Two-loop level supersymmetric contribution to the fermion EDM

N. YAMANAKA (Kyoto U.), based on Phys. Rev. D 87, 011701 (R) (2013).

Motivation:

Matter abundant Universe, dark matter, neutrino mass … Standard model has many unsatisfactions with observations

⇒ **We need New Physics beyond SM!**

A good candidate of new physics : Supersymmetry

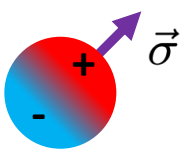
Advantages of SUSY:

Cancellation of power divergences, better grand unification, …

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

Advantages of EDM:

Lower cost than high energy exp, sensitive to many New Physics, small SM background

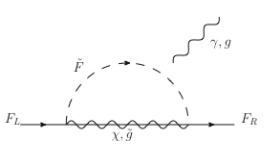


Available experimental data:

- Electron : $d_e < 1.05 \times 10^{-27}$ e cm — J. J. Hudson *et al.*, Nature **473**, 493 (2011).
- Neutron: $d_n < 2.9 \times 10^{-26}$ e cm — C. A. Baker *et al.*, Phys. Rev. Lett. **97**, 131801 (2006).

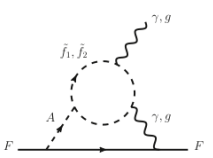
EDM in SUSY :

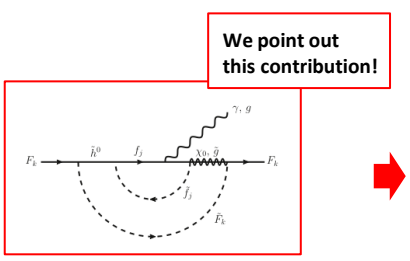
One-loop level:



➡ Strong constraint on 1st & 2nd generation CPV.

Two-loop level:





➡ Constraint on 3rd generation CPV.

At two-loop level, the rainbow diagram contributes at the same order as the Barr-Zee diagram.

Object of study:

Analyze the two-loop rainbow diagram contribution to the fermion EDM with fermion inner loop and compare with the Barr-Zee type contribution.

Analysis:

Leading contribution : chromo-EDM (quark sector CPV)

Suppressed with the Yukawa coupling of external fermion

Vanish for degenerate intra-generation sfermion mass

Same isospin for external and inner loop fermion

Depend on gaugino & fermion CPV $\propto \sin(\theta_{1,2} - \delta_f)$

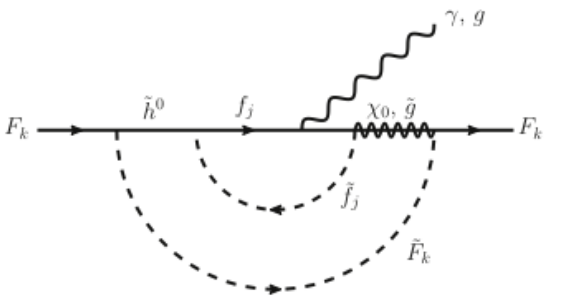
⇒ Interfere with Barr-Zee type diagram: constructive or destructive??

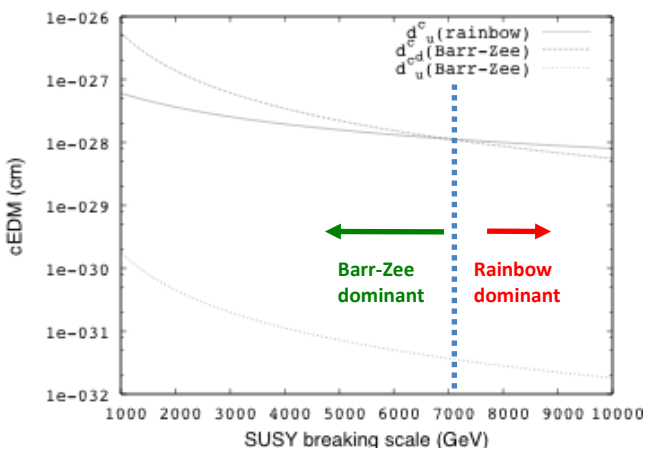
For small tanβ, Rainbow > Barr-Zee

For large tanβ, Rainbow > Barr-Zee

in s-top sector CPV with heavy SUSY breaking

(stronger decrease of Barr-Zee contribution due to fixed μ-parameter)





Summary:

- We have analyzed the two-loop level rainbow diagram contribution to the fermion EDM in MSSM.
- Rainbow diagram contribution becomes dominant in heavy SUSY breaking region due to the fixed μ-parameter.
- Current experimental data cannot probe the CPV of TeV scale SUSY breaking, but upcoming experiments can do it.
- Future prospect : evaluation of the rainbow diagram with chargino inner loop.