The universe on edge: Limits of the effective field theory approach in the very early universe
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In this appendix we provide some intermediate results in the calculation of (3.38–3.39). Using the expressions as stated in appendix D, to first order in $|G_q|$, the second derivatives of the potential are given by

$$V_{qq} = e^G \left[ (2 + e^{-G}V) \nabla_q G_q + (\nabla_q \nabla_q G_q)G^q \right] + O(|G_q|^2), \quad (E.1)$$

$$V_{q\bar{q}} = e^G \left[ G_{q\bar{q}}(1 + e^{-G}V) + G^{q\bar{q}}(\nabla_q G_q)(\nabla_{\bar{q}} G_{\bar{q}}) \right] + O(|G_q|^2). \quad (E.2)$$

Using the supersymmetry breaking restriction (3.35) in (E.1) and (E.2), we find

$$V_{qq} = -e^G G_{q\bar{q}} \left[ (2 + e^{-G}V)(1 + e^{-G}V)G^{q\bar{q}} - G^{q\bar{q}}(\nabla_q \nabla_q G_q)G^q \right] + O(|G_q|^2), \quad (E.3)$$

$$V_{q\bar{q}} = e^G \left[ G_{q\bar{q}}(1 + e^{-G}V) + (1 + e^{-G}V)^2 G^{q\bar{q}} G_q G_{\bar{q}} \right] + O(|G_q|^2)$$

$$= e^G G_{q\bar{q}}(2 + e^{-G}V)(1 + e^{-G}V) + O(|G_q|^2), \quad (E.4)$$

and hence

$$|V_{qq}| = e^G G_{q\bar{q}}(2 + e^{-G}V)(1 + e^{-G}V) \times$$

$$\times \sqrt{\frac{1}{1 - \frac{2G^{q\bar{q}} G_{q\bar{q}} G_q G_{\bar{q}}}{(2 + e^{-G}V)(1 + e^{-G}V)} + \frac{|G_{q\bar{q}}(\nabla_q \nabla_q G_q)G^q|^2}{(2 + e^{-G}V)^2(1 + e^{-G}V)^2} + O(|G_q|^2)}}$$

$$= e^G G_{q\bar{q}} \left[ (2 + e^{-G}V)(1 + e^{-G}V) - G^{q\bar{q}} \text{Re}\left\{ (\nabla_q \nabla_q G_q)G^{q\bar{q}} G^q \right\} \right] + O(|G_q|^2). \quad (E.5)$$

Then (3.37) is evaluated to be

$$m_q^- = e^G G^{q\bar{q}} \text{Re}\left\{ (\nabla_q \nabla_q G_q)G^{q\bar{q}} G^q \right\} |G_{q\bar{q}}| + O(|G_q|^2), \quad (E.6)$$

$$m_q^+ = e^G \left[ 2(2 + e^{-G}V)(1 + e^{-G}V) - G^{q\bar{q}} \text{Re}\left\{ (\nabla_q \nabla_q G_q)G^{q\bar{q}} G^q \right\} \right] + O(|G_q|^2). \quad (E.7)$$