

# Dynamical R-parity violations from exotic stringy instantons

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**Based on a series of papers with M.Bianchi,  
G.Ricciardi, M.Y.Khlopov, J.Valle**

**Talk in String Phenomenology 2016, Ioannina (Greece)**

## **B-L has to be violated**

- **SM Perturbative Lagrangian: B,L accidental**
- **Non-perturbative Standard Model: B+L violated, B-L preserved by sphalerons**

**Vs**

- **Baryogenesis,  
Sakharov's conditions**

**Standard Model + Gravity is not a UV  
complete theory.**

**It'd be completed in context of some  
String theory**

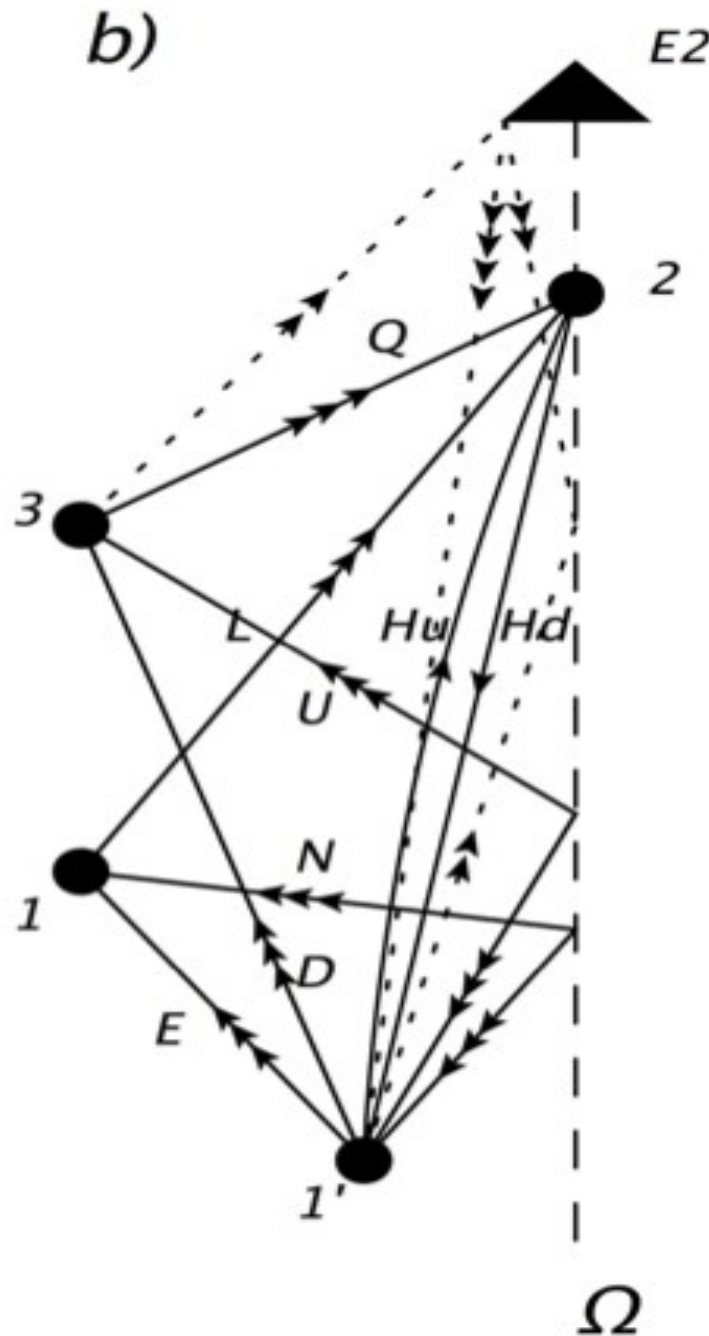
**This is why we are in StrPh16...**

**This is our logic:  
to search some indirect stringy effects  
which could solve fundamental  
problems of SM in a calculable and  
controllable way  
with testable signatures.**

# Exotic Instantons

- In open strings, E-branes wrapping  $n$ -cycles (not the same as physical D-branes) on CY, open strings as moduli.
- Mixed disk amplitudes
- They have not gauge insertion!!! Subtly compatible with gauge invariance.
- They can violate B-L and R
- Non perturbative generation of B-L operators

# SM quiver for a Majorana Neutron



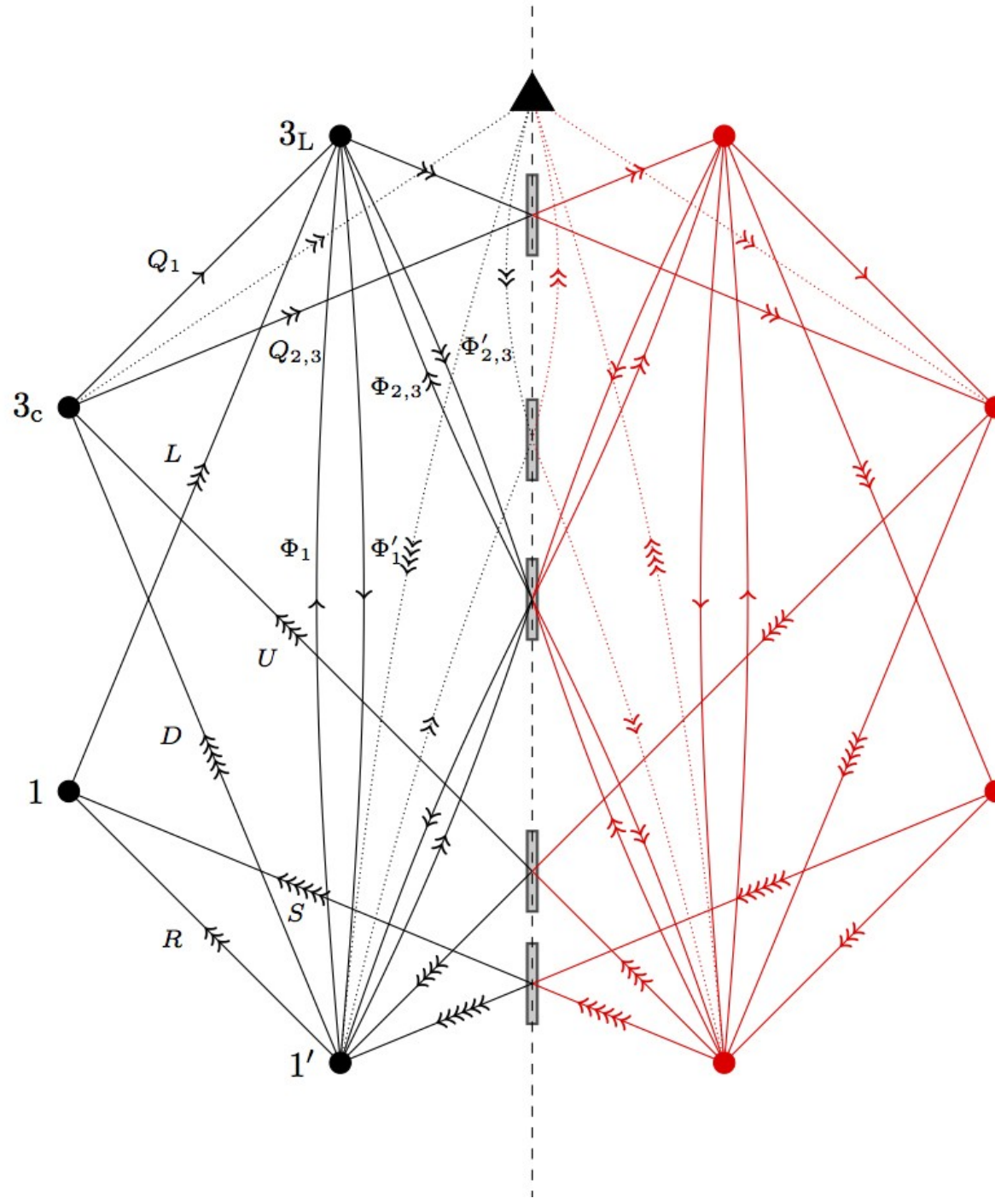
**Perturbative Yukawa**

**Tadpoles cancellation**

**Massless hypercharge**

# In a 331 Model

A.A. C. Vaquera, J. Valle '16'

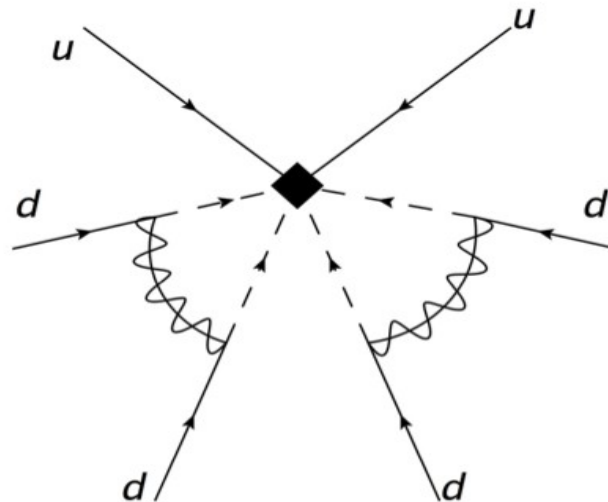


# Six quarks superpotential:

$$\mathcal{L}_{eff} \sim C_f^{(1)} U_f^i \tau_i \alpha + C_f^{(2)} D_f^i \tau_i \beta$$

$$W_{E2} = \int d^6 \tau d^4 \beta d^2 \alpha e^{\mathcal{L}_{eff}}$$

$$= \frac{e^{-S_{E2}}}{M_S^3} C_{f1}^{(1)} C_{f2}^{(2)} C_{f3}^{(2)} C_{f4}^{(1)} C_{f5}^{(2)} C_{f6}^{(2)} \epsilon_{ijk} \epsilon_{i'j'k'} U_R^{i,f1} D_R^{j,f2} D_R^{k,f3} U_R^{i',f4} D_R^{j',f5} D_R^{k',f6}$$



$$\mathcal{M}^5 = m_{\tilde{g}}^2 M_S^3 e^{+S_{E2}}$$

# Cosmology and supergravity

- **Context of Starobinsky-like Supergravity in framework of Vokulov-Akulov, no-scale and R-gauged**

*(Linde, Kallosh, Ferrara, Sagnotti, Dudas, Porratti and many others)*

- **Assuming supersymmetry broken at high scales**

**SuperHeavy Gravitinos production in adiabatic inflation**

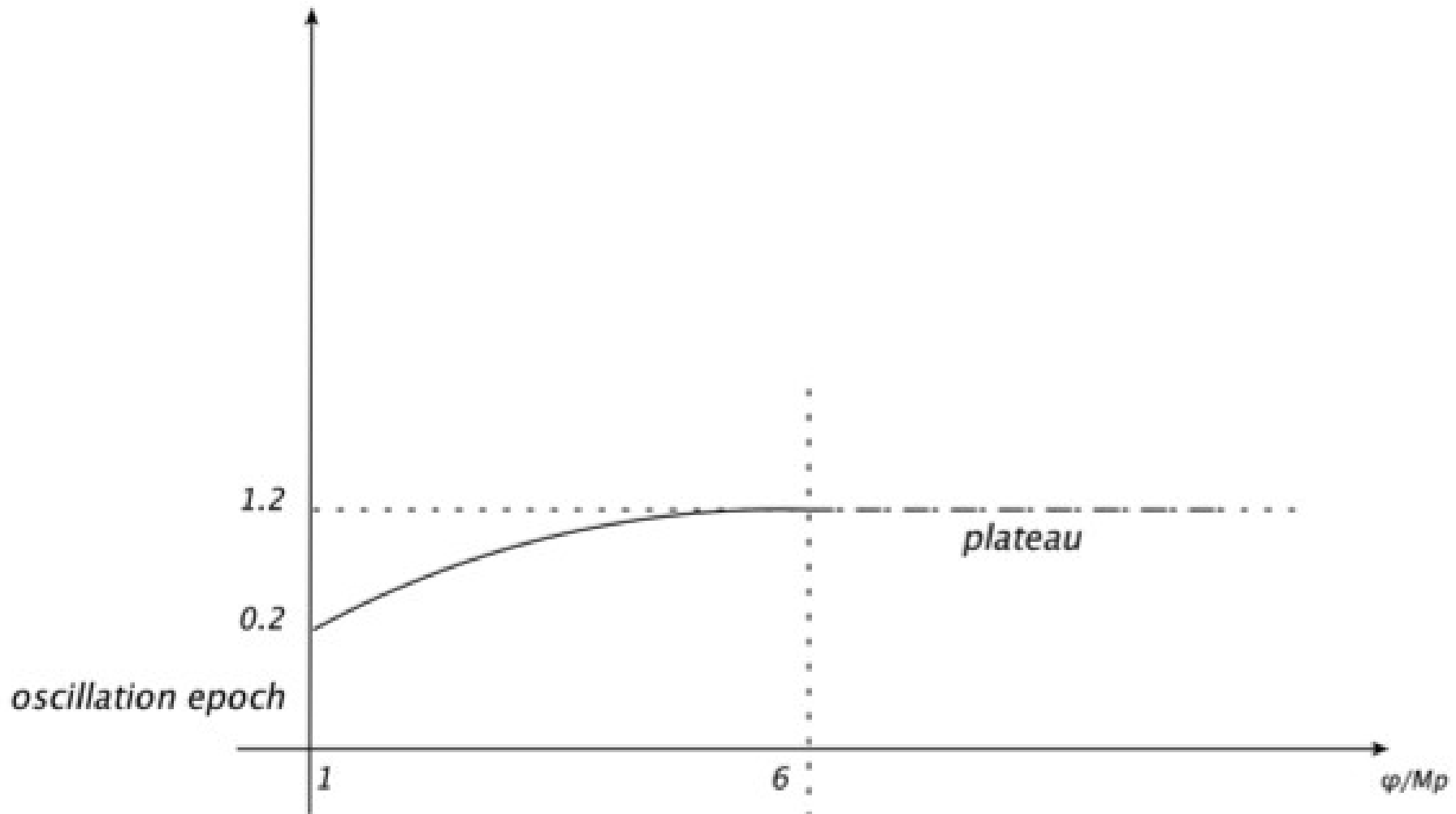
**New Predictions**

- **The presence of exotic instantons can destabilize the gravitino**

A.A, M.Y.Khlopov and in preparation '16'



# Mass spectrum



**Correct abundance with average gravitino mass  $10^{(11-13)}$  GeV. While gravitino problem and thermal production avoided.**

$$\mathcal{K} = -3 \log[\mathcal{T} + \bar{\mathcal{T}} - \Phi(z, \bar{z})]$$

$$V = \frac{1}{a} \left( \frac{3}{\mathcal{X}} - 3 \right)^2 = \frac{9}{a} \left[ e^{-\sqrt{2/3}\phi} - 1 \right]^2$$

$$\mathcal{X} = e^{\sqrt{2/3}\phi} = \mathcal{T} + \bar{\mathcal{T}} - \frac{1}{3}\Phi$$

$$m_{\tilde{G}} = e^{\mathcal{K}/2} \frac{\mathcal{W}}{M_{Pl}^2}$$

$$i\gamma^{mn}\partial_m\psi_n = - \left( m_{\tilde{G}} + i\frac{a'}{a}\gamma^0 \right) \gamma^m\partial_m\psi$$

# R-parity can be dynamically broken, Gravitino destabilization

$$L_{int} = -\frac{i}{8M_{Pl}} \bar{\psi}_\mu [\gamma^\nu, \gamma^\rho] \gamma^\mu \lambda F_{\nu\rho}$$

$$\int d^2\theta \mathcal{W} = \int d^2\theta \int d^2\tau^{(1)} d\beta^{(1)} d\gamma^{(1)} e^{\mathcal{L}_E}$$

$$= M_S e^{-S_{E2}} (C^{(1)} C_i'^{(1)}) H_u L^i$$

$$\Gamma_{\tilde{G} \rightarrow \gamma\nu}^{(0)} = \frac{1}{32\pi} \cos^2 \theta_W \frac{m_\nu}{m_\chi} \frac{m_{\tilde{G}}^3}{M_{Pl}^2} \left(1 - \frac{m_\nu^2}{m_{\tilde{G}}^2}\right)^3 \left(1 + \frac{m_\nu^2}{3m_{\tilde{G}}^2}\right)$$

**Fluxes non-perturbative protection 11<sup>th</sup> orders**  
**10<sup>7</sup> PeV neutrini: ANTARES and IceCube?**

# THE QUIET BEFORE THE STORM?

