



# Muon $g-2$ in Semi-constrained SUSY models

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Based on

arXiv: 2011.12848 (CPC), Kun Wang, **Jingya Zhu**, Q. Jie

arXiv: 2002.05554 (JHEP), Kun Wang, **Jingya Zhu**

arXiv: 1808.10851 (JHEP), F. Wang, Kun Wang, J.M. Yang, **Jingya Zhu**

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# Outline

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- I. CMSSM/CNMSSM extensions with NUGM / NUHM
- II. Interpreting muon  $g-2$  in NUHM / NUGM SUSY models
- III. Checking with dark matter detection experiments
- IV. Summary

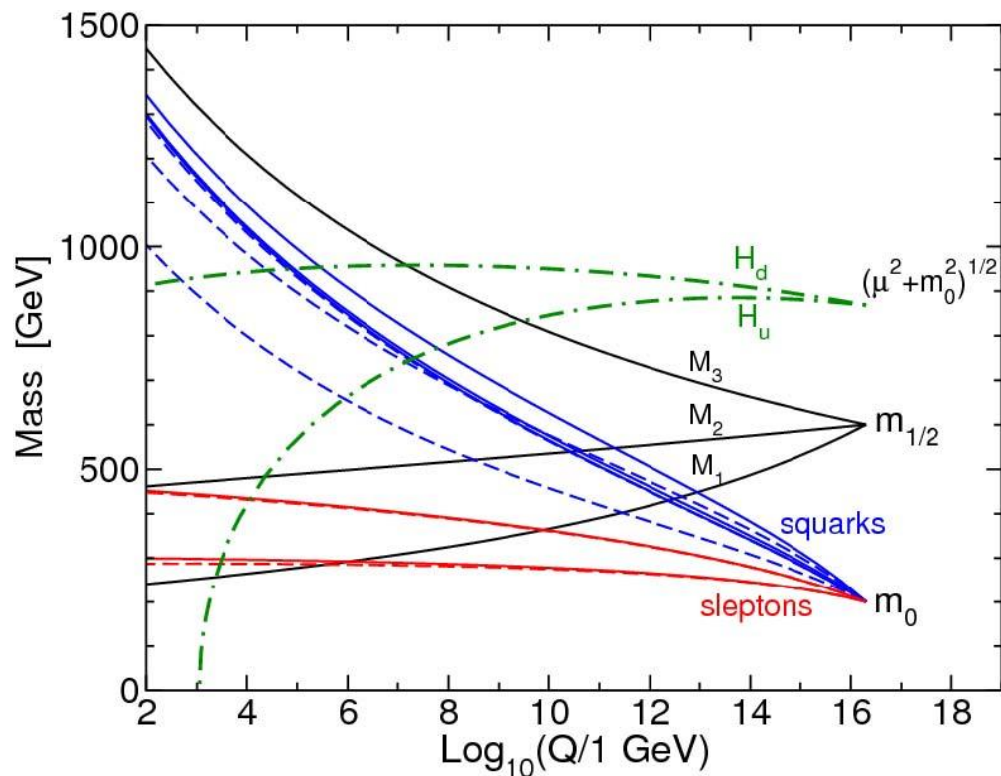
# I.1 Problems of CMSSM/CNMSSM

Free parameters:  $\tan\beta$ ,  $M_{1/2}$ ,  $M_0$ ,  $A_0$ ,  $\text{Sign}(\mu)$

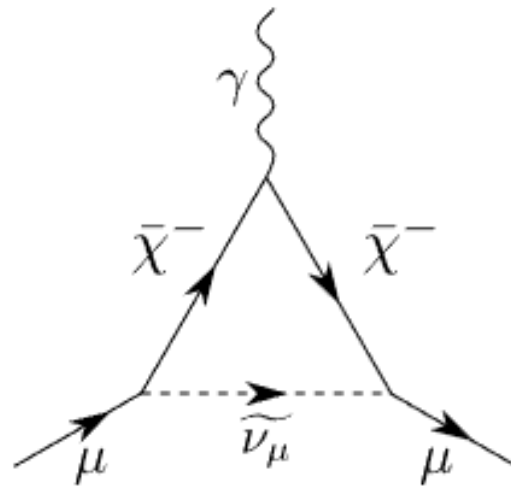
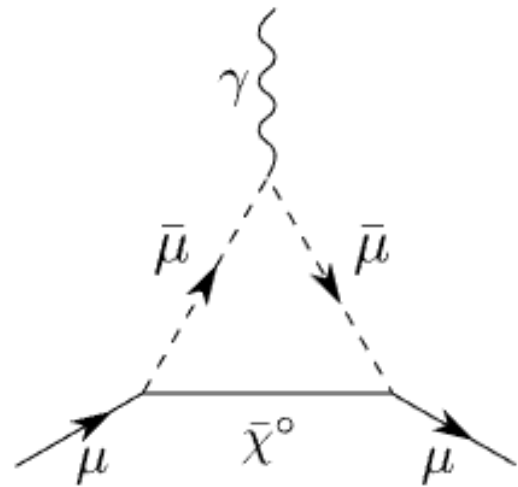
Confronting with current experimental results:

- high mass bounds of gluino and the first-two generation squarks
- muon  $g-2$
- 125 GeV Higgs mass
- dark matter relic density
- .....

nearly be excluded



# I.2 SUSY contributions to muon g-2



- smuon + neutralino
- chargino + sneutrino

$$\begin{pmatrix} \tilde{\chi}_1^+ \\ \tilde{\chi}_2^+ \end{pmatrix} = V_{ij} \begin{pmatrix} \tilde{W}^+ \\ \tilde{H}_u^+ \end{pmatrix},$$

$$\begin{pmatrix} \tilde{\chi}_1^- \\ \tilde{\chi}_2^- \end{pmatrix} = U_{ij} \begin{pmatrix} \tilde{W}^- \\ \tilde{H}_d^- \end{pmatrix}$$

$$\begin{pmatrix} \tilde{\chi}_1^0 \\ \tilde{\chi}_2^0 \\ \tilde{\chi}_3^0 \\ \tilde{\chi}_4^0 \\ \tilde{\chi}_5^0 \end{pmatrix} = N_{ij} \begin{pmatrix} \tilde{B} \\ \tilde{W}^0 \\ \tilde{H}_d \\ \tilde{H}_u \\ \tilde{S} \end{pmatrix}$$

# I.3 Two extensions: NUGM and NUHM

**NUGM:** Non-Universal Gaugino Masses

$$(24 \otimes 24)_{\text{symm}} = 1 \oplus 24 \oplus 75 \oplus 200$$

Representations	GUT scale	EW scale
1	1 : 1 : 1	1 : 2 : 6
24	$1 : \frac{1}{3} : -\frac{1}{2}$	3 : 2 : -9
75	$-\frac{1}{5} : \frac{1}{3} : 1$	-3 : 10 : 90
200	$\frac{1}{10} : \frac{1}{2} : 1$	1 : 10 : 60

**NUHM:** Non-Universal Higgs Masses

$$M_{H_u}^2 \neq M_0^2 + \mu^2 \quad A_\lambda \neq A_0$$

$$M_{H_d}^2 \neq M_0^2 + \mu^2 \quad A_\kappa \neq A_0$$

$$M_S^2 \neq M_0^2 + \mu^2$$

$$\lambda, \kappa, \mu_{\text{eff}}, A_\lambda, A_\kappa, \tan\beta, A_0, M_0, M_{1/2}$$

## II.1 Calculation of muon g-2 (with NMSSMTools)

- The experimental data
- SM calculation without the Higgs contribution
- SUSY contribution including that of the SM-like Higgs
- theoretical uncertainty in SUSY contribution

$$a_{\mu}^{\text{ex}} = (11659208.0 \pm 6.3) \times 10^{-10},$$

$$\Delta a_{\mu} \equiv a_{\mu}^{\text{ex}} - a_{\mu}^{\text{SM}} = (27.4 \pm 9.3) \times 10^{-10}.$$

$$\delta^{\text{th}} \approx 3 \times 10^{-10}$$

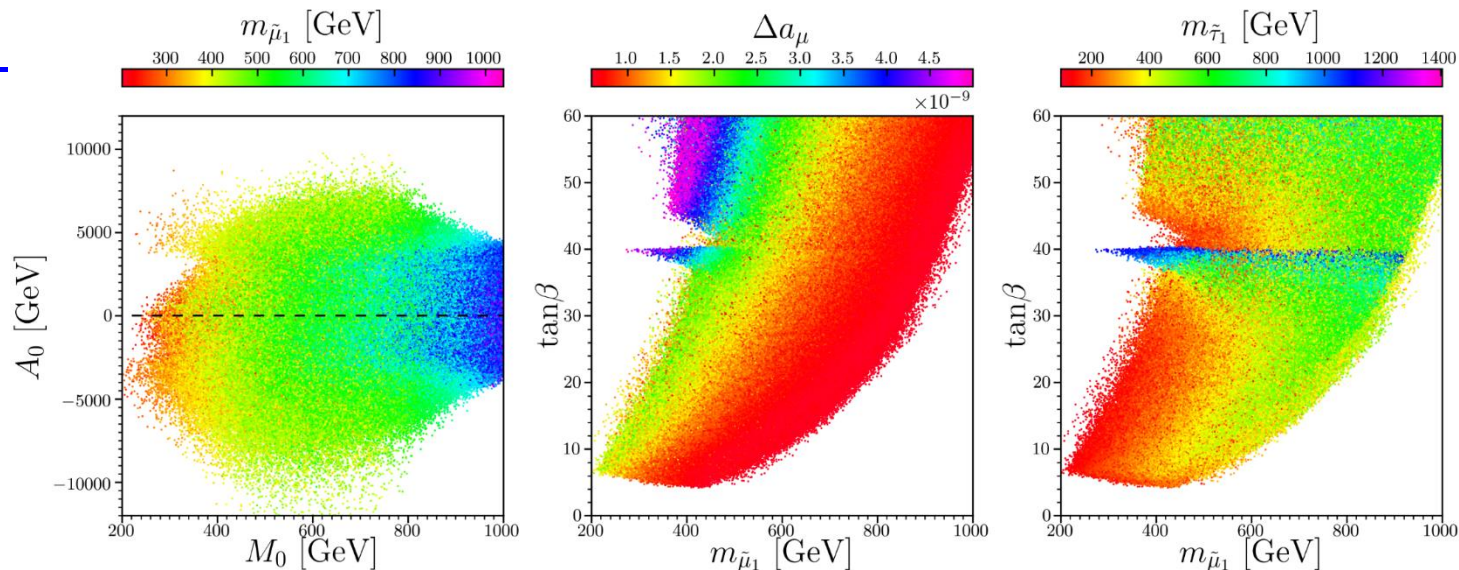
$$a_{\mu}^{\text{ex}}(\text{FNAL}) = (11659204.0 \pm 5.4) \times 10^{-10},$$

$$a_{\mu}^{\text{ex}}(\text{combine}) = (11659206.1 \pm 4.1) \times 10^{-10}$$

# II.2 Muon g-2 in NUHM / NUGM SUSY models

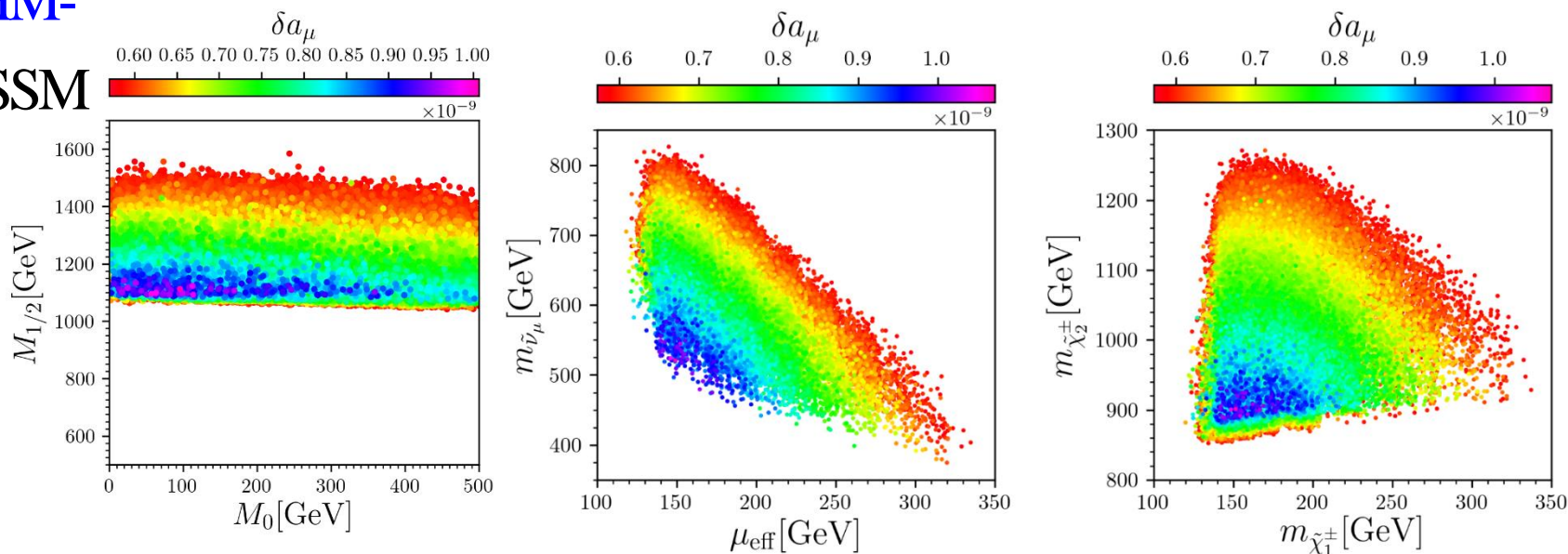
NUGM-

MSSM



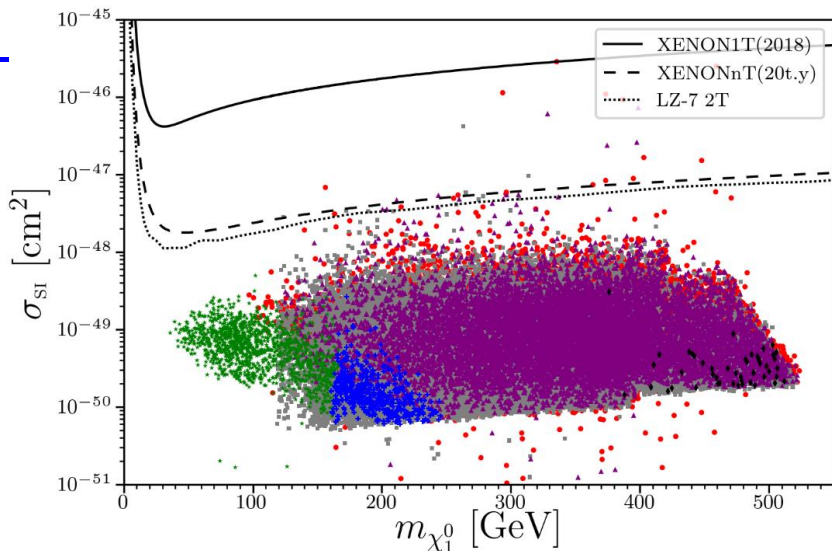
NUHM-

NMSSM



# III. Checking with dark matter experiments

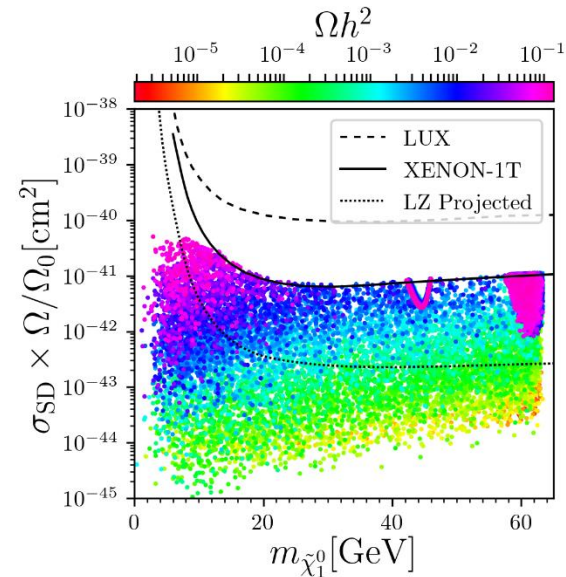
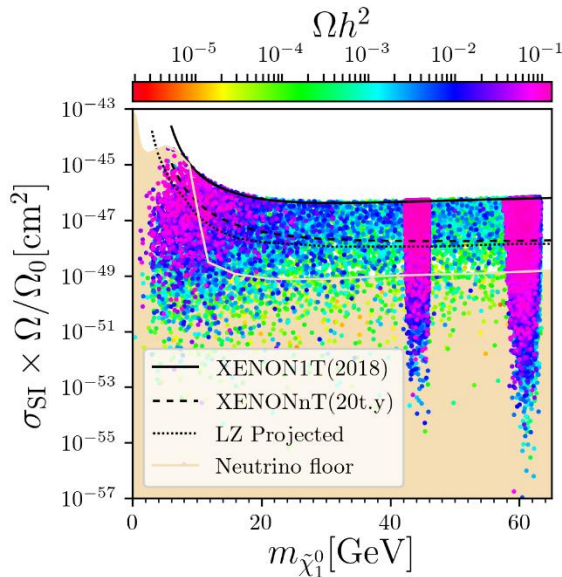
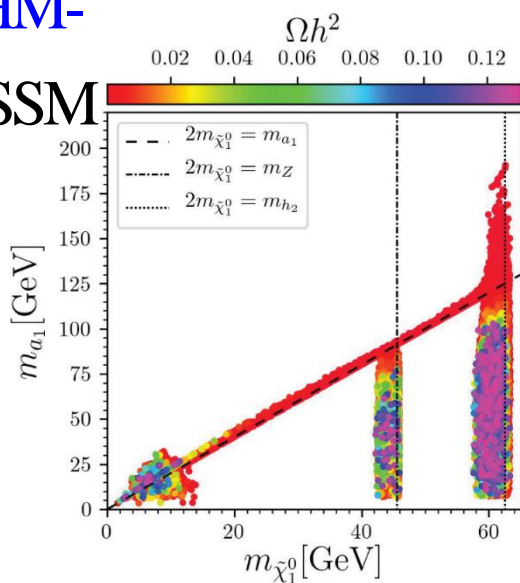
NUGM-  
MSSM



$$\begin{aligned} \tilde{\tau}_1 \text{ exchange : } & m_{\tilde{\tau}_1} < 200 \text{ GeV,} \\ \tilde{\tau}_1 \text{ coannihilation : } & \frac{m_{\tilde{\tau}_1}}{m_{\chi_1^0}} < 1.2, \frac{m_{\chi_1^\pm}}{m_{\chi_1^0}} > 1.2, \\ \chi_1^\pm \text{ coannihilation : } & \frac{m_{\tilde{\tau}_1}}{m_{\chi_1^0}} > 1.2, \frac{m_{\chi_1^\pm}}{m_{\chi_1^0}} < 1.2, \\ \text{hybrid2 : } & \frac{m_{\tilde{\tau}_1}}{m_{\chi_1^0}} < 1.2, \frac{m_{\chi_1^\pm}}{m_{\chi_1^0}} < 1.2, \\ \tilde{\tau}_1 \text{ hybrid3 : } & \frac{m_{\tilde{\tau}_1}}{m_{\chi_1^0}} > 1.2, \frac{m_{\chi_1^\pm}}{m_{\chi_1^0}} > 1.2, \quad 200 < m_{\tilde{\tau}_1} < 400 \text{ GeV,} \\ \tilde{\ell} \text{ annihilation : } & \frac{m_{\tilde{\tau}_1}}{m_{\chi_1^0}} > 1.2, \frac{m_{\chi_1^\pm}}{m_{\chi_1^0}} > 1.2, \quad m_{\tilde{\tau}_1} > 400 \text{ GeV.} \end{aligned}$$

$\tilde{\tau}_1$  exchange by green star '★',  $\tilde{\tau}_1$  hybrid3 by blue cross '+',  $\tilde{\tau}_1$  coannihilation by red bullet '•',  $\chi^\pm$  coannihilation by purple triangle '▲', hybrid2 by gray square '■', and  $\tilde{\ell}$  annihilation by black lozenge '◆'.

NUHM-  
NMSSM





# IV. Summary

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- CMSSM/CNMSSM can not interpret muon  $g-2$  result under current constraints.
- Muon  $g-2$  can be interpreted in semi-constrained SUSY models such as **NUGM-NMSSM** and **NUHM-NMSSM**.
- Muon  $g-2$  in **NUGM-MSSM** can be larger because wino, bino, and sneutrino can all be light.
- Muon  $g-2$  in **NUHM-NMSSM** can be interpreted because small  $\mu$  parameter.
- The interpreting scenarios in **NUHM-NMSSM** can be checked with spin-dependent detection experiment by LZ-7 ton in the future.

# 谢谢！

欢迎大家到八朝古都开封  
访问河南大学(双一流)！