SUSY-Breaking via Non-Perturbative Monopole Dynamics

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1. Quick Historical Overview Of Monopoles

(Based on slides by John Terning)
Dirac 1931

Charge Quantization

\[ qg = \frac{n}{2} \]

Proc. Roy. Soc. Lond. A133 (1931) 60
Non-Local Lorentz-Invariant Action

\[ F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu + \ast G_{\mu\nu} \]

\[ G_{\mu\nu}(x) = 4\pi(n \cdot \partial)^{-1} [n_\mu K_\nu(x) - n_\nu K_\mu(x)] \]
\[ = \int d^4 y \left[ f_\mu(x - y) K_\nu(y) - f_\nu(x - y) K_\mu(y) \right] \]

\[ \partial_\mu f^\mu(x) = 4\pi \delta(x) \]
\[ f_\mu(x) = 4\pi n^\mu (n \cdot \partial)^{-1} \delta(x) \]

Phys. Rev. 74 (1948) 817
Schwinger 1969

Dyons

$q_1 g_2 - q_2 g_1 = \frac{n}{2}$

Science 165 (1969) 757
Local Lorentz-Violating Action

\[
\mathcal{L} = -\frac{1}{2n^2e^2} \left\{ [n \cdot (\partial \wedge A)] \cdot [n^* \cdot (\partial \wedge B)] - [n \cdot (\partial \wedge B)] \cdot [n^* \cdot (\partial \wedge A)] \right. \\
+ [n \cdot (\partial \wedge A)]^2 + [n \cdot (\partial \wedge B)]^2 \right\} - J \cdot A - \frac{4\pi}{e^2} K \cdot B.
\]

\[
F = \frac{1}{n^2} \left( \{ n \wedge [n \cdot (\partial \wedge A)] \} - \ast \{ n \wedge [n \cdot (\partial \wedge B)] \} \right)
\]

Phys. Rev. D3 (1971) 880
t’Hooft-Polyakov 1974

Topological Monopoles

Nucl. Phys., B79 1974, 276
JETP Lett., 20 1974, 194
Magnetic condensate confines electric charge

Phys. Rept. 23 (1976) 245
\( \theta \) term causes magnetic charge to shift electric charge

\[
\mathcal{L}_{\text{free}} = -\frac{1}{4e^2} F_{\mu\nu} F_{\mu\nu} - \frac{\theta}{32\pi^2} F_{\mu\nu} \star F_{\mu\nu}
\]

\[
q_{\text{eff},j} = q_j + g_j \frac{\theta}{2\pi}
\]

Massless Fermionic Monopoles,

$\mathcal{N} = 2$

Exactly Solvable
Low-Energy Effective Theory

hep-th/9407087
Argyres-Douglas 1995

CFT with massless electric and magnetic charges

hep-th/9505062
2. Motivation
Motivation

- **Always looking for new ways to break SUSY.**

- Studying calculable Seiberg-Witten monopoles can provide profound insights into (potentially) physically important $\mathcal{N} = 1$ phenomena.
  - e.g. gaugino condensation

- Light monopoles *might* play a role in electroweak symmetry breaking (Csaki, Shirman, Terning 2010)
  - Problems with calculability. Toy Models?
3. Review: Seiberg-Witten Analysis of \( \mathcal{N} = 2 \) \( SU(2) \) SYM
In $\mathcal{N} = 2$ SUSY, entire action is holomorphic. More calculable.

$\mathcal{N} = 2$ SU(2) SYM: One adjoint vector SF. Microscopic theory:

$$\mathcal{L} = \frac{1}{8\pi} \text{Im} \text{Tr} \left[ \tau_{\text{orig}} \left( \int d^2 \theta W^\alpha W_\alpha + 2 \int d^4 \theta \Phi^\dagger e^{-2V} \Phi \right) \right]$$

D-flat: $[\phi^\dagger, \phi] = 0 \Rightarrow$ Moduli Space parameterized by $u = \frac{1}{2} \text{Tr} \phi^2$

Generic Point on MS: SU(2) $\rightarrow$ U(1).

Low-E theory depends on $u$: U(1) gauge theory with charged matter. (Also topological monopoles, usually massive.)

- $u \gg \Lambda$: obtain low-energy theory perturbatively from microscopic electric theory
- $u \lesssim \Lambda$: ??? [strongly coupled]
How to find low-energy effective action?

- In general (e.g. IR effective theory), $\mathcal{N} = 2$ SYM action given in terms of prepotential $\mathcal{F}(\Phi)$:

$$
\mathcal{L} = \frac{1}{8\pi} \text{Im} \left( \int d^2 \theta \mathcal{F}_{ab}(\Phi) W^{a\alpha} W^{b}_{\alpha} + 2 \int d^4 \theta (\Phi^{\dagger} e^{2gV})^{a} \mathcal{F}_{a}(\Phi) \right)
$$

$\implies$ Want to find low-energy effective prepotential as a function of $u$!

- Low-energy dynamics given in terms of $U(1)$ gauge field $F_{\mu\nu}$ and holomorphic gauge coupling $\tau$.

$\rightarrow$ S-duality: $\phi, \tau, F_{\mu\nu} \longleftrightarrow \phi_D, \tau_D, F_{D\mu\nu}$ can exchange a strongly coupled description for a weakly coupled one via an $SL(2, \mathbb{Z})$ transformation on fields & coupling: $e \longleftrightarrow g \sim \frac{1}{e}$. 
Singularities in Moduli Space

Consider $\text{Im} \tau$ as a function of $u$:

→ Changes as we go around origin at $\infty \rightarrow \text{nontrivial monodromy}$

→ Requires 2 (for consistency) singularities near origin where $\text{Im} \tau \rightarrow \infty$

→ In formulating EFT, we integrated out a massless particle!

Could be topological monopoles!

- arise from SSB, e.g. $SU(2) \rightarrow U(1)$ (see e.g. Preskill 1984)
- size, mass coupling $\sim \frac{1}{\alpha}$

→ If $\alpha \rightarrow \infty$, become elementary, light, weakly coupled.
Plausible idea: at two places in MS near origin, $\text{Im} \tau$ diverges and normally heavy topological states become light, elementary & weakly coupled.

⇒ weakly coupled low-energy description is then $U(1)_{\text{mag}}$ with massless charged matter: **Monopoles**!

- topological degrees of freedom are BPS states
  ⇒ masses are given by *calculable* central charge!
For the experts:

**Because** $\tau$ **is a section on an** $SL(2, \mathbb{Z})$ **associated bundle over the moduli space, it is naturally interpreted as the modular parameter of a torus, which must be described by the elliptic curve**

$$y^2 = (x - \Lambda)(x + \Lambda)(x - u)$$

**in order to reproduce the correct weak coupling limit.**
Derivation of low-energy effective action

Using various arguments & checks, can show that low-energy effective prepotential & BPS masses can be derived from an elliptic curve

\[ y^2 = (x - \Lambda)(x + \Lambda)(x - u). \]

Curve describes a **torus** with complex structure that depends on \( u \). \( \tau_{\text{eff}} \) is the period of that torus.

- Some roots of curve become degenerate
- Torus becomes singular
- Singularity
- Some BPS masses go to 0
Derivation of low-energy effective action

⇒ massless monopoles/dyons at \( u = \pm \Lambda \)

Torus singular as

\[
\begin{align*}
    u & \rightarrow \infty & \text{electrons} & \text{massless & weakly coupled} \\
    +\Lambda & \text{monopoles} & \downarrow \\
    -\Lambda & \text{dyons} & \text{theory in terms of different dual of } F_{\mu\nu}, \tau, \phi
\end{align*}
\]

Near singularities we can write down an approximate effective superpotential for the monopoles:

\[
W \approx (u - \Lambda) M \tilde{M}
\]

for \((u - \Lambda) \ll \Lambda\)
Softly break to $\mathcal{N} = 1$

- Add $\delta W = m\, u$, i.e. electric mass term for $\Phi$ adjoint chiral superfield.

$\Rightarrow$ Below scale $m$, we have pure $\mathcal{N} = 1$ SYM $\Rightarrow$ gaugino condensation & electric confinement

- “Derive” this.

$W = (u - \Lambda)\tilde{M}\tilde{M} + m u$

$$\frac{\partial W}{\partial u} = \tilde{M}\tilde{M} + m \quad \frac{\partial W}{\partial M} = (u - \Lambda)\tilde{M}$$

$\Rightarrow \langle M\tilde{M} \rangle = -m, \langle u \rangle = \Lambda$

- Moduli space is lifted: $\phi$ is driven towards singularities.

- Monopole condensation $\rightarrow$ electric confinement via magnetic Meissner effect!
Can exactly solve for low-energy theory of $\mathcal{N} = 2$ $SU(2)$ SYM.

$\rightarrow$ generalizes to $SU(N)$ with fundamental flavors ($\Box, \Box$ hypers)

$\rightarrow$ cool stuff at higher rank: $SU(3)$ SYM can have simultaneously massless electric & magnetic charges! (Argyres-Douglas Point)

Can softly break to $\mathcal{N} = 1$ to use powerful $\mathcal{N} = 2$ calculational machinery to learn about nontrivial $\mathcal{N} = 1$ physics.
4. Review: Application of Seiberg-Witten Methods to $\mathcal{N} = 1$ Theories
SW methods can be applied to $\mathcal{N} = 1$ theories in the Coulomb phase $[G \to U(1) \times \text{any}]$ to describe low-energy $U(1)$ dynamics.

For $\mathcal{N} = 1$, only gauge kinetic term & superpotential holomorphic:

- Get $\tau_{\text{eff}}$ from curve. If singular, we know there are light monopoles or dyons!
- Cannot calculate explicit masses for monopoles/dyons.
- No Kahler Info! Can only use global symmetries to constrain $K$. (Same as e.g. Seiberg Duality.)

→ Gives us significant, though not complete, calculational control over $\mathcal{N} = 1$ theories with monopoles!
How to derive $\mathcal{N} = 1$ elliptic curves?

Say have one low-energy $U(1)$ and moduli space parameterized by single coordinate $u$.

→ most general form is $y^2 = x^3 + ax^2 + bx + c$

Constraints on curve that usually fix the coefficients:

1. $a, b, c$ holomorphic in $u$ and other parameters of theory
2. respect global symmetries
3. reproduce correct weak coupling limit: as $\Lambda \to 0$, singular $\forall u$
4. Give correct perturbatively calculable monodromies
5. in various limits, correctly reproduce the known curves of other models
SU(2)² Model

SU(2)₁  SU(2)₂  Moduli space parameterized by $M_{fg} = Q_f \cdot Q_g$

$Q_1$  □  □
$Q_2$  □  □  $\rightarrow M_{11}, M_{22}, M_{12}$

(low-energy dynamical superpotential forbidden by symmetries)

- SU(2)$_F$ flavor invariant: $u = \det M_{fg}$. $u \neq 0 \Rightarrow SU(2)^2 \rightarrow U(1)$

  $\rightarrow \tau_{\text{eff}} = \tau_{\text{eff}}(u, \Lambda^4_1, \Lambda^4_2)$ (By flavor symmetry and form of instanton contribution to gauge coupling.)

  $\rightarrow$ Symmetries constrain curve to depend only on $u$.

- Need to find curve $y^2 = x^3 + ax^2 + bx + c$
Find Curve $y^2 = x^3 + ax^2 + bx + c$

- Consider $u \gg \Lambda_{1,2}^4$ limit, e.g. $M_{11}$ large.

$\rightarrow$ $SU(2)^2 \rightarrow SU(2)_D$ with triplet $\Phi_D$: $\mathcal{N} = 2$ $SU(2)$ SYM!

$\rightarrow$ In this limit, curve must be $y^2 = x^3 - x^2 u + \Lambda_1^4 \Lambda_2^4$.

$\rightarrow$ by $\mathbb{Z}_2 (1 \leftrightarrow 2)$ symmetry & correctly reproducing various limits, this gives

$$a = -u + \alpha (\Lambda_1^4 + \Lambda_2^4), \quad b = \Lambda_1^4 \Lambda_2^4, \quad c = 0.$$ 

- Now consider $\Lambda_2 \gg \Lambda_3$ limit. Again looks like $\mathcal{N} = 2$ $SU(2)$ SYM.

$\rightarrow$ Get $\alpha = 1$.

Hence complete curve is $y^2 = x^3 + x^2 (-u + \Lambda_1^4 + \Lambda_2^4) + \Lambda_1^4 \Lambda_2^4$. 
Singular submanifold of moduli space

\[ y^2 = x^3 + x^2(-u + \Lambda_1^4 + \Lambda_2^4) + \Lambda_1^4 \Lambda_2^4 \]

\[ u \to \infty \quad \text{pair of electric charges } q, \tilde{q} \]
\[ u \to (\Lambda_1^2 + \Lambda_2^2)^2 \quad \text{pair of monopoles } E_+, \tilde{E}_+ \quad \text{become light & weakly coupled.} \]
\[ u \to (\Lambda_1^2 - \Lambda_2^2)^2 \quad \text{pair of dyons } E_-, \tilde{E}_- \]

Near monopole singularity,

\[ W_{\text{eff}} \approx c_+ \left[ \det M - (\Lambda_1^2 + \Lambda_2^2)^2 \right] E_+ \tilde{E}_+ \]

where \( c_+ \) is some unknown constant.
SU(2)$^3$ Model

(Csaki, Erlich, Freedman, Skiba '02)

\[ SU(2)_1 \quad SU(2)_2 \quad SU(2)_3 \quad 4 \text{ moduli space coordinates:} \]

\[ Q_1 \quad \square \quad \square \]
\[ Q_2 \quad \square \quad \square \]
\[ Q_3 \quad \square \quad \square \]

\[ M_i = Q_i Q_i \quad T = Q_1 Q_2 Q_3 \]

Can reduce theory to SU(2)$^2$ in two limits: one large VEV $(Q_3 \propto 1, \gg \text{all})$ and $\Lambda_3 \gg \Lambda_{1,2}$.

⇒ together with $S_3$ symmetry $1 \leftrightarrow 2 \leftrightarrow 3$, this gives full curve:

\[ y^2 = x^3 + x^2 \left[ \Lambda_1^4 M_2 + \Lambda_2^4 M_3 + \Lambda_3^4 M_1 - M_1 M_2 M_3 + T^2 \right] + x \Lambda_1^4 \Lambda_2^4 \Lambda_3^4 \]
Again just like original Seiberg-Witten: As

\[ \Lambda_1^4 M_2 + \Lambda_2^4 M_3 + \Lambda_3^4 M_1 - M_1 M_2 M_3 + T^2 \to \infty, \pm 2\Lambda_1^4 \Lambda_2^4 \Lambda_3^4, \]

electric, magnetic or dyonic charges become massless, elementary and weakly coupled.

Near monopole singularity, again obtain effective superpotential:

\[ W_{eff} \approx c_+ \left( -\Lambda_1^4 M_2 - \Lambda_2^4 M_3 - \Lambda_3^4 M_1 + M_1 M_2 M_3 - T^2 + 2\Lambda_1^2 \Lambda_2^2 \Lambda_3^2 \right) E_+ \tilde{E}_+ \]
5. SUSY-Breaking via Monopole Condensation
A particular point

in $SU(2)^3$ moduli space
Explore massless monopoles in $SU(2)^3$

- Consider $SU(2)^3$ model with $\Lambda_i = \Lambda$ for simplicity.
- Rescale $M_i$, $T$ to have correct mass dimensions of low-energy degrees of freedom.
- To study massless monopoles, restrict ourselves to be close to the subspace of moduli space where

$$M_1 + M_2 + M_3 - \frac{M_1 M_2 M_3}{\Lambda^2} + \frac{T^2}{\Lambda} = 2\Lambda^2$$

is satisfied.

$$\Rightarrow \quad W_{\text{eff}} = c_+ \left[ -M_1 - M_2 - M_3 + \frac{M_1 M_2 M_3}{\Lambda^2} - \frac{T^2}{\Lambda} + 2\Lambda^2 \right] E_+ \tilde{E}_+$$
Consider particular point in moduli space where monopoles are massless:

\[ M_1 = 2\Lambda \]

Near singularity, \( M_i \) and \( T \) are good low-energy d.o.f. since they are weakly coupled composites of confined electric quarks. But what is the Kahler of their fluctuations around \( M_1 = 2\Lambda \)?

⇒ can only use global symmetries to restrict \( K \):

→ non-anomalous \( Z_3 \) broken to \( Z_2 \) forbids \( M_i T \) quadratic mixing!
Near $M_1 = 2\Lambda$, superpotential for approximately canonical low-energy degrees of freedom $\tilde{M}_i, \tilde{T}$ is

$$W_{eff} \approx \left[ a\tilde{M}_1 + b\tilde{M}_2 + c\tilde{M}_3 - d\frac{\tilde{T}^2}{\Lambda} \right] E_+ \tilde{E}_+,$$

where $a, b, c, d$ are unknown. This is valid for $\tilde{M}_i, \tilde{T} \ll \Lambda$.

- $\tilde{E}_+, E_+$ are charged under $U(1)_{mag}$ with $g_{mag} \rightarrow 0$.

- Can this theory be modified to break SUSY?
Shih model of SUSY breaking

(hep-th/0703196)
Shih’s O’Raifeartaigh model (2008)

- generalized O’Raifeartaigh model with $R$-charges other than 0, 2, which can break $R$-symmetry without tuning.

- $W = X(f + \lambda \phi_1 \phi_2) + m_1 \phi_1 \phi_3 + \frac{1}{2} m_2 \phi_2^2$

  - This is generic for $R_X = 2, R_{\phi_1} = -1, R_{\phi_2} = 1, R_{\phi_3} = 3$.

  - Can make all constants $> 0$ with field redefinitions. Define two useful parameters

    \[ y = \frac{\lambda f}{m_1 m_2}, \quad r = \frac{m_2}{m_1}, \]

    which control whether SUSY and $R$-symmetry can be spontaneously broken in a metastable vacuum.
Minimizing the scalar potential

For $y < 1$, there exists a stable SUSY-breaking pseudomoduli space

$$\phi_i = 0 \ , \quad X = \text{undetermined at tree-level} \quad \text{with} \quad |X| < X_{\text{max}}$$

Quantum corrections generate $V_{\text{CW}}(|X|)$ at 1-loop.

There is also a SUSY-runaway:

$$\phi_3 \to \infty \ , \quad X \sim \phi_3^{2/3} \ , \quad \phi_2 \sim \phi_3^{1/3} \ , \quad \phi_1 \sim \phi_3^{-1/3} \ ,$$

meaning SUSY-breaking is metastable.
For $y < 1$ and $0 < r \lesssim O(10)$, the Shih model exhibits SUSY. For $r \gtrsim 2$, also have $\mathcal{R}$.

$\langle X \rangle$ in units of $\sqrt{f/\lambda}$

$V_{CW}$:

$r = 1.5$, $y = 0.20$

$r = 4.0$, $y = 0.20$
Deforming the $SU(2)^3$ model to break SUSY
Deforming the $SU(2)^3$ model

- We want to deform the $SU(2)^3$ model to get an effective Shih model of metastable SUSY.

- We would like monopole condensation to play an ‘essential’ role for SUSY.

- Consider $SU(2)^3$ model around $M_1 = 2\Lambda$:

$$W_{\text{eff}} \approx \left[a\tilde{M}_1 + b\tilde{M}_2 + c\tilde{M}_3 - d\frac{T^2}{\Lambda}\right] E_+ \tilde{E}_+.$$  

Add some tree-level terms and extra $SU(2)^3$ singlet fields:

$$\delta W = -\mu^2 \tilde{M}_1 + \lambda \tilde{M}_2 \phi_1 \phi_2 + \frac{1}{2} m_2 \phi_2^2 + m_1 \phi_1 \phi_3 + m_Z Z T + m_Y \tilde{M}_3 Y$$
\[ W_{\text{eff}} \approx \left[ a\tilde{M}_1 + b\tilde{M}_2 + c\tilde{M}_3 - d\frac{T^2}{\Lambda} \right] E_+ \tilde{E}_+ - \mu^2 \tilde{M}_1 + \lambda \tilde{M}_2 \phi_1 \phi_2 + \frac{1}{2} m_2 \phi_2^2 + m_1 \phi_1 \phi_3 + m_Z Z T + m_Y \tilde{M}_3 Y \]

\[ F_{\tilde{M}_1} \rightarrow \langle E_+ \tilde{E}_+ \rangle \sim \mu^2 \Rightarrow \tilde{M}_2 \text{ gets a tadpole } \sim \langle E_+ \tilde{E}_+ \rangle \sim \mu^2. \]

(spectator moduli are stabilized by giving them a mass with singlets)

\[ \Rightarrow \text{ effective Shih-model with } X \rightarrow \tilde{M}_2, \ f \rightarrow \sim \langle E_+ \tilde{E}_+ \rangle \]

Metastable SUSY-breaking via non-perturbative monopole dynamics!
**Electric Theory**

\[
SU(2)_1 \quad SU(2)_2 \quad SU(2)_3
\]

\[
Q_1 \quad \square \quad \square \quad \square
\]

\[
Q_2 \quad \square \quad \square \quad \square
\]

\[
Q_3 \quad \square \quad \square \quad \square
\]

\[SU(2)'s \text{ become strong below scale } \Lambda\]

\[
W_{\text{tree}} = \tilde{m}(QQ)_A + \frac{\lambda}{\Lambda_{\text{UV}}} (QQ)_B \phi_1 \phi_2 + \frac{1}{2} m_2 \phi_2^2 + m_1 \phi_1 \phi_3
\]

\[
+ \frac{a_Z}{\Lambda_{\text{UV}}} Q_1 Q_2 Q_3 Z + a_y (QQ)_C Y,
\]

\((QQ)_{A,B,C}\) are linear combinations of \(Q_1^2, Q_2^2, Q_3^2\) that become canonical \(\tilde{M}_i\) in the IR.

- \(\Lambda \to 0\) restores SUSY.
- \(\lambda \sim \frac{\Lambda}{\Lambda_{\text{UV}}} \lesssim 10^{-2}\).
- \(m \ll \ll \Lambda \ll \Lambda_{\text{UV}}\)
Other ways to get an effective Shih model

Model 2:

\[ W_{\text{eff}} \approx \left[ a\tilde{M}_1 + b\tilde{M}_2 + c\tilde{M}_3 - d \frac{\tilde{T}^2}{\Lambda} \right] E_+ \tilde{E}_+ \]

\[ \delta W = -f\tilde{M}_1 + X(\lambda T\phi_1 - \mu^2) + m_1\phi_1\phi_3 + m_ZZ\tilde{M}_2 + m_Y\tilde{M}_3Y \]

\[ F_{\tilde{M}_1} \rightarrow \langle E_+ \tilde{E}_+ \rangle \sim f \Rightarrow \tilde{T} \text{ gets a mass} \sim \langle E_+ \tilde{E}_+ \rangle / \Lambda \sim f / \Lambda. \]

\[ \Rightarrow \text{effective Shih-model with } \phi_2 \rightarrow \tilde{T}, \ m_2 \rightarrow \sim \langle E_+ \tilde{E}_+ \rangle / \Lambda \]

- Good: less restrictive constraints on scales.
- Bad: \( \lambda \sim \left( \frac{\Lambda}{\Lambda_{\text{UV}}} \right)^2 \), monopole dynamics less essential to SUSY.
Other ways to get an effective Shih model

Model 3:

\[ W_{\text{eff}} \approx \left[ a\tilde{M}_1 + b\tilde{M}_2 + c\tilde{M}_3 - d\frac{\tilde{T}^2}{\Lambda} \right] E_+ \tilde{E}_+ \]

\[ \delta W = -f\tilde{M}_1 + \lambda\tilde{M}_2 T\phi_1 + m_1\phi_1\phi_3 + m_2\tilde{M}_3 Y \]

\[ F_{\tilde{M}_1} \rightarrow \langle E_+ \tilde{E}_+ \rangle \sim f \]

\[ \Rightarrow \tilde{M}_2 \text{ gets tadpole} \sim \langle E_+ \tilde{E}_+ \rangle \sim f \]

\[ \Rightarrow \tilde{T} \text{ gets a mass} \sim \langle E_+ \tilde{E}_+ \rangle / \Lambda \sim f / \Lambda. \]

\[ \Rightarrow \text{effective Shih-model with both } \phi_2 \text{ and pseudomodulus } X \]

components coming from monopole condensation & composite d.o.f.

- **Good:** Shih model maximally embedded in monopole sector.

- **Bad:** \( \lambda \sim \left( \frac{\Lambda}{\Lambda_{\text{UV}}} \right)^3 \), severe constraints on scales, loss of calculability for \( m_2 \), astrophysically light pseudomodulus.
Due to incalculable Kahler in IR, Deformations required to achieve SUSY involve very contrived linear combinations of $Q_iQ_i$ in the electric theory.

→ How closely do they have to be aligned to the near-canonical $\tilde{M}_i$ low-energy d.o.f.?  

→ Is there some way to make SUSY alignment-insensitive?

→ Could start with $\mathcal{N} = 2$ theory softly broken to $\mathcal{N} = 1$ to (approximately) remove Kahler ambiguity?

Can these models be made generic?

Could we use $SU(2)^3$ and other calculable theories with monopoles to reproduce different kinds of low-energy SUSY models (e.g. original O’Raifeartaigh model)?
6. Conclusion
Seiberg-Witten methods give us a handle on low-energy $U(1)$-dynamics, where light monopoles and dyons can play an important role.

We show that metastable SUSY-breaking via non-perturbative monopole dynamics can be achieved.

→ In spirit similar to ISS.

These strategies should be applicable to a wide variety of different models in the Coulomb phase with calculable light monopoles to obtain different low-energy SUSY-models.

→ Lots of things to try!

(Might even graduate to /hep-ph...some day.)