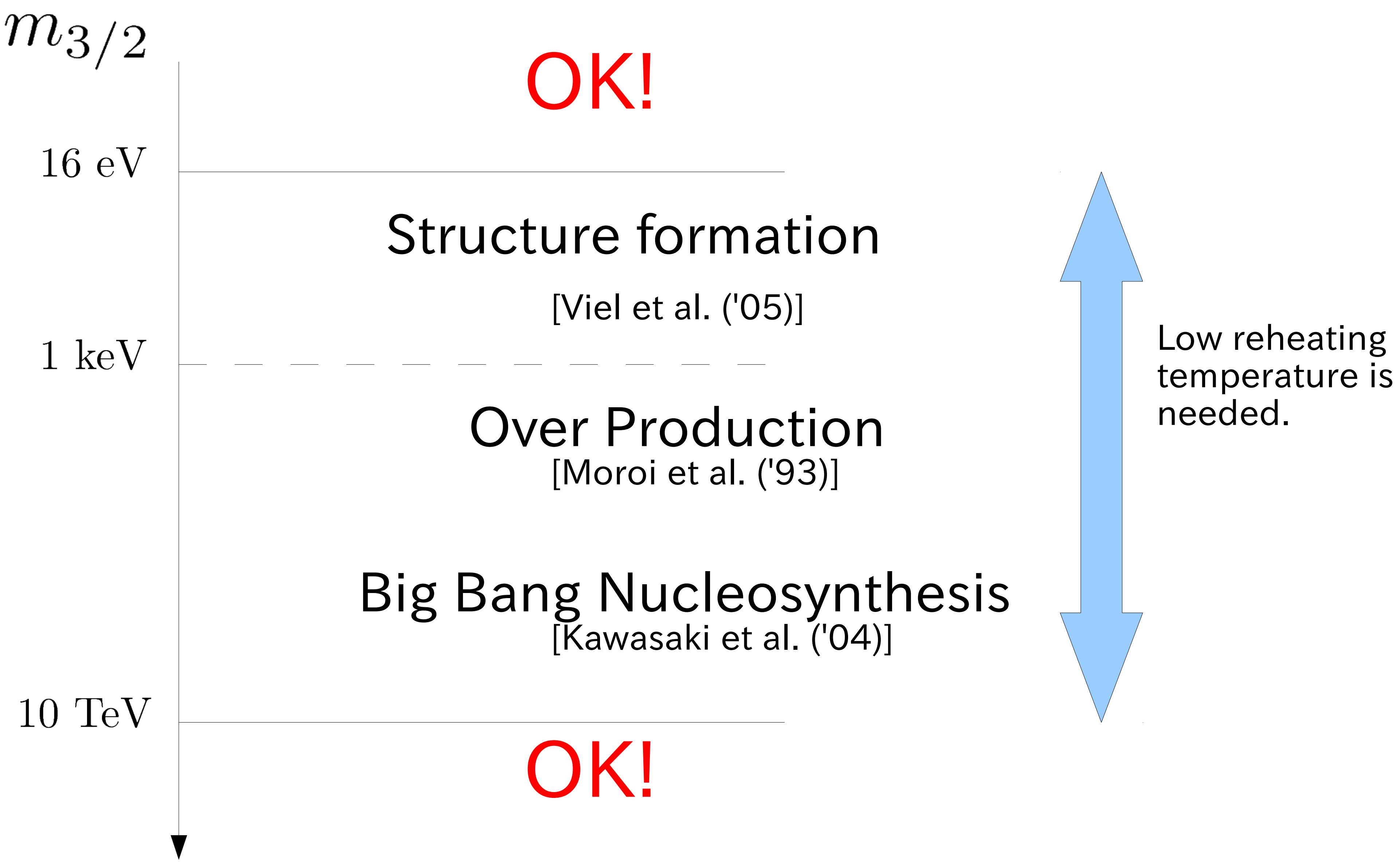
"Low Scale Direct Gauge Mediation with Perturbatively Stable Vacuum"
R.S. and K.Yonekura [hep-ph:0912.2802]

"LHC Reach of Low Scale Gauge Mediation with Perturbatively Stable Vacuum"
R.S. and S.Shirai [hep-ph:1005.1255]

1. Introduction

gravitino causes some cosmological problems



1. Introduction

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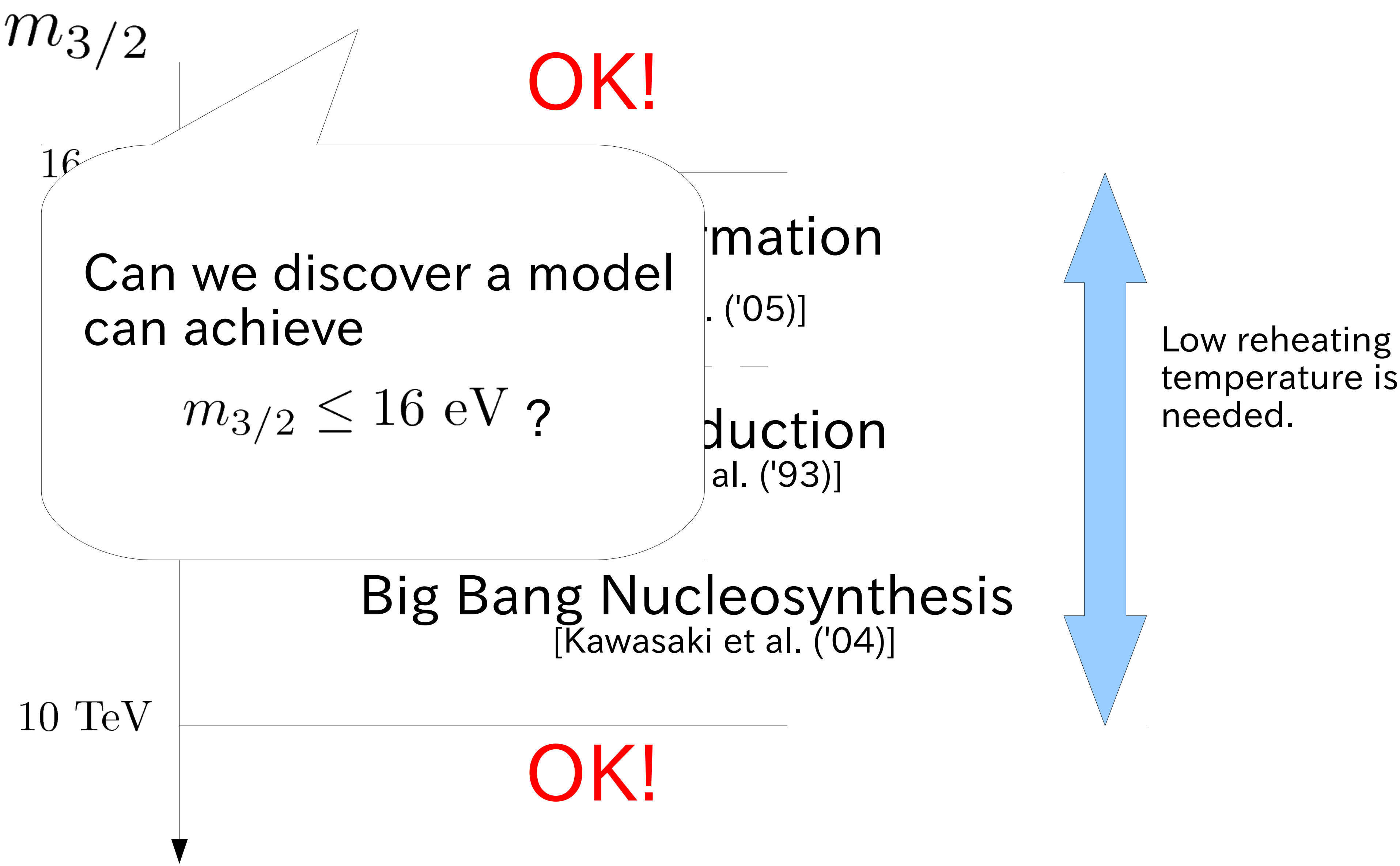


1. Introduction

2. The model with light gravitino
and stable vacuum

3. Discovery region of the model

4. Summary

2. The GMSB model with light gravitino and stable vacuum

(1) based on the Izawa-Yanagida-Intriligator-Thomas (IYIT) model

$$W = fZ + \begin{pmatrix} \tilde{\Psi}_1 & \tilde{\Psi}_2 \end{pmatrix} \begin{pmatrix} kZ & m \\ m' & 0 \end{pmatrix} \begin{pmatrix} \Psi_1 \\ \Psi_2 \end{pmatrix}$$

[Izawa et al.(1997)]

(2) based on the Intriligator-Seiberg-Shih (ISS) model

Intriligator-Seiberg-Shih model

[Intriligator et al. (2006)]

$$W = k\Phi_{ai}M^i_j\tilde{\Phi}^{aj} + \mu^2 \mathrm{tr}M$$

In the present model, the gaugino masses are suppressed.

$$m_{\tilde{g}} = \frac{\alpha}{4\pi}\frac{F}{m}\left(\cancel{c_1} + c_2\frac{F}{m^2} + c_3\left(\frac{F}{m^2}\right)^2 + \cdots\right) \sim \frac{\alpha}{4\pi}\frac{F^2}{m^3}$$

$$m_{\tilde{s}} \sim \frac{\alpha}{4\pi}\frac{F}{m}$$

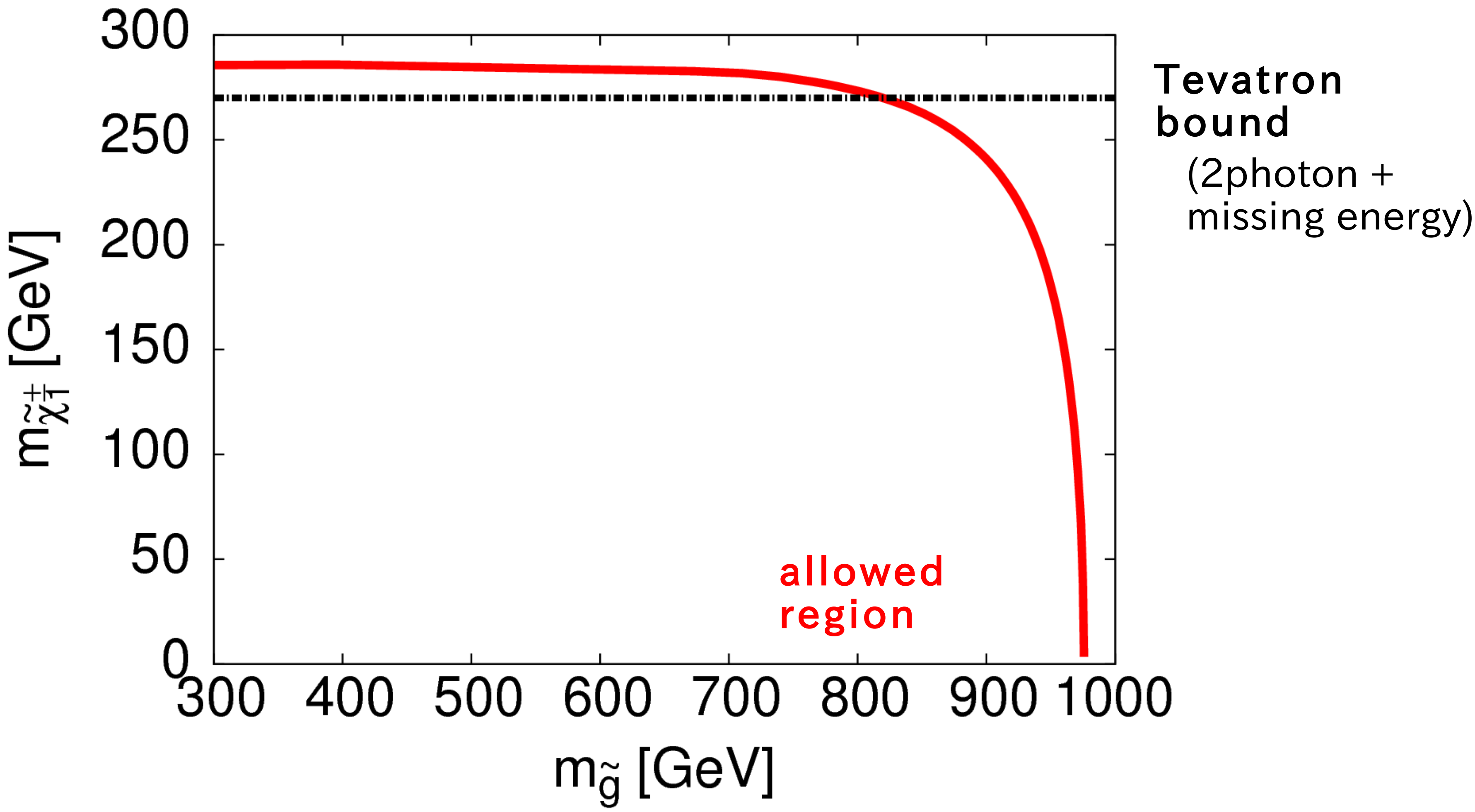
→ Discovery region of the model are determined by <u>the gaugino masses</u>.

Upperbounds of gaugino masses ⟺ Yukawa couplings

Flavor number of messengers

3. Discovery region of the model

The allowed region of the gaugino masses $(m_{3/2} = 16\ \mathrm{eV})$



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Event Selection

In the present model, **NLSP is Bino.**

→ 2 photon with missing energy

Cut A

- At least 2 isolated photons with $p_T > 20$ GeV
- At least 4 jets with $p_T > 50$ GeV
- The leading jet with $p_T > 100$ GeV
- $E_{\mathrm{T,miss}} > \max(100\ \mathrm{GeV}, 0.2 M_{\mathrm{eff}})$

$$M_{\mathrm{eff}} \equiv \sum_{4\ \mathrm{leading\ jets}} p_{T,j} + E_{\mathrm{T,miss}} + \sum_{\mathrm{lepton}} p_{T,l}$$

Cut B

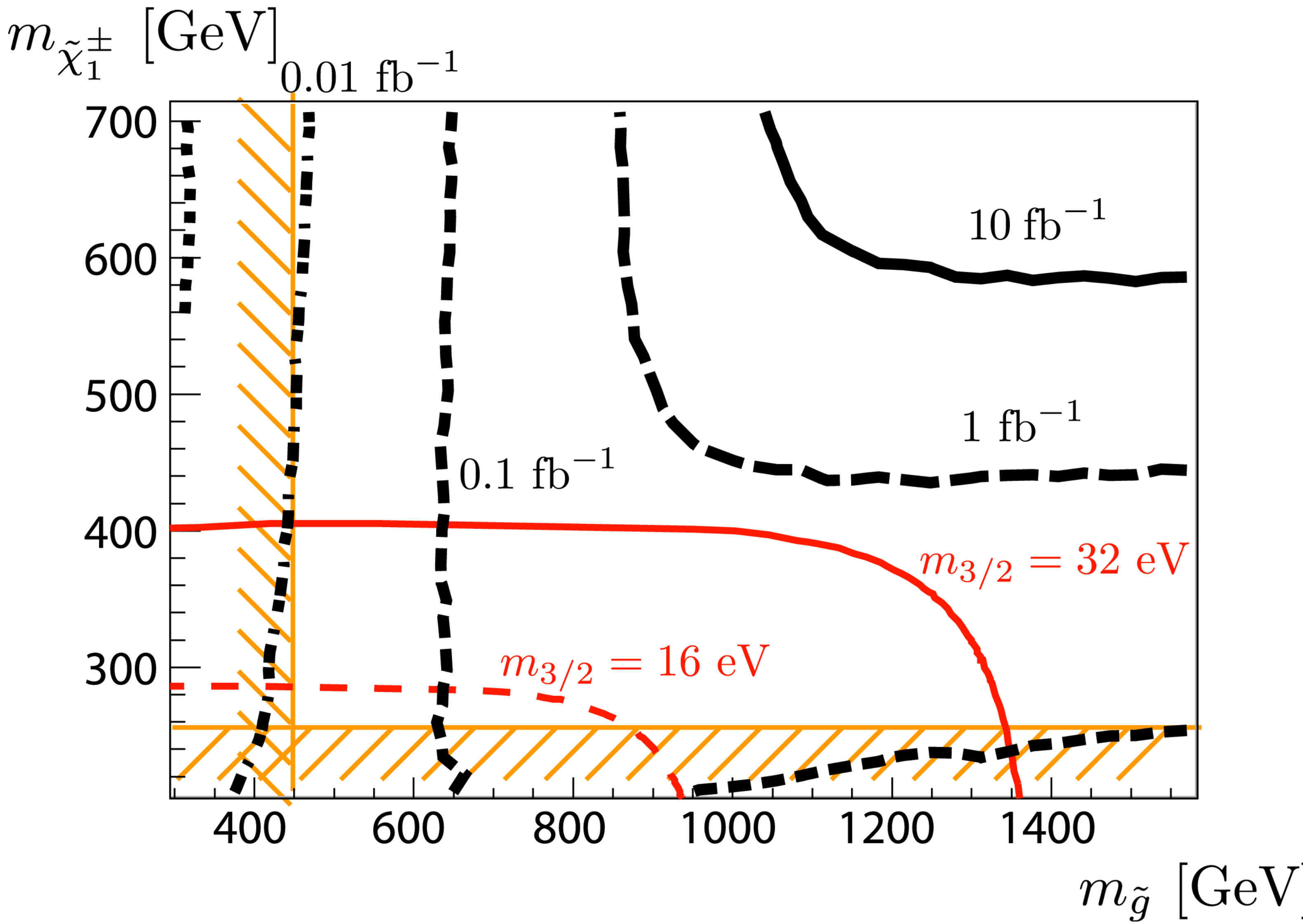
- At least 2 isolated photons with $p_{T,\gamma 1} > 60\ \mathrm{GeV},\ p_{T,\gamma 2} > 20\ \mathrm{GeV}$
- $E_{\mathrm{T,miss}} > 80$ GeV
- $m_{\gamma 1 \gamma 2} > 100$ GeV

$$\mathrm{significance} = \frac{\#\ \mathrm{of\ signals}}{\max(1,\ \#\ \mathrm{of\ BG})}$$

The discovery region @ 7TeV LHC

The discovery region where the significance reaches 5.

(2 photon + missing energy)



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4. Summary

Light gravitino mass $m_{3/2} < 16$ eV satisfies all constraints from cosmology.

In the known model which can achieve the gravitino mass $m_{3/2} < 16$ eV, the gaugino masses are suppressed.

These model can be completely discovered / excluded @ 7TeV LHC.

(Backup slide)

In the present model, the gaugino masses are suppressed.

$$m_{\tilde{g}} = \frac{\alpha}{4\pi}\frac{F}{m}\left(\cancel{c_1} + c_2\frac{F}{m^2} + c_3\left(\frac{F}{m^2}\right)^2 + \cdots\right) \sim \frac{\alpha}{4\pi}\frac{F^2}{m^3}$$

$$W = fZ + m_{ij}\tilde{\Psi}_i\Psi_j + k_{ij}Z\tilde{\Psi}_i\Psi_j \quad \Rightarrow \quad \det(m+kZ) = \det\ m$$

With stable SUSY breaking vacuum

[Komargodoski and Shih (2009)]

The leading term of the gauigno masses are given as follows

$$m_{\tilde{g}} = \frac{\alpha}{4\pi}F\frac{\partial}{\partial Z}\det(m+kZ)$$

[Guidice and Rattazi (1998)]