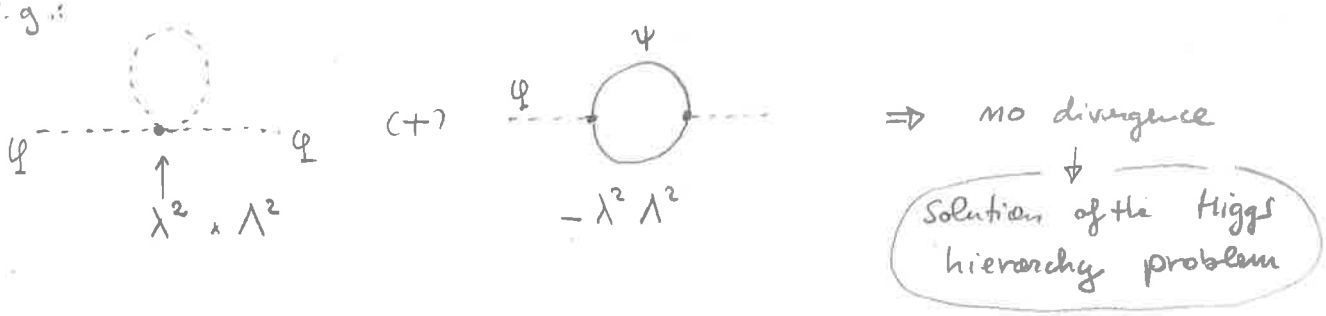
Soft supersymmetry breaking

An important aspect of SUSY are the so-called non-renormalization theorems, that imply that quantum corrections have a much simpler structure than in the non-SUSY case

(A) Key feature on the pheno-side ⇒ no quadratic divergences (essentially only wave-field renormalizations)

e.g.:



(B) Bad feature on the pheno-side ⇒ degenerate spectrum of scalars & fermions

⇓

A realistic model must include SUSY-breaking terms, but we are interested in maintaining the "good feature" (A)

⇓

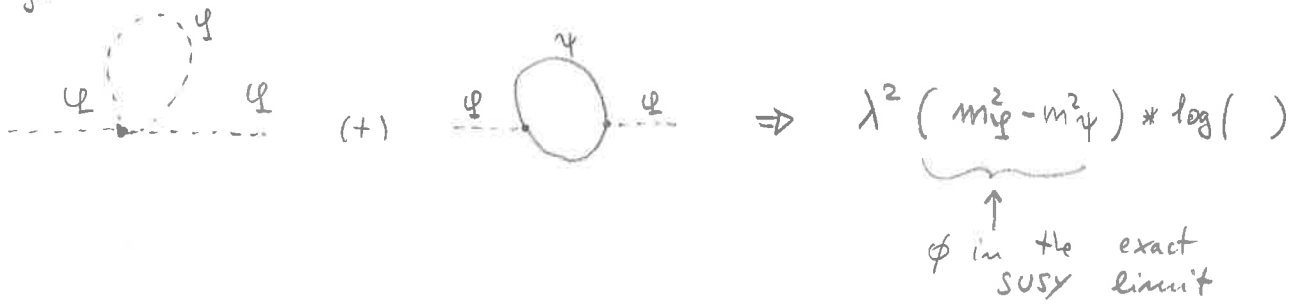
SOFT-SUSY breaking

Effective parameterization of the dynamics of SUSY-breaking (e.g.: spontaneous SUSY-breaking) that preserve (A) in the UV limit

Main idea → ⊙ introduce susy-breaking mass terms (UV irrelevant)

⊙ leave untouched relations among UV relevant/marginal operators

e.g.:



$\Rightarrow \lambda^2 \underbrace{(m_\varphi^2 - m_\psi^2)}_{\uparrow} * \log(\ )$

$\uparrow$ ϕ in the exact SUSY limit

The most general soft SUSY-breaking $\mathcal{L}$ has the form

$$\mathcal{L}_{soft} = -\frac{1}{2} m_\lambda (\lambda^a \lambda^a + h.c.) - (m^2)_{ij} \varphi_j^* \varphi_i$$
$$-\left(\frac{1}{2} b_{ij} \varphi_i \varphi_j + \frac{1}{6} a_{ijk} \varphi_i \varphi_j \varphi_k + h.c.\right)$$

- Gaugino mass terms (m_λ)
- scalar mass terms (m_{ij}^2 & b_{ij})
- trilinear couplings a_{ijk}

→ fermion mass terms are not introduced since they are redundant (re-absorbed by re-definition of terms in $\mathcal{L}_{SUSY}$)

Girardello & Grisaru in 1982 proved that $\mathcal{L}_{soft}$ do not generate quadratic corr. to all-orders in perturbation theory