Maximal CP-violation within EDM-constrained R-parity violating interactions

N. YAMANAKA (RCNP) in collaboration with T. SATO, T. KUBOTA (Osaka U.)

Motivation:

Matter abundant Universe, Dark matters, neutrino mass … Standard model has many unsatisfactions with observations

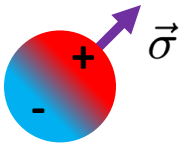
⇒ **We need New Physics beyond SM!**

One good candidate of new physics : **Supersymmetry**

Supersymmetric extension of SM allows R-parity violating interactions

⇒ We must test R-parity violation (RPV)

How to test? ➡ **Electric dipole moment!**



Advantages of EDMs:

- Lower cost than high energy exp
- Very sensitive to many New Physics
- Small SM backgrounds

Available exp data:

• ^{205}Tl :	$d_{Tl} < 9.4 \times 10^{-25}$ e cm	B. C. Regan *et al.*, Phys. Rev. Lett. **88** 071805 (2002).
• ^{199}Hg :	$d_{Hg} < 3.1 \times 10^{-29}$ e cm	W. C. Griffith *et al.*, Phys. Rev. Lett. **102**, 101601 (2009).
• Neutron:	$d_n < 2.9 \times 10^{-26}$ e cm	C. A. Baker *et al.*, Phys. Rev. Lett. **97**, 131801 (2006).
• ^{129}Xe :	$d_{Xe} < 6.6 \times 10^{-27}$ e cm	M. A. Rosenberry *et al.*, Phys. Rev. Lett. **86**, 22 (2001).

RPV has many parameters: we must find other CPV sensitive observables to determine RPV

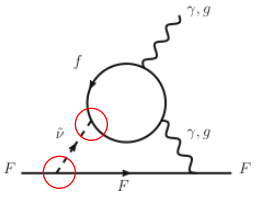
Object of study:

Investigate the maximal CP-violation of RPV within ^{205}Tl, ^{199}Hg , ^{129}Xe and neutron EDM constraints. (⇒ Try to find interesting observables sensitive to CPV of RPV)

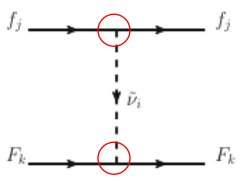
Tested CPV observables : proton, deuteron, ^{3}He, ^{211}Rn, ^{225}Ra EDMs, R-correlation

Analysis:

RPV contributions:

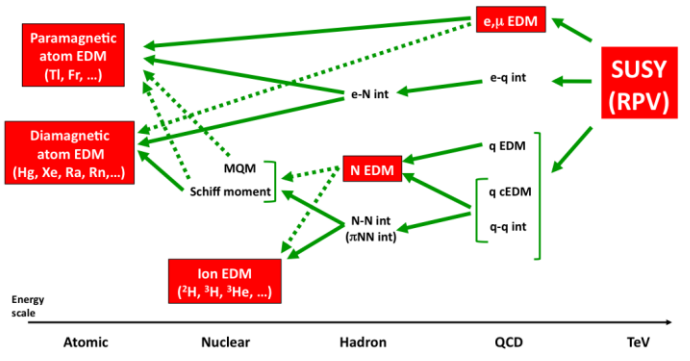


Barr-Zee 2-loop diagram



P, CP-odd 4-fermion interaction

Relations between RPV & EDMs:



J. S. M. Ginges, V. V. Flambaum, Phys. Rept. **397**, 63 (2004).

⇒ Accuracy of hadron, nuclear and atomic level is important!

RPV parameter space:

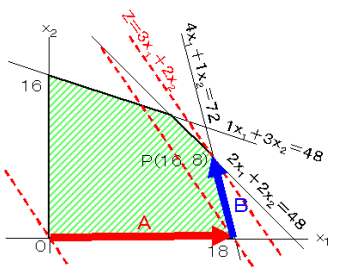
⇒ 10 dimensional

$\mathrm{Im}(\lambda_{311}\lambda^{*}_{322})$
$\mathrm{Im}(\lambda_{211}\lambda^{*}_{233})$
$\Sigma_i \mathrm{Im}(\lambda_{i11}\lambda'^{*}_{i11})$
$\Sigma_i \mathrm{Im}(\lambda_{i11}\lambda'^{*}_{i22})$
$\Sigma_i \mathrm{Im}(\lambda_{i11}\lambda'^{*}_{i33})$
$\Sigma_i \mathrm{Im}(\lambda_{i22}\lambda'^{*}_{i11})$
$\Sigma_i \mathrm{Im}(\lambda_{i33}\lambda'^{*}_{i11})$
$\Sigma_i \mathrm{Im}(\lambda'_{i11}\lambda'^{*}_{i22})$
$\Sigma_i \mathrm{Im}(\lambda'_{i11}\lambda'^{*}_{i33})$
$\Sigma_i \mathrm{Im}(\lambda'_{i22}\lambda'^{*}_{i33})$

Method used:

Calculate max CPV observables within Tl, Hg, neutron, Xe EDMs.

⇒ **Linear Programming**



Results:

Maximal CPV observables within EDM-constraints

$d_p = 1.9 \times 10^{-23}$ e cm	$d_{Rn} = 6.6 \times 10^{-26}$ e cm
$d_d = 3.9 \times 10^{-22}$ e cm	$d_{Ra} = 1.5 \times 10^{-22}$ e cm
$d_{He} = 6.0 \times 10^{-22}$ e cm	$R = 5.1 \times 10^{-6}$

Summary:

- Maximal values of d_p, d_d, d_{He}, d_{Rn}, d_{Ra} and R were given from linear programming method within ^{205}Tl, ^{199}Hg, neutron and ^{129}Xe EDM constraints.
- Proton, deuteron, ^{211}Rn and ^{225}Ra EDMs are well within the prospected experimental limits.
- Accurate determination of hadronic, nuclear and atomic level dependences is needed for stabilizing the analysis.