Superpotential:

The moduli we are studying are gauge neutral.

$\to$ no D-term potential.

Relevant part of low energy action:

$$\int d^4x \sqrt{-\det g} \left(\frac{1}{2} R - G_{i\bar{j}} (\vec{\Phi}) \partial_\mu \phi^i \partial^\mu \bar{\Phi}^{\bar{j}} - V_F (\Phi, \bar{\Phi}) \right)$$

$$G_{i\bar{j}} = \partial_i \partial_{\bar{j}} K.$$

$$V_F = e^K \left(G^{i\bar{j}} D_i W D_{\bar{j}} \bar{W} - 3 |W|^2 \right)$$

$$D_i W = \partial_i W + W \partial_i K.$$

So far $W = 0$.

Symmetry: $K \to K + f(\vec{\Phi}) + \overline{f(\vec{\Phi})}$

Potential not invariant.

Need $W \to e^{-f(\vec{\Phi})} W$.

$$D_i W \to \partial_i (e^{-f(\vec{\Phi})} W) + e^{-f} W \partial_i (K + f + \bar{f})$$

$$= e^{-f} (\partial_i W - \partial_i f W + W \partial_i K + W \partial_i f)$$

$$= e^{-f} D_i W$$

Thus W also transforms under

$K \to K + f(\Phi) + \bar{f}(\bar{\Phi})$

Now consider switching on 3-form fluxes $F^{(3)}, H^{(3)}$.

$$G^{(3)} = F^{(3)} - \tau H^{(3)}$$

$$W = \int_{CY_3} \Omega \wedge F^{(3)}.$$

Note: Ω has a freedom.

$$\Omega \to f(\{t^A\})\, \Omega$$

Any function of the complex structure moduli t^A

$$t^A = \frac{Z^A}{Z^0} \qquad A = 1, \dots h^+_{1,2}$$

Under this $Z^I \to f Z^I \qquad I = 0, \dots h^+_{1,2}$

$$K \to K + \ln f + \overline{\ln f}$$

V is invariant.

Divide the fields into ρ and the rest.

Kahler modulus (overall size).

$\partial_\rho W = 0$. (no dependence on Kahler moduli)

$$D_\rho W = W \partial_\rho K = -\frac{3W}{\rho - \bar{\rho}}$$

since $K = -\ln(\rho - \bar{\rho}) + K_{rest}$

$$D_\rho W \overline{D_\rho W} = -\frac{9|W|^2}{(\rho - \bar{\rho})^2}$$

$$G_{\rho\bar{\rho}} = \partial_\rho \partial_{\bar{\rho}} K = -\frac{3}{(\rho - \bar{\rho})^2}$$

$$G^{\rho\bar{\rho}} = -\frac{(\rho - \bar{\rho})^2}{3}$$

$$G^{\rho\bar{\rho}} D_\rho W \overline{D_\rho W} - 3|W|^2 = 0$$

$$\Rightarrow V_F = \sum_\alpha |D_\alpha W|^2$$

Runs over ~~complete~~ complex structure moduli and τ.

By choosing fluxes appropriately we can ensure that $D_\alpha W = 0$. fixes complex structure moduli and τ.

→ Does not fix other Kahler moduli