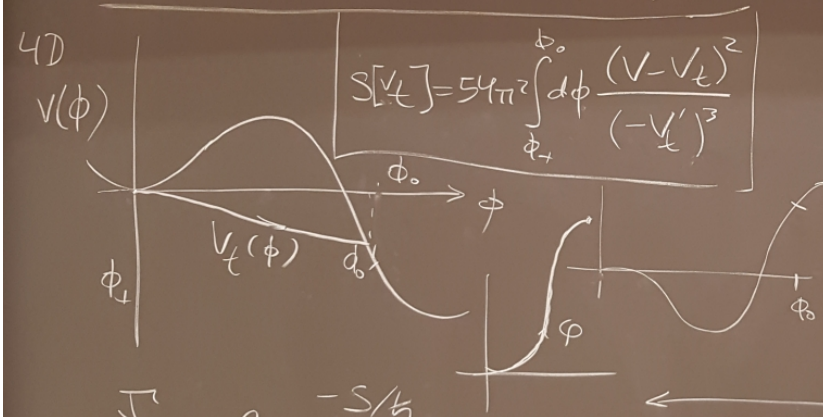
TUNNELING ACTIONS

EUCLIDEAN WAY

Coleman.



$$S[V_t] = 54\pi^2 \int_{\phi_+}^{\phi_0} d\phi \frac{(V-V_t)^2}{(-V_t')^3}$$

$$\frac{\Gamma}{V} = A e^{-S/\hbar}(1+O(\hbar)) \quad \longleftrightarrow \quad V_t = V - \frac{1}{2}\dot{\phi}^2$$

$O(4)$ $\phi_b(r)$

$$S_E(\phi) = 2\pi^2 \int_0^\infty dr\, r^3 \left[\frac{1}{2}\left(\frac{d\phi}{dr}\right)^2 + V(\phi)\right]$$

$$\frac{d^2\phi}{dr^2} + \frac{3}{r}\frac{d\phi}{dr} = \frac{dV}{d\phi}$$

$\phi(0) = \phi_0$, $\dot{\phi}(0) = 0$, $\phi(\infty) = \phi_+$

$$\dot{\phi} = -\sqrt{2(V-V_t)}$$

$$\ddot{\phi} = V' - V_t'$$

$$r = \frac{3\sqrt{2(V-V_t)}}{|V_t'|}$$

PROPS

1) $V_t \leq V$

2) $V_t' \leq 0$, V_t monotonic.

3) $S[V_t]$ is a minimum

APPS

1) Polynomial app to V_t $\quad \frac{\delta S}{S} \lesssim 1\%$

2) Multifield $V(\phi_i)$ [T. Konstandin]

VEVACIOUS.

3) Finite T $\quad \frac{S}{T} \propto \int d\phi \frac{(V-V_t)^{3/2}}{(V_t')^2}$

4) $V \leftrightarrows V_t$ $\quad (4V_t' - 3V')V_t = 6(V_t - V)\left[V_t'' + \frac{3V - 2V_t}{m_p^2}\right]$

GRAVITY

Coleman, De Luccia.

$\Delta V \lesssim m_p^4$ $\quad \Delta\phi \lesssim m_p$

$O(4)$ $\phi_b(r)$ $\quad \rho(r) \to S_E[\phi_b, \rho]$.

$$S[V_t] = 6\pi^2 m_p^4 \int_{\phi_+}^{\phi_0} d\phi \frac{(D+V_t')^2}{D V_t^2}$$

$$D \equiv \sqrt{(V_t')^2 + 6(V-V_t)V_t/m_p^2}$$

PROPS

1) dS, AdS, Mink (V_t)

2) dS ($V_t > 0$) $V_t \uparrow$ No CdL

Hawking–Moss.

3) Quenching.

D real