

Theoretical Particle Physics: Assignment GUT+SUSY

Due 04/18/08

1. Use naive dimensional analysis to estimate the proton life time as a function of the GUT gauge boson masses, m_X .
2. Use the above life time and the fact that experimentally we know that it has to be longer than 10^{34} yr to bound m_X from below.
3. Use the SM running to find the value of $\sin^2 \theta_W$ at the M_Z scale.
4. Insert (20) into (17) and derive (21) in the review by Jan Louis, Ilka Brunner and Stephan J. Huber.
5. Derive (26) from (22) and (25) in the same review.
6. Use the SUSY running to find the value of $\sin^2 \theta_W$ at the M_Z scale.
7. Without detailed calculations assume the proton longevity bound to derive an upper bound on the R-parity violating couplings (any product of two would do).
8. Without a detailed calculation write the generic contributions to FCNC observables within most general SUSY breaking parameters (assume R-parity conservation).
9. Given the previous estimation, for 500GeV SUSY masses, what is the bound on the SUSY mixing angles?
10. Derive the tree-level upper bound on the Higgs mass within the MSSM, why is this bound a problem for low energy SUSY (MSSM)?
11. Use Eq. (7.25) of Martin's review to maximize the stop contributions to the Higgs mass and show that with less than a TeV masses the Higgs mass is smaller than 135GeV.
12. Use the size of these contributions to estimate the corresponding fine tuning in the Higgs potential.