Next-to-Leading Order Correction to Gauge-Mediated Gaugino Masses

hep-ph/9802446

Marco Picariello *e* Alessandro Strumia
Istituto Nazionale di Fisica Nucleare, Sezione di Pisa
Dipartimento di Fisica dell'Università di Pisa

Sommario

- Motivazioni Fisiche
- Modello Standard e Supergravitá
- Modello Standard e Gauge-Mediation
- Supersimmetria Perturbativa
- Conclusioni

Unificazione delle Costanti di Gauge

Predizioni vs Dati Sperimentali :

$$\begin{cases} \text{MSSM} + \text{Soft} \\ \quad \text{(SUGRA)} \end{cases} \begin{cases} LO & OK \\ NLO & OK \end{cases}$$

$$\begin{cases} \text{MSSM} + \text{Mess.} \\ \quad \text{(GM)} \end{cases} \begin{cases} LO & OK \\ NLO & \boxed{??} \end{cases}$$

Unificazione delle Masse dei Gaugini

Origine della Rottura della Supersimmetria

Predizioni :

$$\boxed{\text{Supergravitá} \overset{??}{\neq} \text{Gauge-Mediation}}$$

SUGRA

Dati :

- $\alpha_s(m_Z) = 0.12$
- $\alpha(m_Z)^{-1} = 128$
- $M_s \sim m_Z$

Risultati :

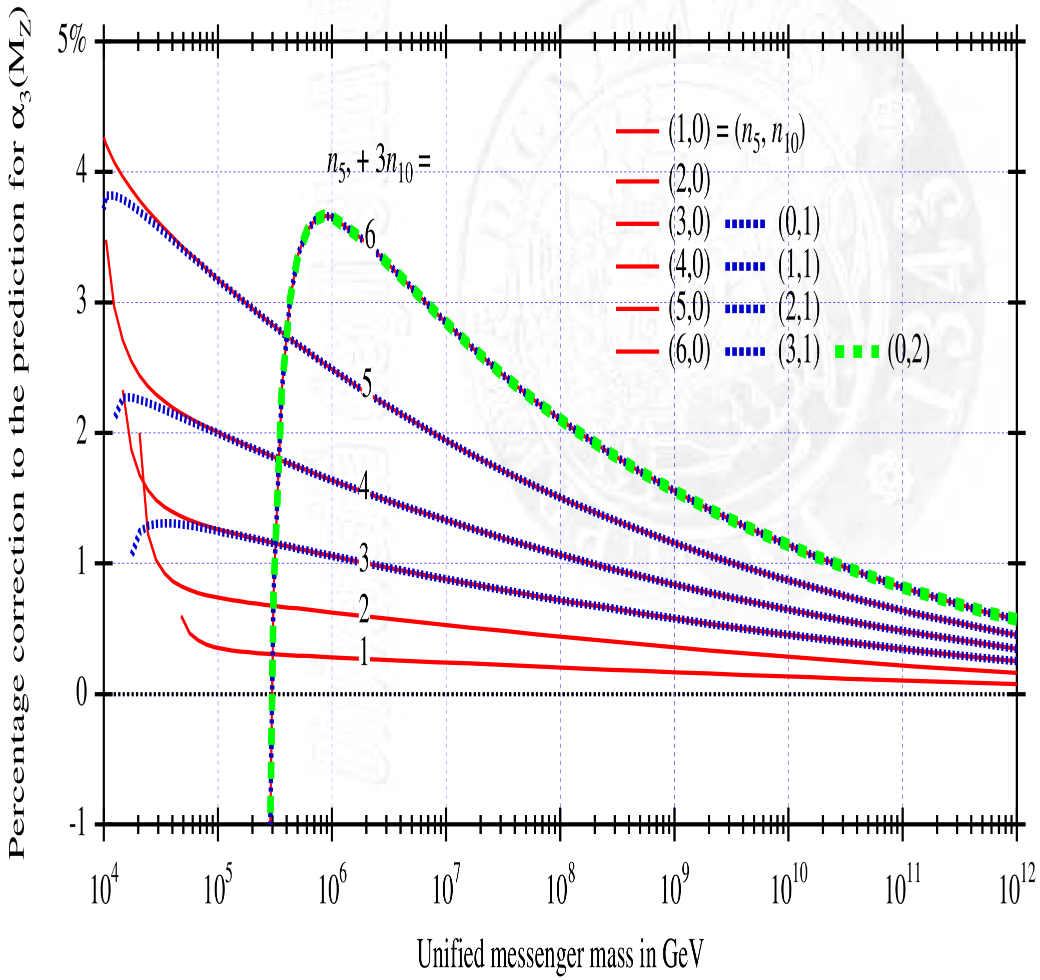
$$\frac{m_i}{\alpha_i} = \frac{m_G}{\alpha_G}\left[1 - \begin{pmatrix} 0.043 \\ 0.068 \\ 0.036 \end{pmatrix} - \begin{pmatrix} 0.87 \\ 1 \\ 0.67 \end{pmatrix} \Delta_t\right]$$

con

$$\Delta_t = \frac{0.09\alpha_t}{1 + 11\alpha_t}\left[1 + 0.4\frac{A_t}{m_G}\right]\Big|_{M_G}$$

Gauge-Mediation

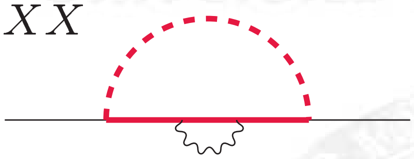
Correzione alla Predizione per α_3



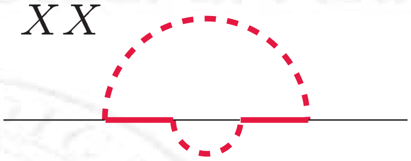
Gauge-Mediation

Diagrammi per le Masse dei Gaugini

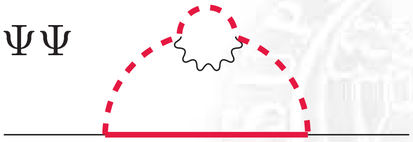
XX



$\widetilde{XX}$

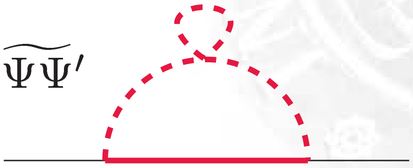


$\Psi\Psi$

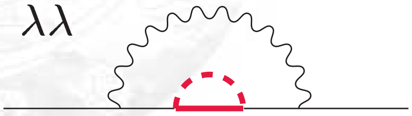


$\widetilde{\Psi\Psi}$

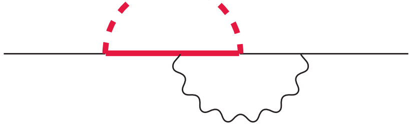
$\widetilde{\Psi\Psi'}$



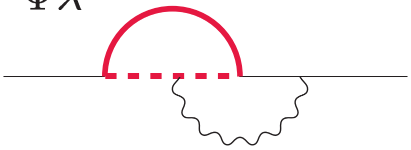
$\lambda\lambda$



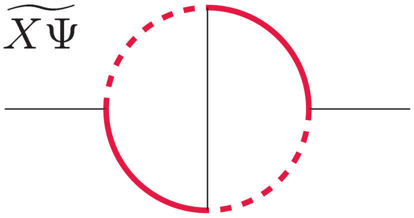
$X\lambda$



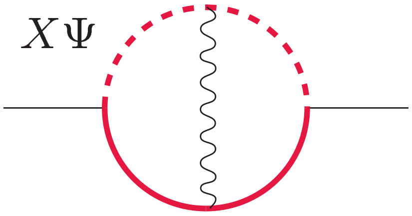
$\Psi\lambda$



$\widetilde{X\Psi}$

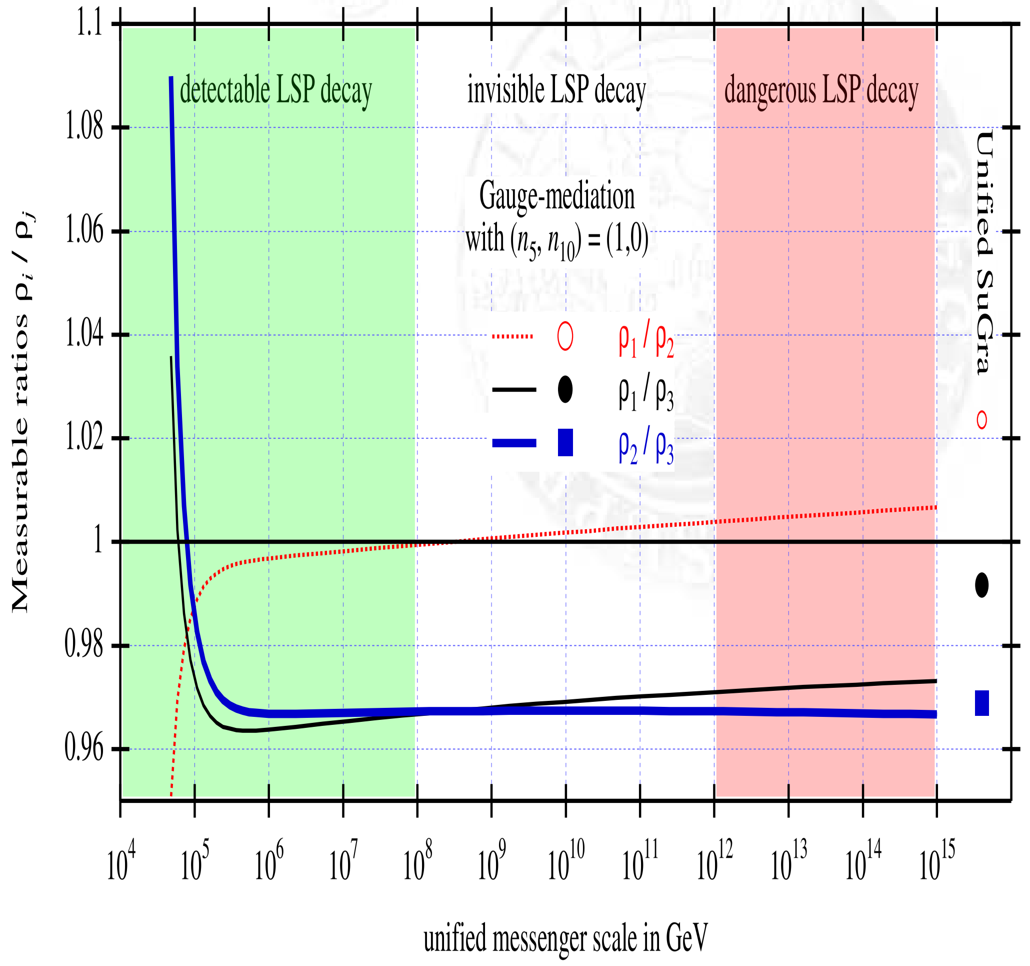


$X\Psi$



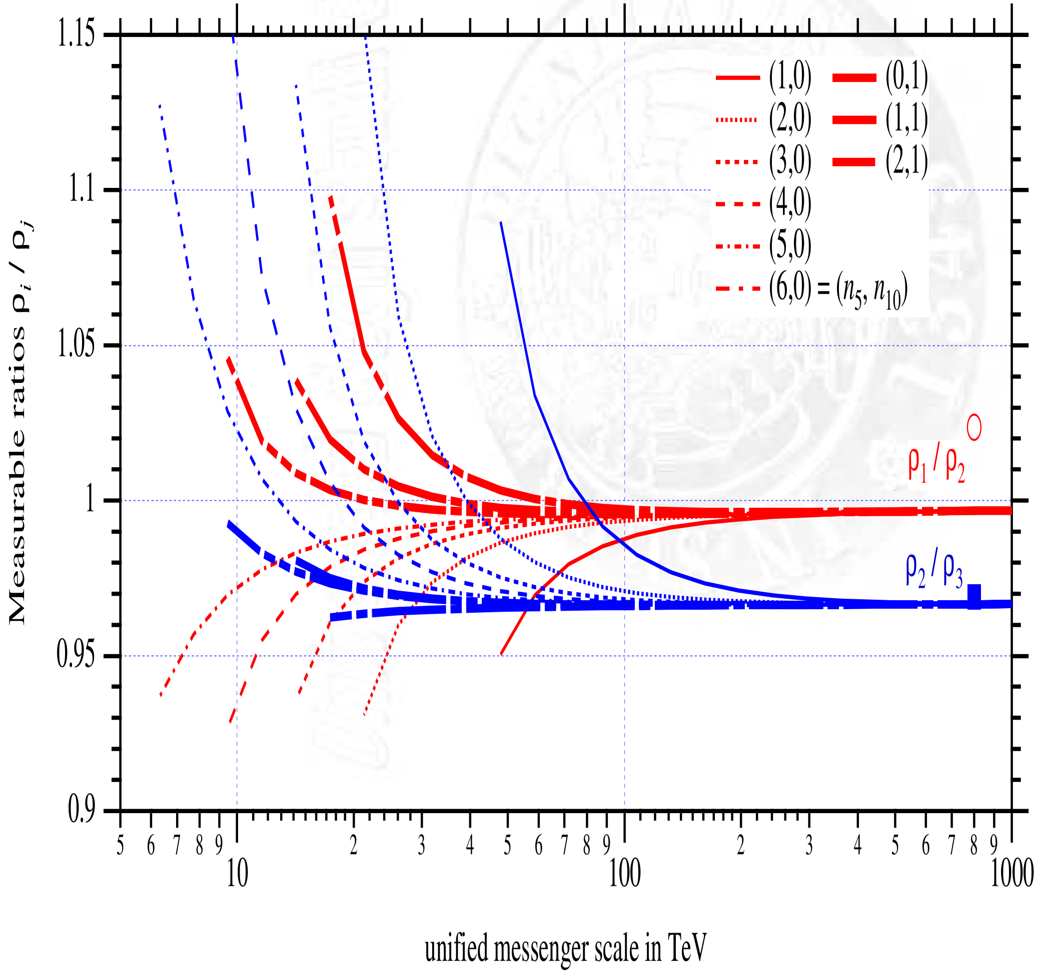
Predizioni

Gauge-Mediation *vs* Supergravità $\rho = \frac{m_\lambda}{\alpha}$



Predizioni

Gauge-Mediation *vs* Supergravità $\rho = \frac{m_\lambda}{\alpha}$



Supersimmetria Perturbativa:

SUGRA

Tecnica degli Spurioni

$$\begin{aligned} \alpha^{-1} \quad &\rightarrow S = \alpha^{-1}\left(1 - 2m_\lambda \theta^2\right) \\ z \quad &\rightarrow \mathcal{Z} = z\left(1 + \sigma\theta^2 + \sigma^\dagger \overline{\theta}^2 + \eta\theta^2\overline{\theta}^2\right) \end{aligned}$$

Rinormalizzazione

$$\frac{1}{\alpha(\mu)} = \frac{1}{\alpha(\Lambda)} + \frac{b}{2\pi}\ln\frac{\Lambda}{\mu} + \frac{t_i}{2\pi}\ln\frac{z_i(M)}{z_i(\mu)} + \frac{t_G}{2\pi}\ln\frac{\alpha(\mu)}{\alpha(\Lambda)}$$

$$\downarrow$$

$$S(\mu) = S(\Lambda) + \frac{b}{2\pi}\ln\frac{\Lambda}{\mu} + \frac{t_i}{2\pi}\ln\frac{\mathcal{Z}_i(\mu)}{\mathcal{Z}_i(\Lambda)} + \frac{t_G}{2\pi}\ln\frac{S(\Lambda)}{S(\mu)}$$

$$\boxed{\frac{\alpha\ m_\lambda}{\beta} = RGI}$$

Supersimmetria Perturbativa:

Gauge-Mediation

Masse dei Gaugini Ordine Leading Log

$$\begin{array}{lcccl} \alpha^{-1} & \to & S & = & \alpha^{-1}\left(1-2m_\lambda\theta^2\right) \\ M & \to & \mathcal{X} & = & M+F\theta^2 \end{array}$$

Rinormalizzazione

$$\frac{1}{\alpha(\mu)} = \frac{1}{\alpha(\Lambda)}+\frac{b}{2\pi}\ln\frac{\Lambda}{\mu}+\frac{t_x}{2\pi}\ln\frac{\Lambda}{M}$$

$$\downarrow$$

$$S(\mu) = S(\Lambda)+\frac{b}{2\pi}\ln\frac{\Lambda}{\mu}+\frac{t_x}{2\pi}\ln\frac{\Lambda}{\mathcal{X}}$$

$$\boxed{m_\lambda(\mu) = -\frac{F_X}{2}\left(\frac{1}{S}\,\frac{\partial S}{\partial \mathcal{X}}\right)\Big|_{\mathcal{X}=M_X}}$$

Supersimmetria Perturbativa:

Gauge-Mediation

Masse dei Gaugini Ordine Next-to-Leading

$$g^{-2}/4\pi \to S \ ; \quad M \to \mathcal{X} \ ; \quad z_i \to \mathcal{Z}_i \ ;$$

$$\boxed{\alpha^{-1} = \Re\left(g^{-2}/4\pi\right) \to R}$$

Rinormalizzazione

$$R(\mu) = S(\mu) + S^{\dagger}(\mu) + \frac{t_i}{2\pi}\ln\frac{\mathcal{Z}_i(\mu)}{\mathcal{Z}_i(\Lambda)} + \frac{t_G}{2\pi}\ln\frac{R(\Lambda)}{R(\mu)}$$

$$m_\lambda(\mu) = -g^2(\mu)R(\mu)\Big|_{\theta^2}$$

$$= \frac{\alpha(\mu)}{2\pi - \alpha(\mu)t_G}\left(t_x\frac{F}{M} + t_i \ln \mathcal{Z}_i(\mu)\Big|_{\theta^2}\right)$$