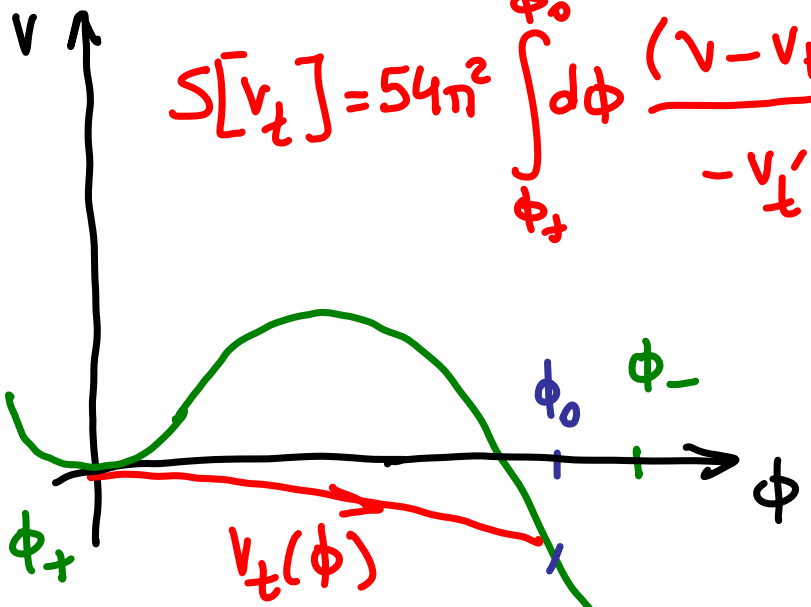
TUNNELING ACTIONS

EUCLIDEAN WAY

Coleman

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



$O(4)$ $\quad \phi(r)$

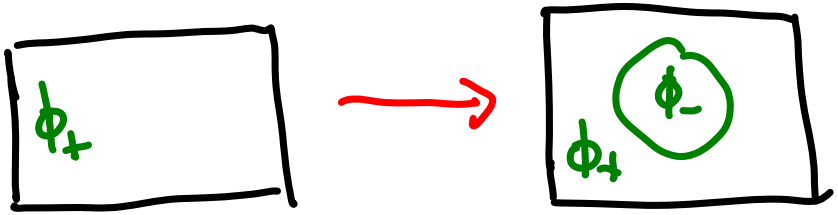
$$S[\phi] = 2\pi^2 \int_0^\infty dr \, r^3 \left[\frac{1}{2}\dot{\phi}^2 + V(\phi) \right]$$

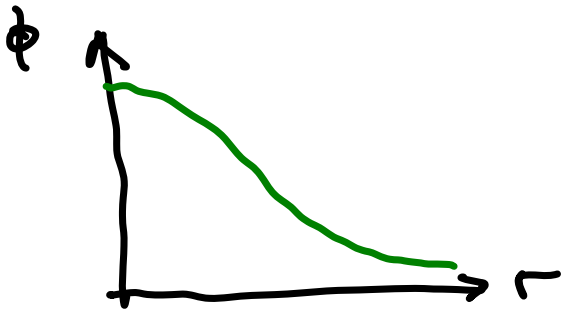
$$\ddot{\phi} + \frac{3}{r}\dot{\phi} = V'$$

$\phi(0) = \phi_0$

$\dot{\phi}(0) = 0$

$\phi(\infty) = \phi_+$





$$\frac{\Gamma}{V} = A e^{-S/\hbar}$$

$$\Longleftrightarrow$$

$$V_t = V - \frac{1}{2}\dot{\phi}^2$$

PROPS

1) $V_t \leq V$
2) $V_t' \leq 0$ V_t monotonic
3) $S[V_t]$ minimized

APPS

1) Polynomial ap V_t 4^{th} $\frac{\delta S}{S} < 1\%$
2) $V(\phi_i)$, w/ Thomas Konstandin
3) PhT → 3d S_3/T
4) $V_t \to V$

GRAVITY

$\Delta V \sim m_p^4 \qquad \Delta\phi \sim m_p$

- EUCLIDEAN Coleman, De Luccia

$O(4) \quad \phi_B(r), \; S_B(r)$

$S = S_E[\phi_B, S_B] - S_E[\phi_+, S_+]$

- V_t

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

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

PROPS

1) Universal Mink, dS, AdS

2) dS $(V_t > 0)$

~~CdL~~ $V_t \uparrow$ Hawking-Moss.

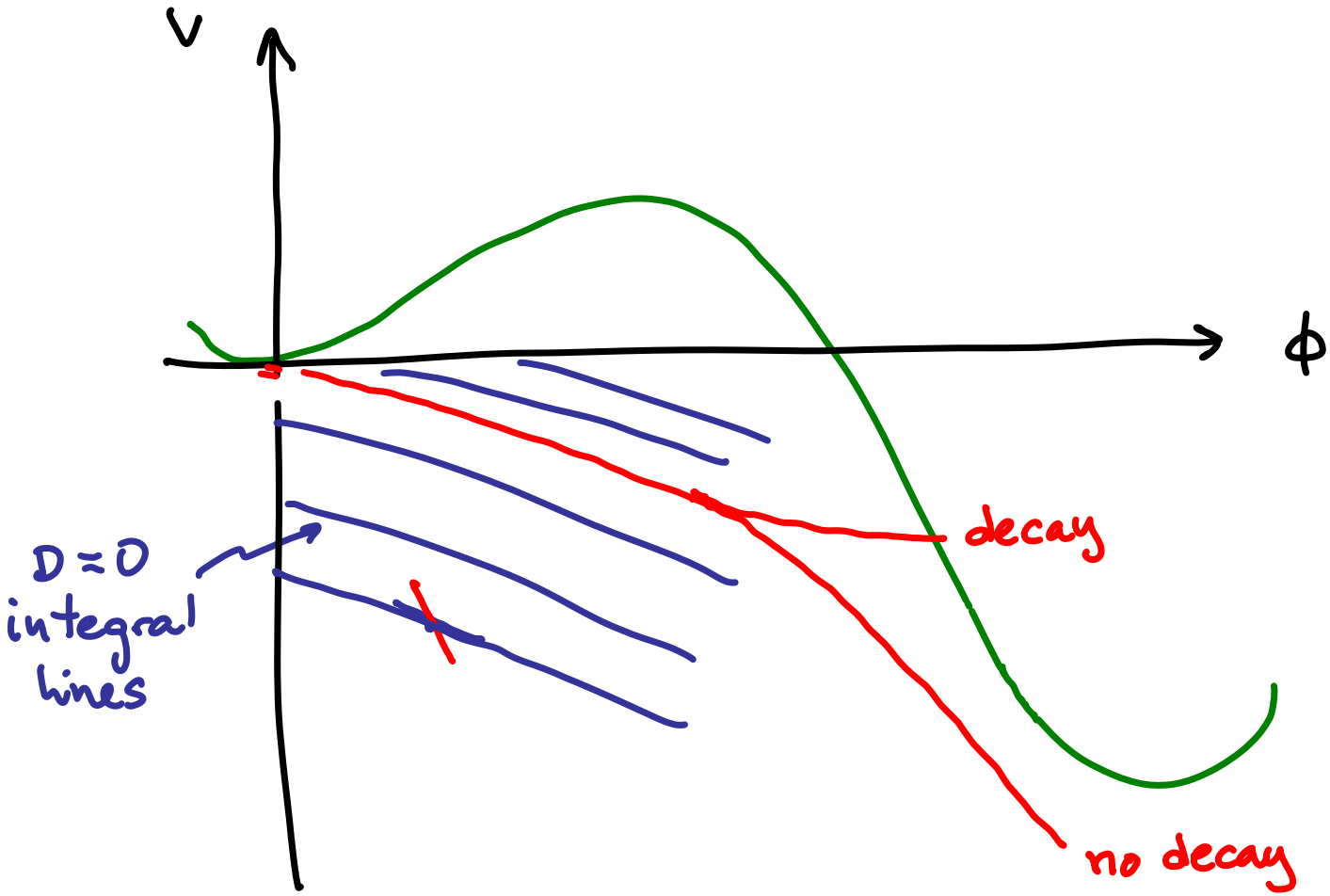
$$S = 24\pi^2 m_p^4 \left(\frac{1}{V_+} - \frac{1}{V_T}\right)$$

$V_T \uparrow$

3) Mink, AdS $(V_+ \leq 0)$

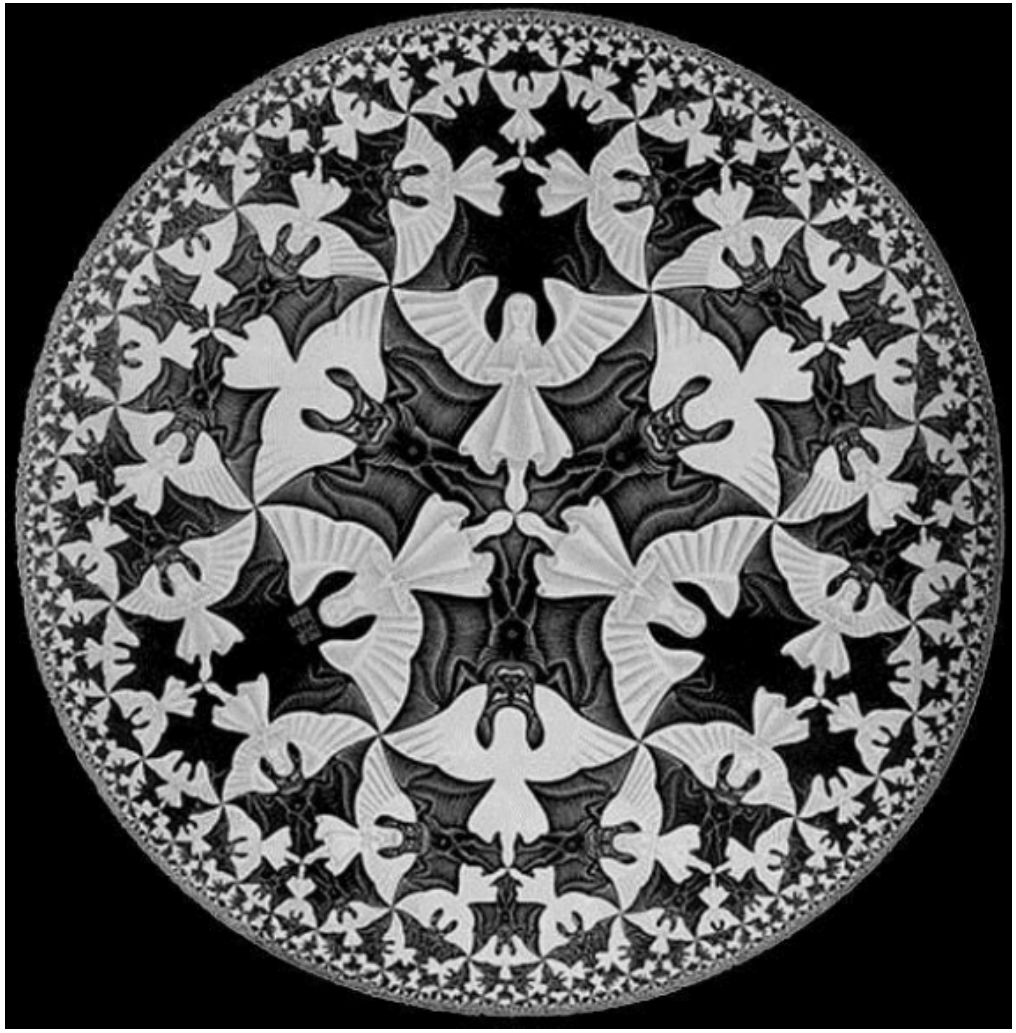
Grav. quenching.

$D^2 < 0$



$D=0 \Rightarrow \quad -V_t' = \sqrt{6(v-v_t)(-v_t)/m_\phi^2}$

$D^2>0 \rightarrow \quad -v_t' > \sqrt{}$



Angels and demons

M.C. Escher