# SuSy breaking in SuSy QM

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Research Training Group
Quantum and Gravitational Fields

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- Additional symmetry that transforms bosons in fermions and vice versa
- Only way to nontrivially connect spacetime symmetry group with internal symmetry group
- So far no supersymmetry observed in nature
- Supersymmetry is broken if it is realised in our world
  $\Rightarrow$ We are interested in a system that allows for Supersymmetry breaking

# In Quantum Mechanics

- We have fermionic and bosonic states $|\psi_{B,F} >$ that are connected by a symmetry transformation related to the Hamiltonian of the system

$$A|\psi_B >= \sqrt{E}|\psi_F >, \; A^\dagger|\psi_F >= \sqrt{E}|\psi_B >, \quad A^\dagger A = H_B, \quad AA^\dagger = H_B$$

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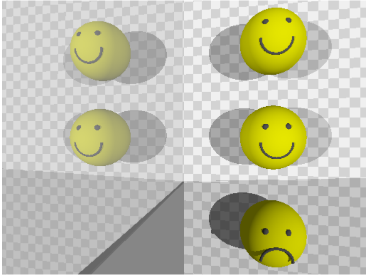
- Therefore a positive ground state energy indicates SuSy breaking



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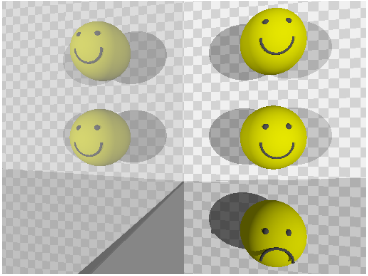

- Use this fact for our later calculations

# FRG reformulation of SuSy QM

- Our used renormalization group approach is formulated for quantum field theories

$$\partial_k \Gamma_k = \frac{1}{2} \mathrm{STr} \frac{\partial_k R_k}{\Gamma_k^{(2)} + R_k}$$

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- $\Phi$ is a real scalar superfield containing two bosonic fields $\phi$ and $F$(auxilliary) as well as two fermionic ones $\psi$ and $\bar{\psi}$
- Now we have a field theory in $(0+1)$ dimension

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- as long as $W'$ has zero expand equations around $F = 0$
- In the broken phase $W'^2/Z$ has no zero and we expand terms in $F$ around its solution of the e.o.m.
  $\Rightarrow$ use $\langle F \rangle$ as an order parameter

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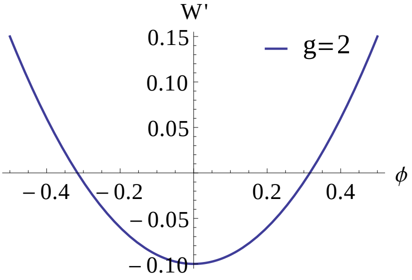
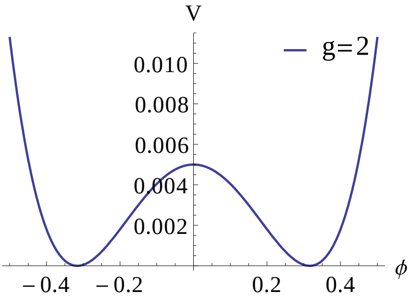
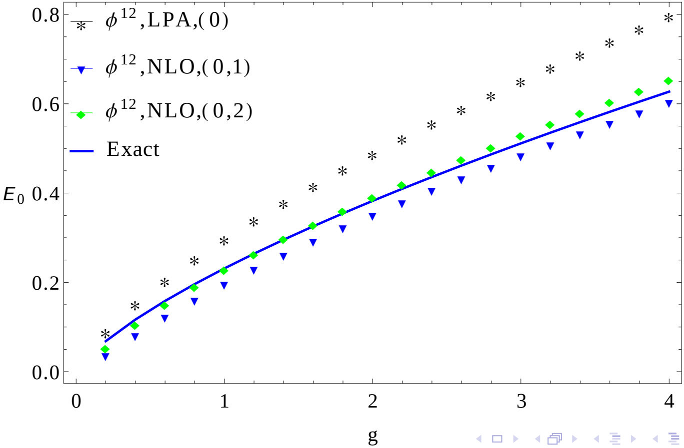
- Starting potential in the UV $W' = g(\phi - \sqrt{0.1/g})(\phi + \sqrt{0.1/g})$
- Potential for bosonic fields $V = W'^2/(2Z)$ in UV is a double well



# Results

- Ground state energy results for two truncations and projections onto different order of $(F - F_{eom})^i$ compared to exact ones



# Summary

- The FRG method using the Wetterich equation can be used to deal with SuSy models
- Can reproduce SuSy breaking
- FRG approach may give new insights for breaking mechanism of SuSy in nature
- further details $\rightarrow$ talk by M. Heilmann (Session III B Tuesday) and poster by B. Knorr