Exercises for Chap. 12

1. Taking all the couplings in the superpotential (12.16) to be equal to λ, and the VEVs to be of order ϕ, estimate the vacuum energy at the minimum of the potential. Is there a regime where the s-confined theory is weakly coupled at the minimum of the potential?

2. Taking the effective superpotential in Eq. 12.36 find the vacuum energy density

$$V = |\mathcal{F}_{\overline{U}}|^2 \ , \tag{1}$$

assuming a VEV for $\overline{U}$ as given in Eq. 12.42. Is there a consistent regime where $\mathcal{F}_{\overline{U}} \ll \Lambda_{SU}^2$. Assuming that the standard model gauge groups are embedded in the global symmetry of this model for $N = 3$ and taking $\lambda = 0.1$ and $\Lambda_{Sp} = \Lambda_{SU}/100$ what scale (in GeV) is required for Λ_{SU} in order to get a 1 TeV gluino mass (take the messenger mass $M = \Lambda_{SU}$, see Eq. (6.6))

3. Consider a dual description of SUSY QCD where the electric quarks have equal masses so that the dual superpotential is

$$W = \bar{\phi} M \phi - f^2 \mathrm{Tr} M \ . \tag{2}$$

Find the relation between N and F in the electric theory which ensures that at the classical level there is a non-vanishing $\mathcal{F}$ component for M at $\langle M \rangle = 0$. Show that the one-loop corrections stabilize this vacuum as was the case for the O'Raifeartaigh model of section 5.1. Since there is a SUSY vacuum, given by Eq. (10.11), at large $\langle M \rangle$ this is an example of metastable SUSY breaking (see hep-th/0602239). Estimate the tunneling time to the SUSY vacuum. What conditions need to be met for the tunneling time to be longer than the age of the Universe?