

# ADS-PHOBIA: CONFRONTING THE SM AND SUSY WITH THE WGC

Alvaro Herráez

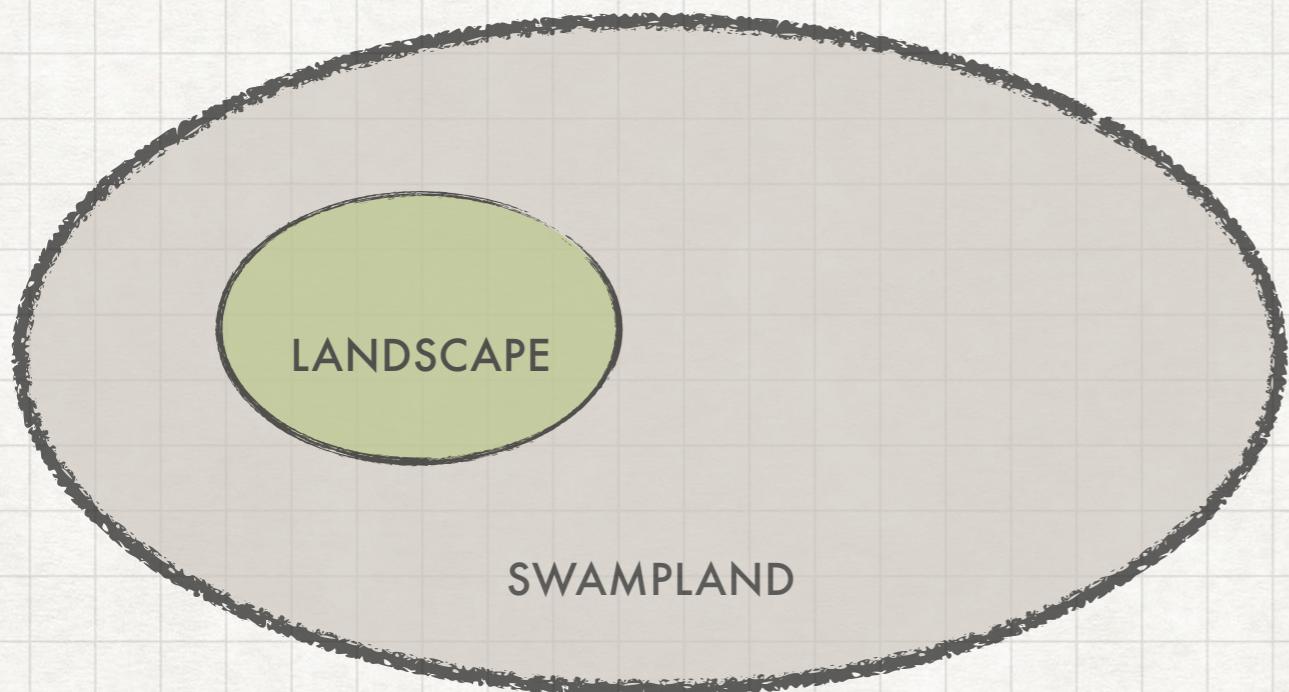
Universidad Autónoma de Madrid & Instituto de Física Teórica UAM-CSIC

Based on: E. Gonzalo, A. H., L. E. Ibáñez [1803.08455]

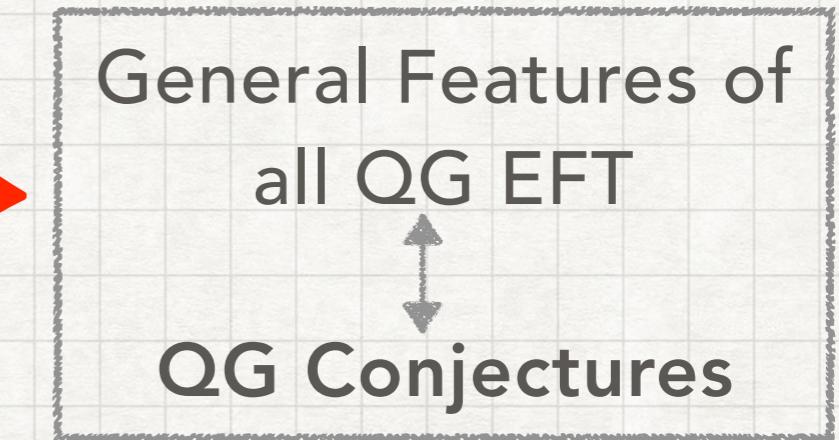
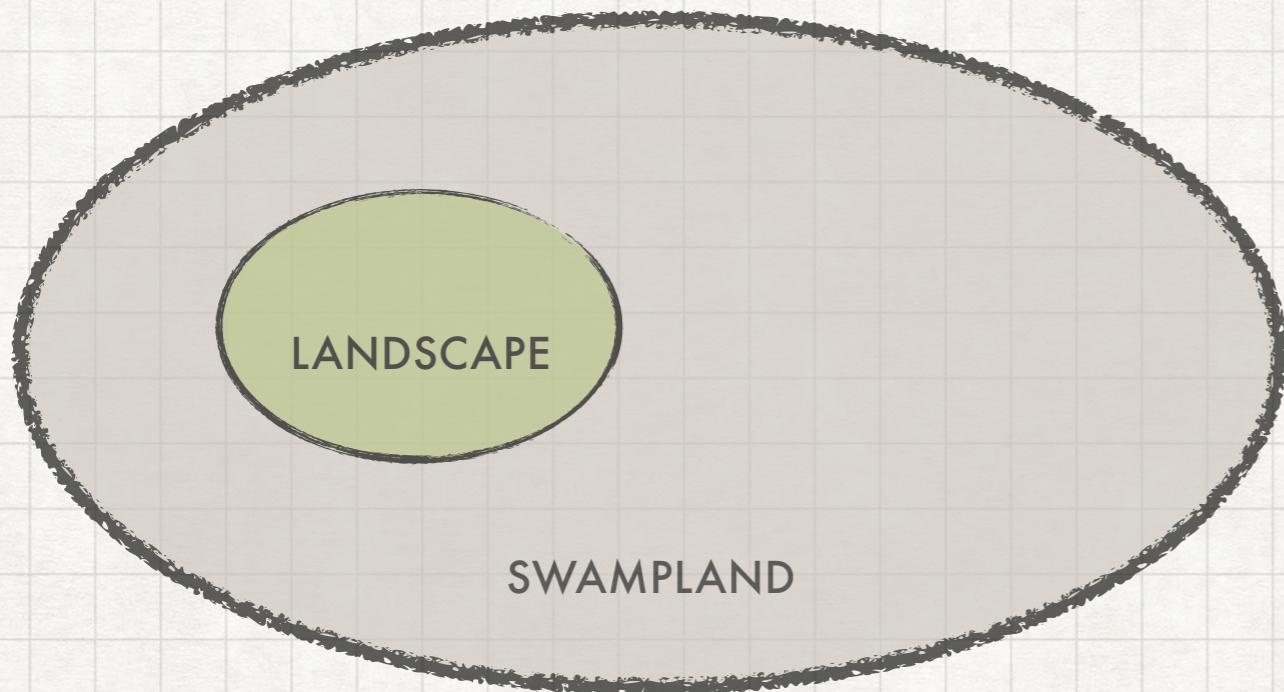


String Pheno 2018, Warsaw  
July 4, 2018

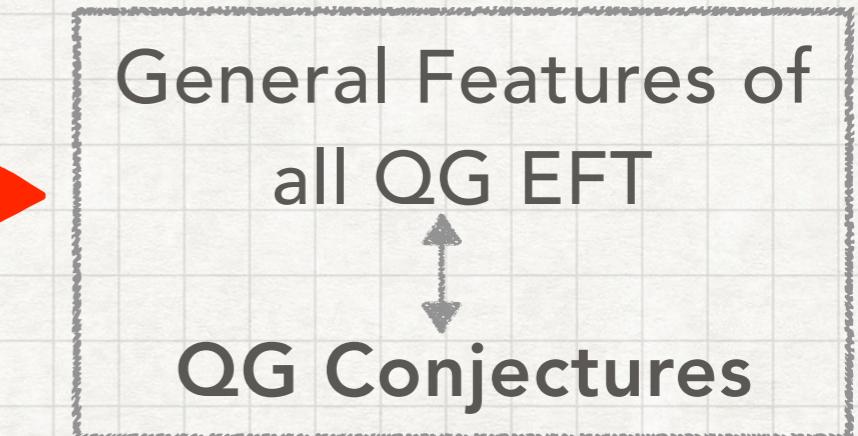
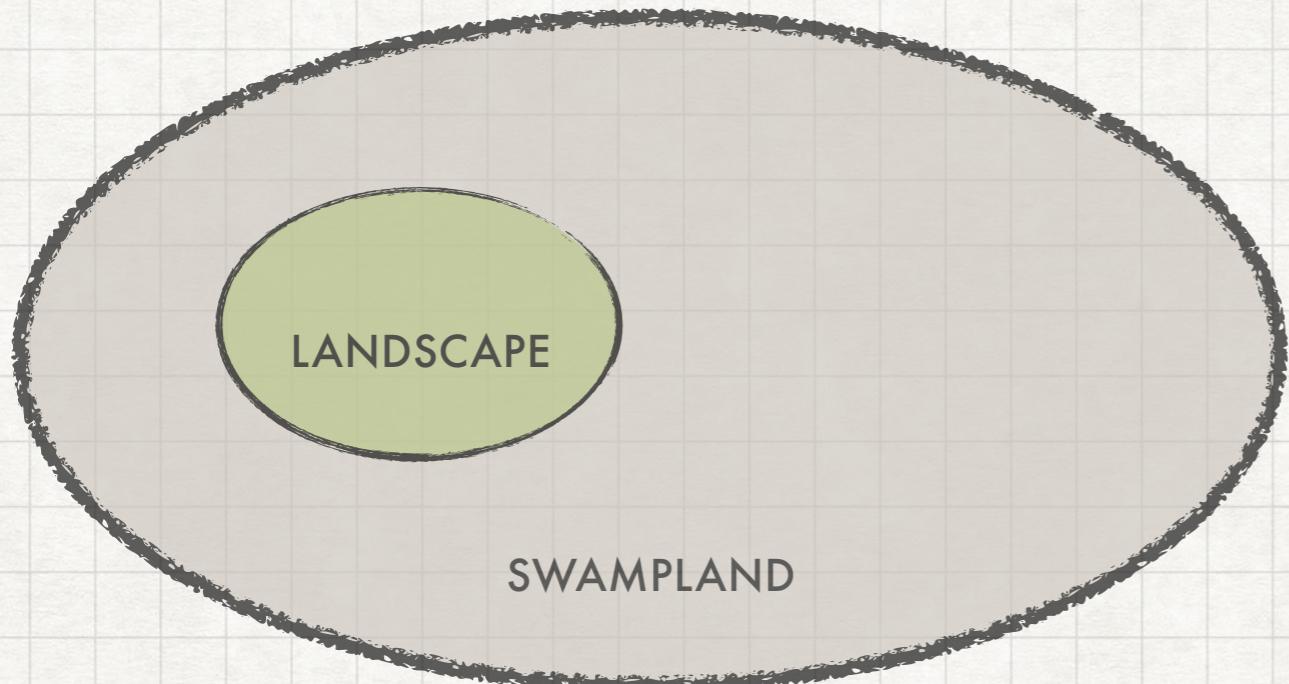
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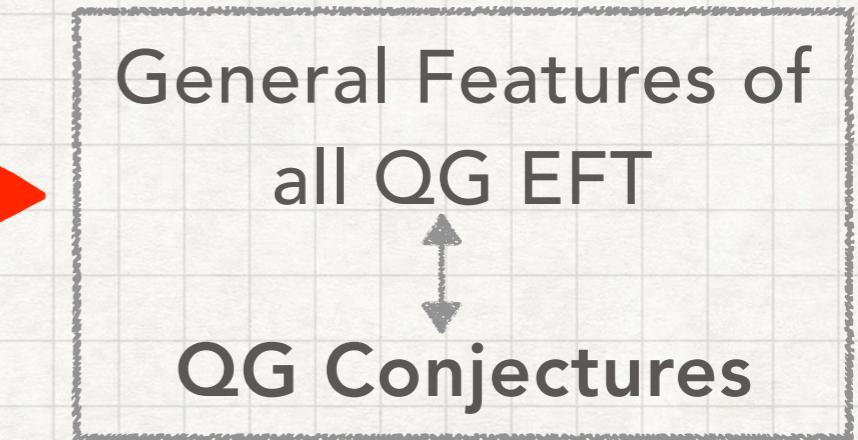
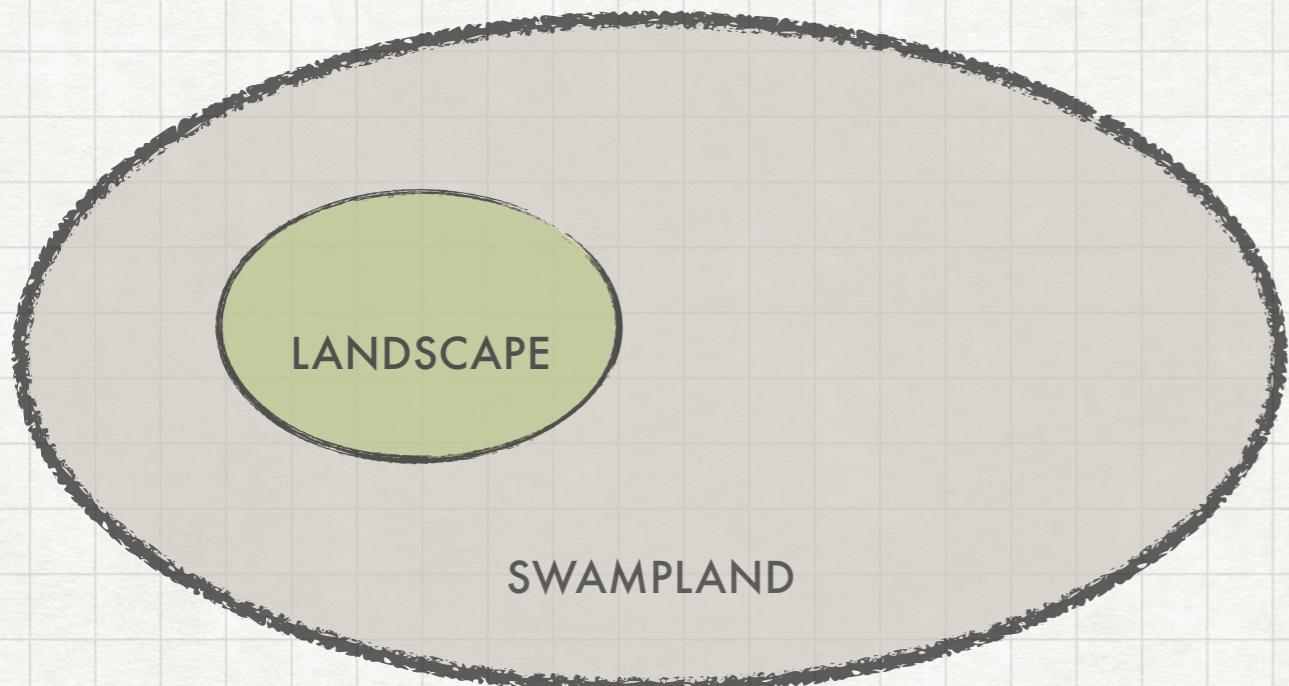
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[Ooguri, Vafa '17]



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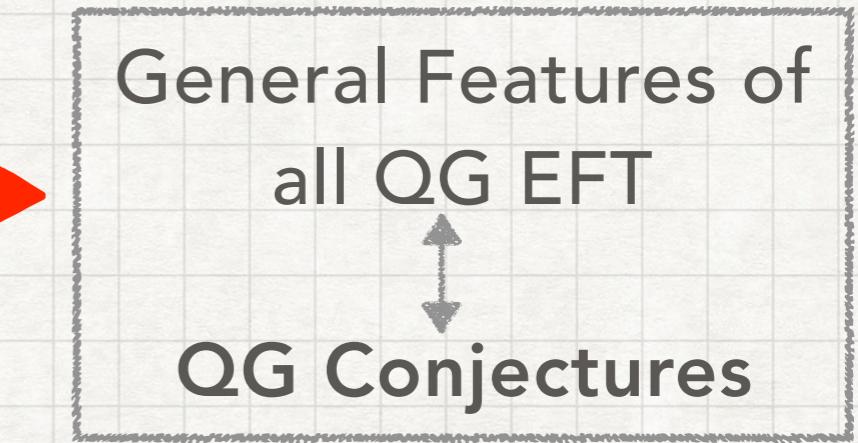
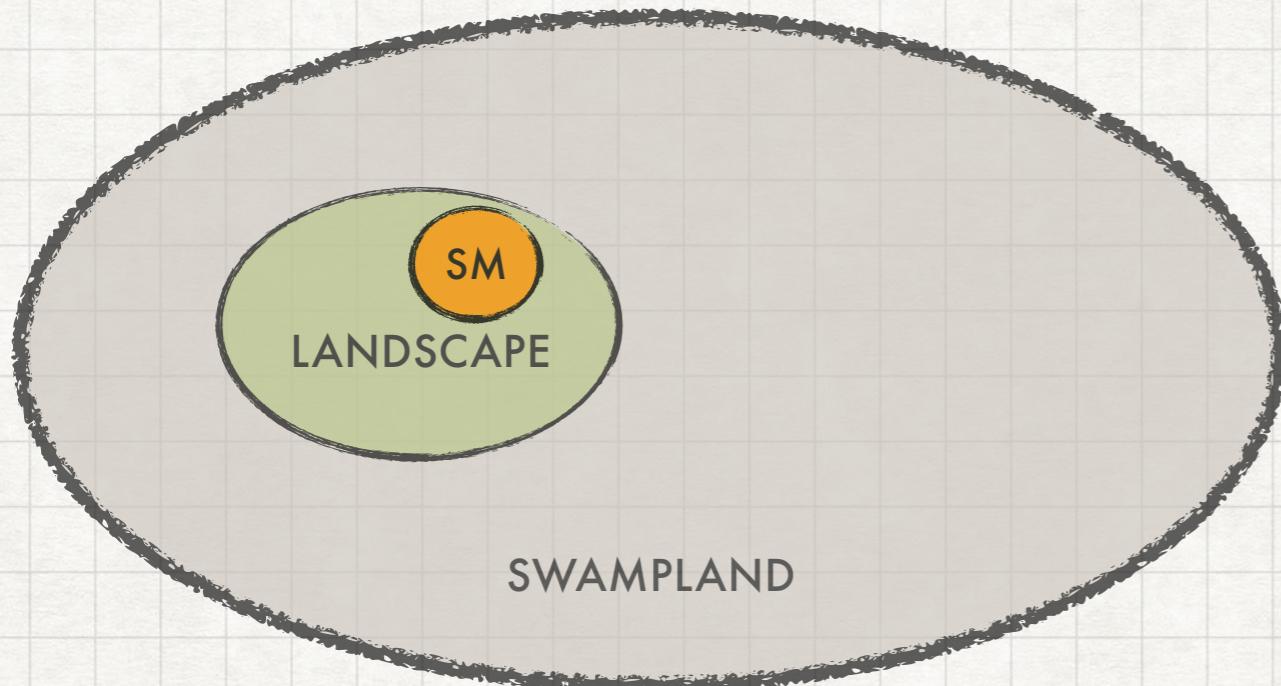
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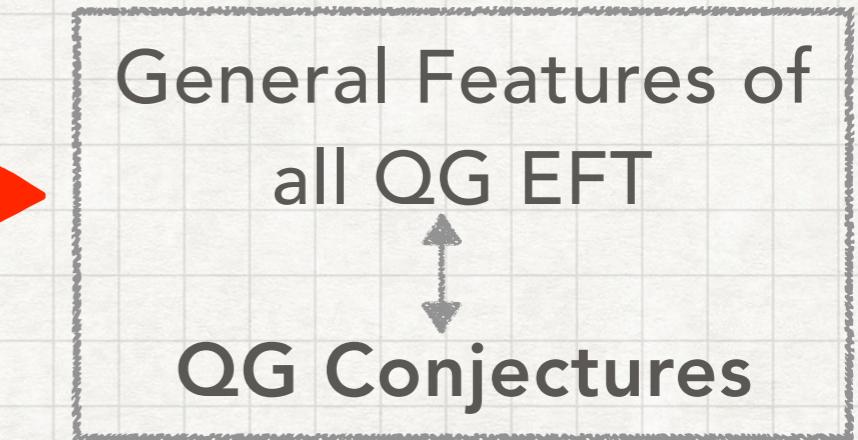
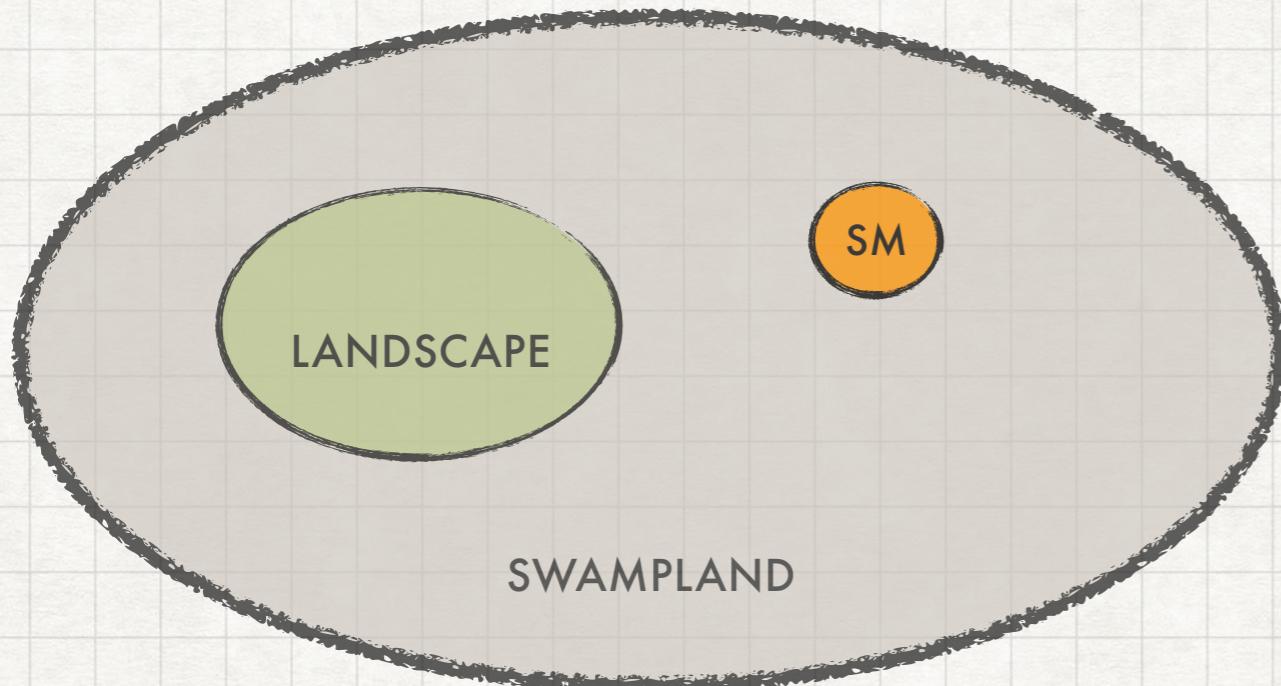
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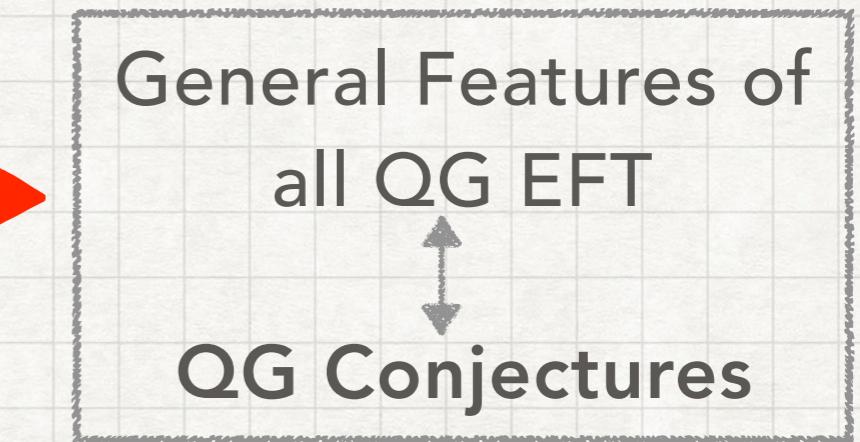
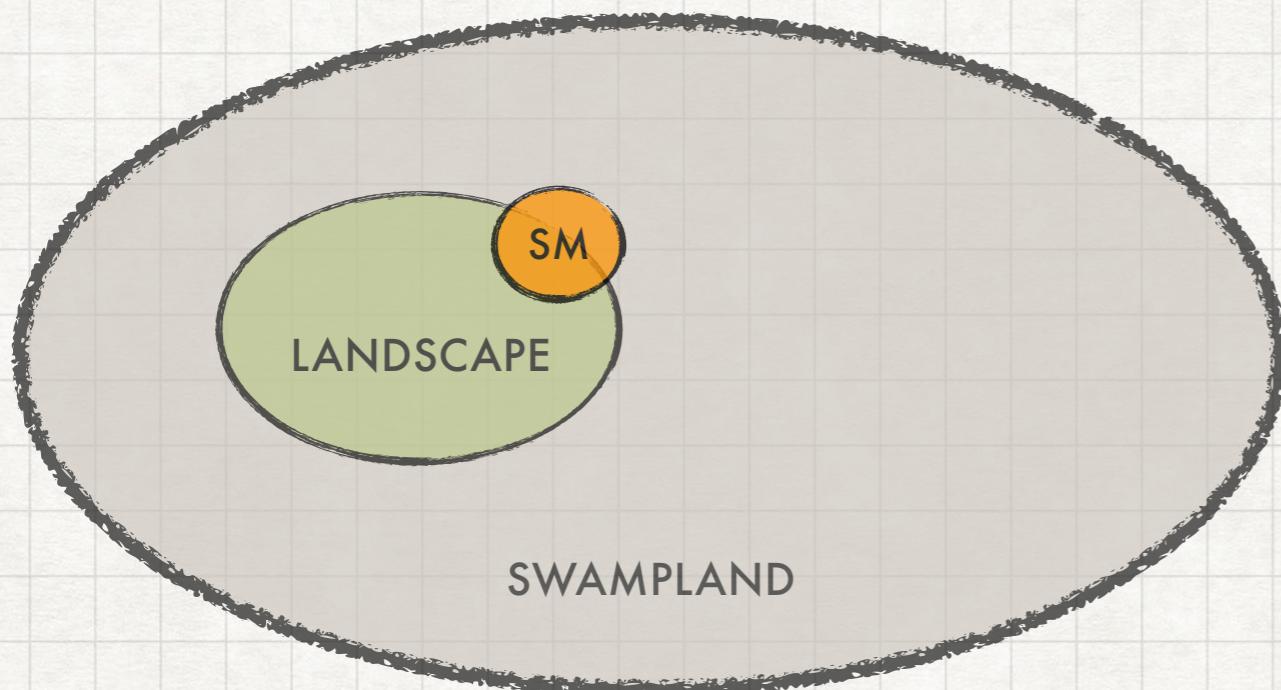
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# ADS-PHOBIA AND THE SM

- Compactify the SM+GR to 3d or 2d → SM landscape

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Casimir Energy

- Massless particles  $\longrightarrow V(R) \sim \pm \frac{n_p}{R^6}$

- Massive particles  $\begin{cases} V(R) \sim e^{-m_p R} & \text{if } m_p \gg R^{-1} \\ V(R) \sim \pm \frac{n_p}{R^6} & \text{if } m_p \ll R^{-1} \end{cases}$

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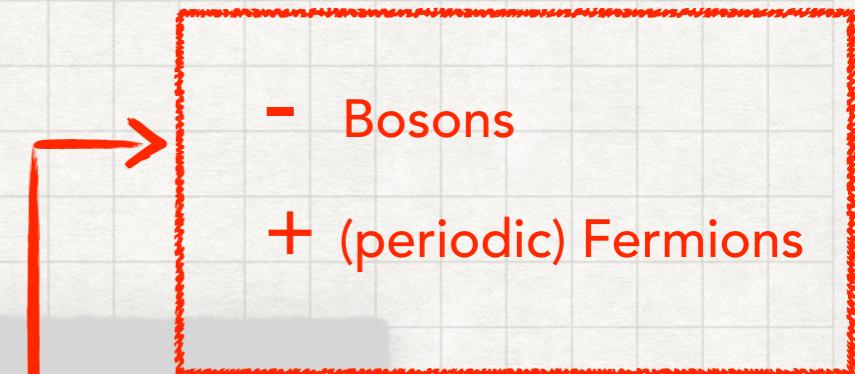
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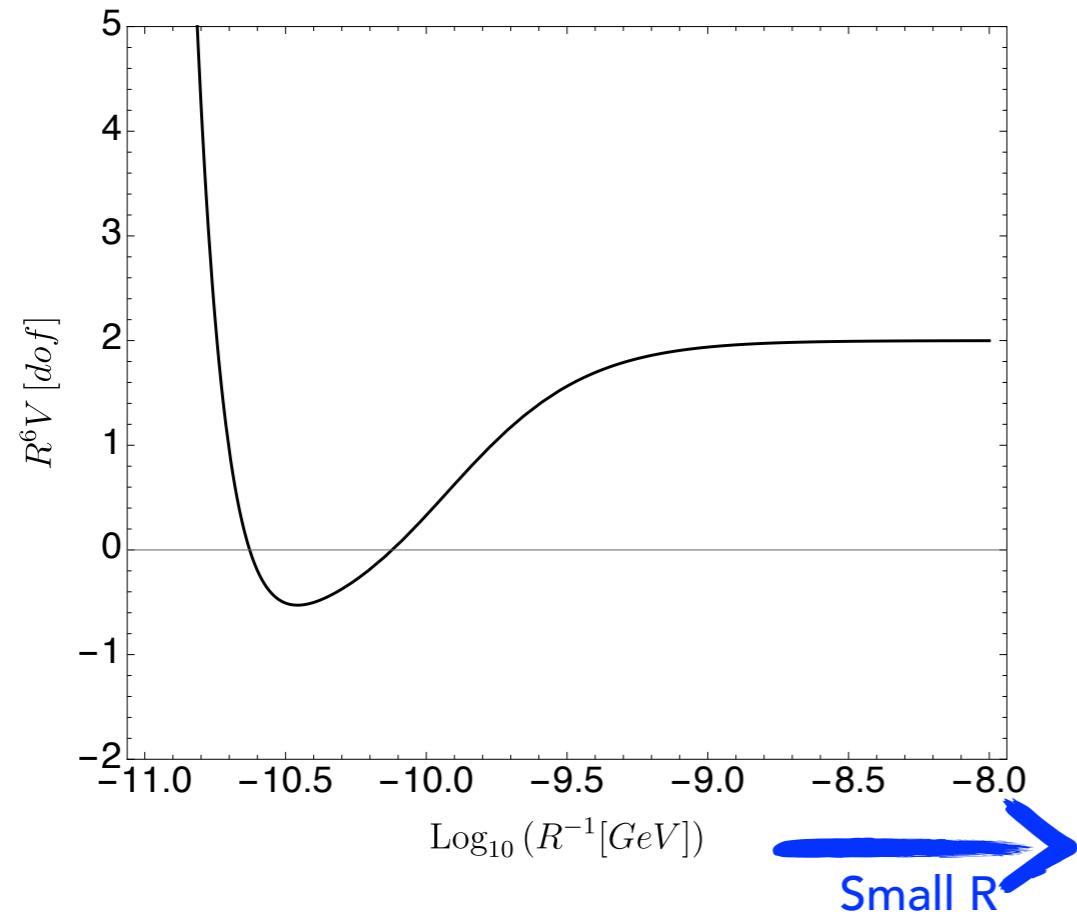
- Photon, graviton and neutrinos → first particles to enter the game

$\gamma, g, \nu$   
 $-2 - 2^{+6} (M)$   
 $+12 (D)$

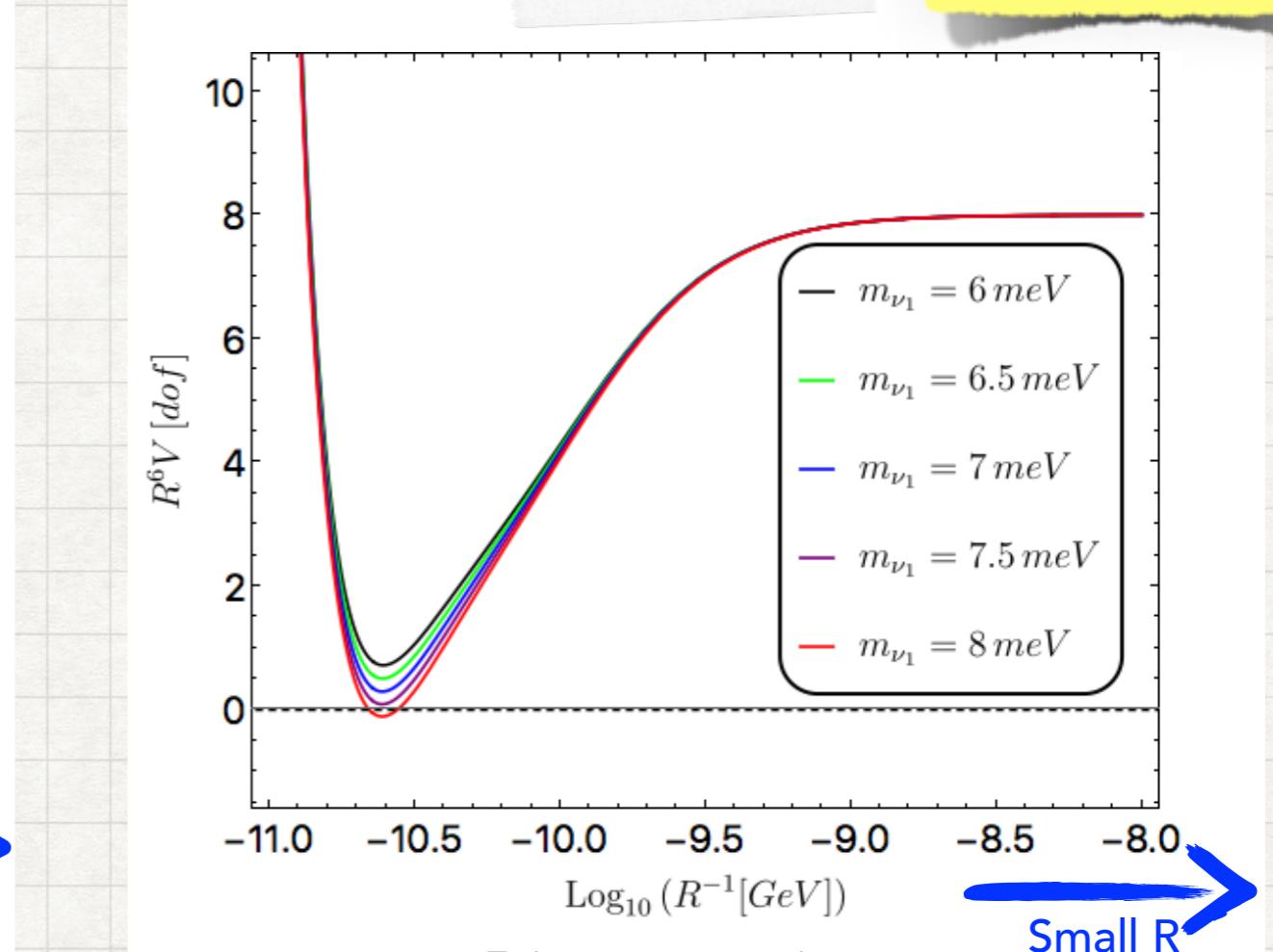
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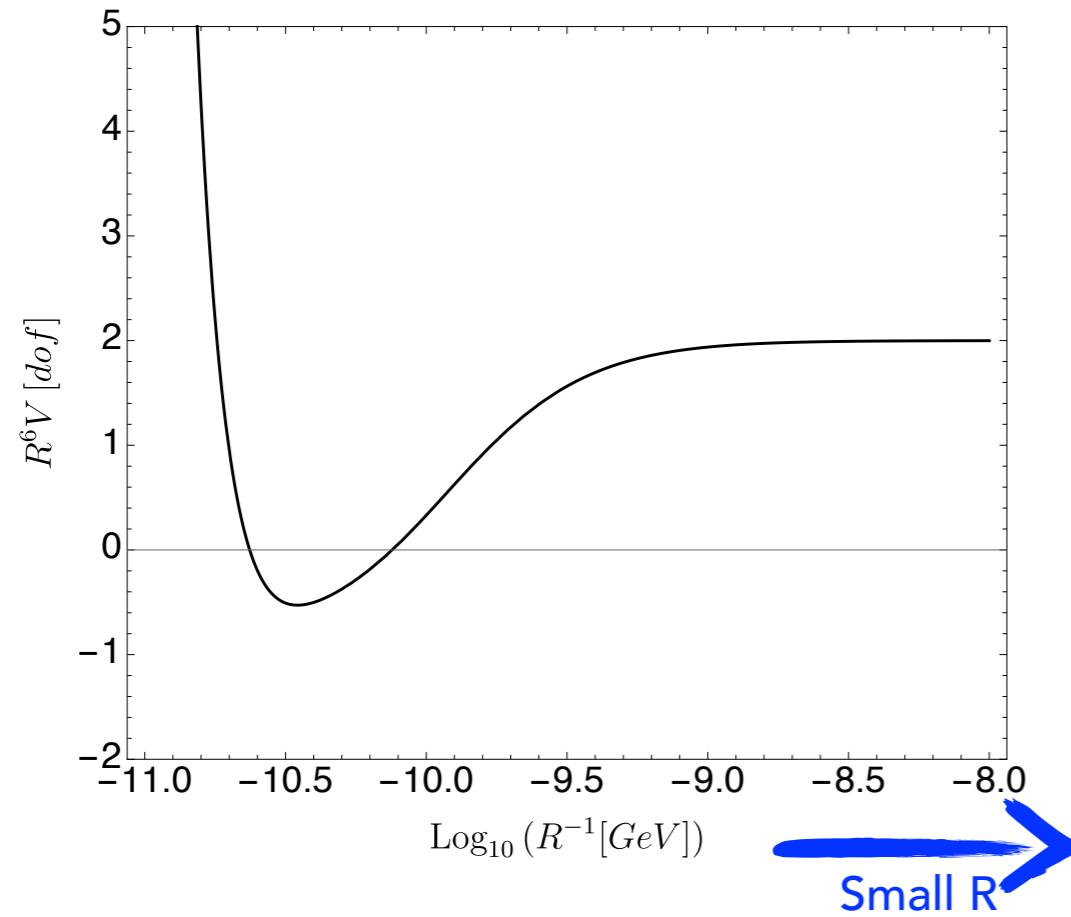
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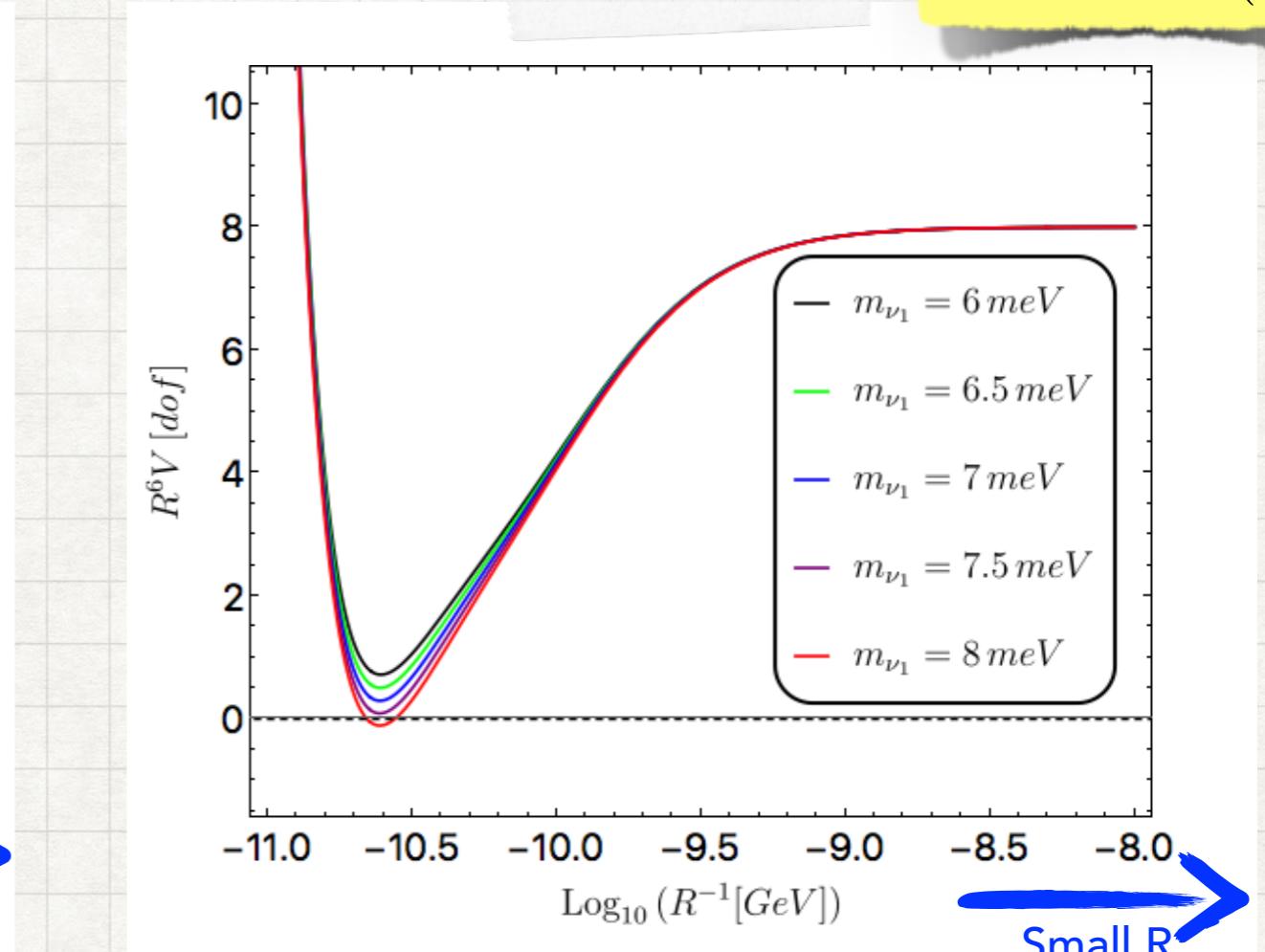
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AdS vacuum always forms!



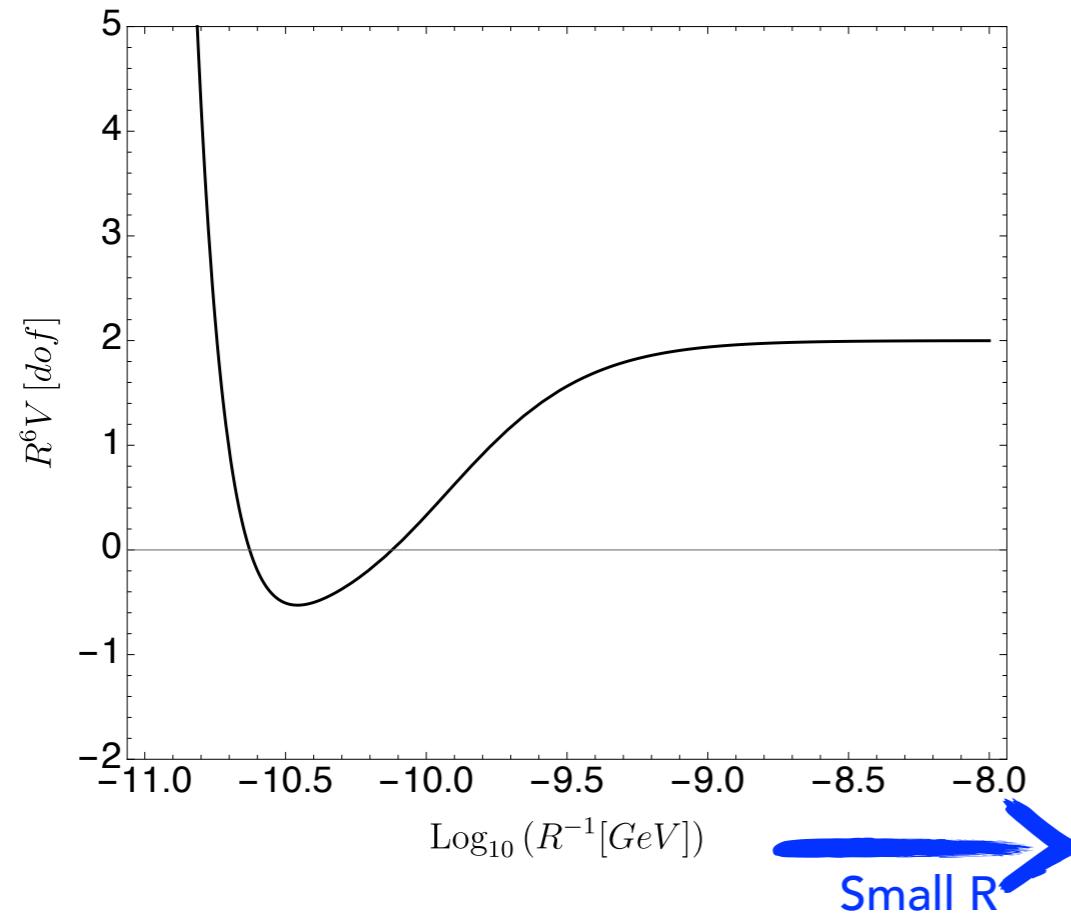
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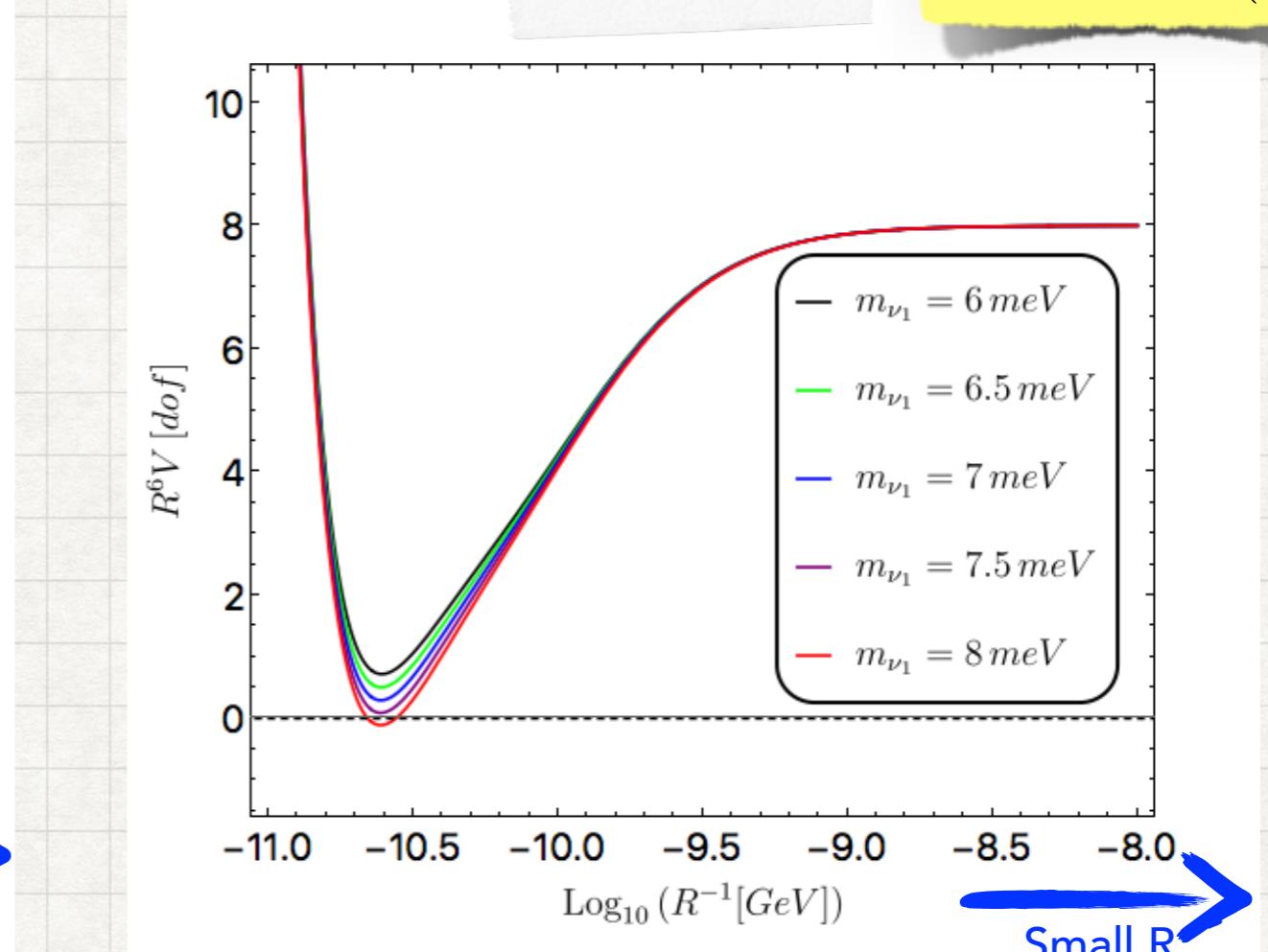
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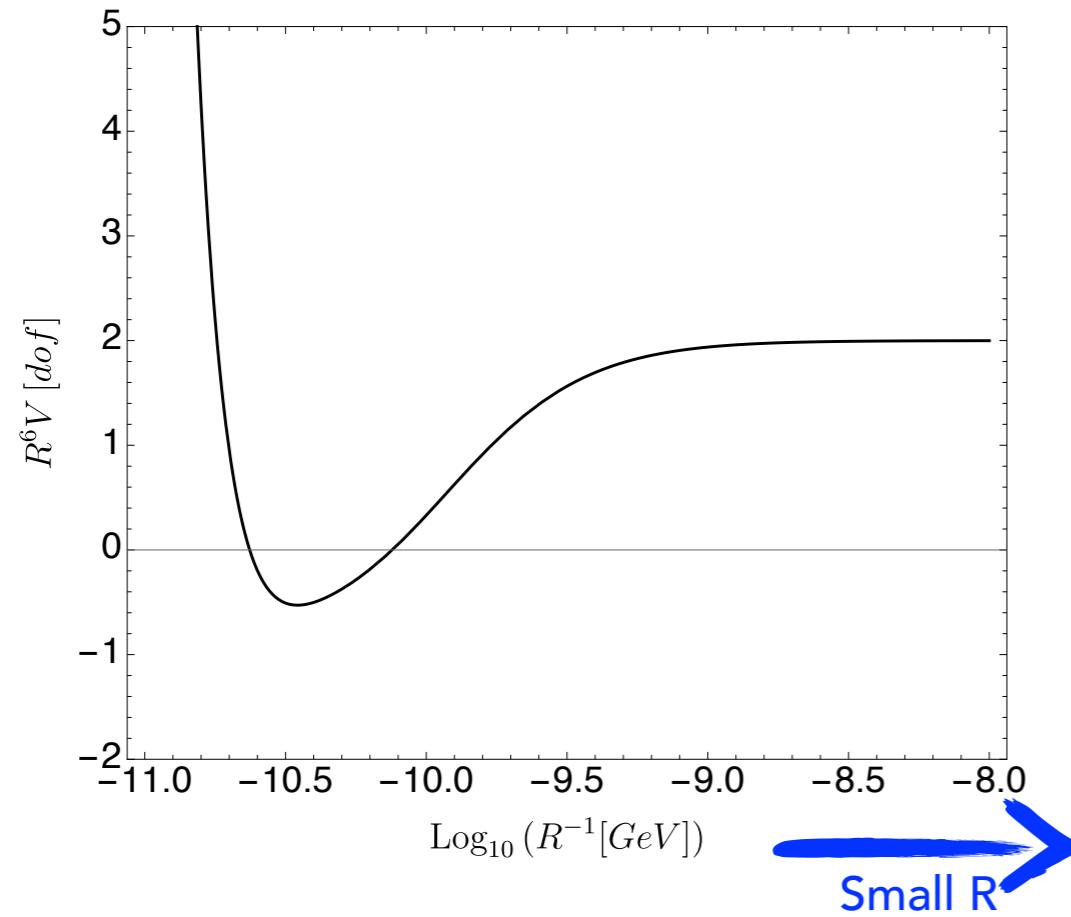
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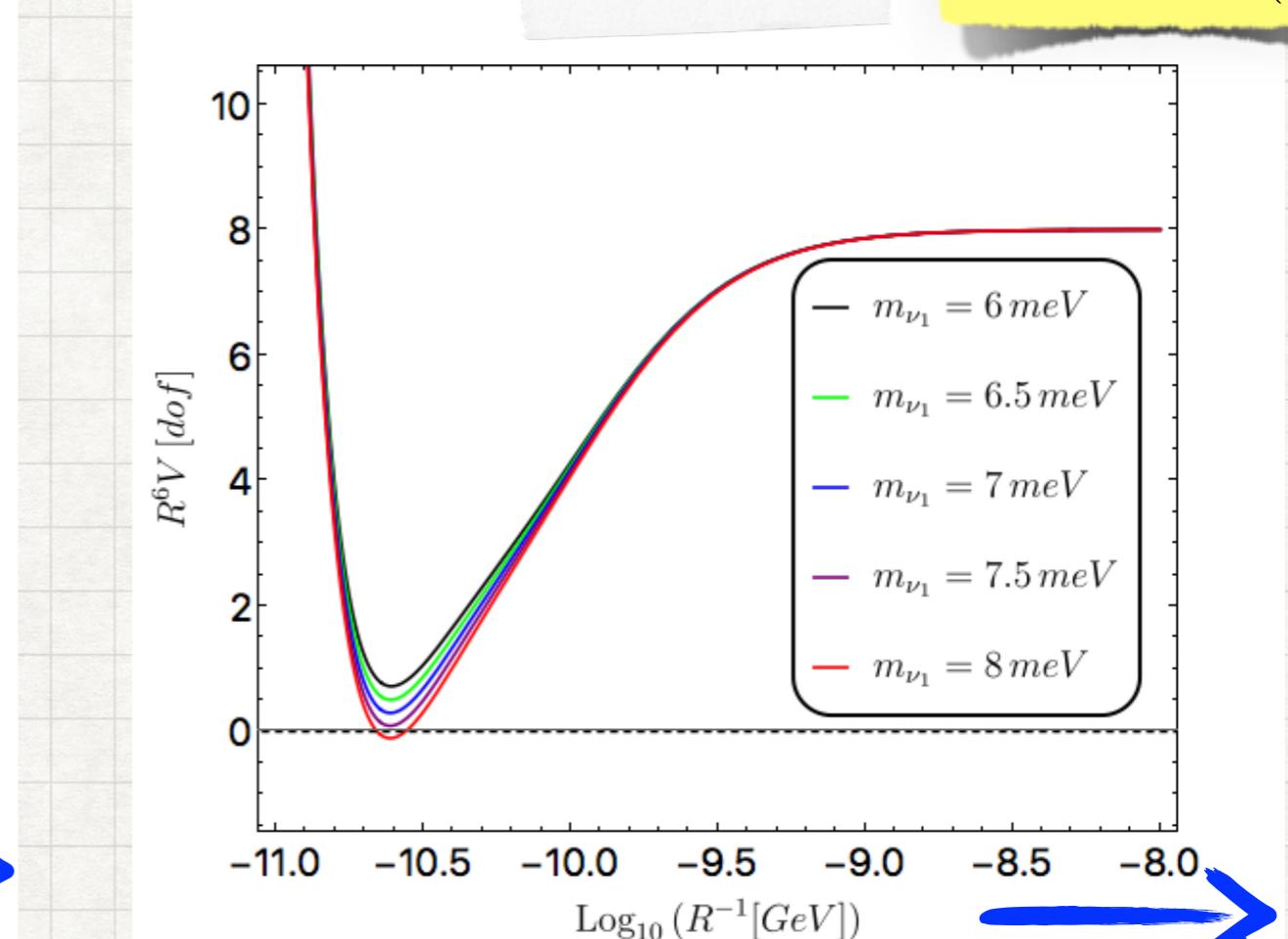
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Small R

SWAMPLAND!



[ Ibáñez, Martín-Lozano, Valenzuela '17 ]

can avoid Ads if masses  
are light enough

# ADS-PHOBIA AND THE SM

- But...

① More particles as  $R$  decreases

② Higgs potential

③ Wilson Lines (WL)

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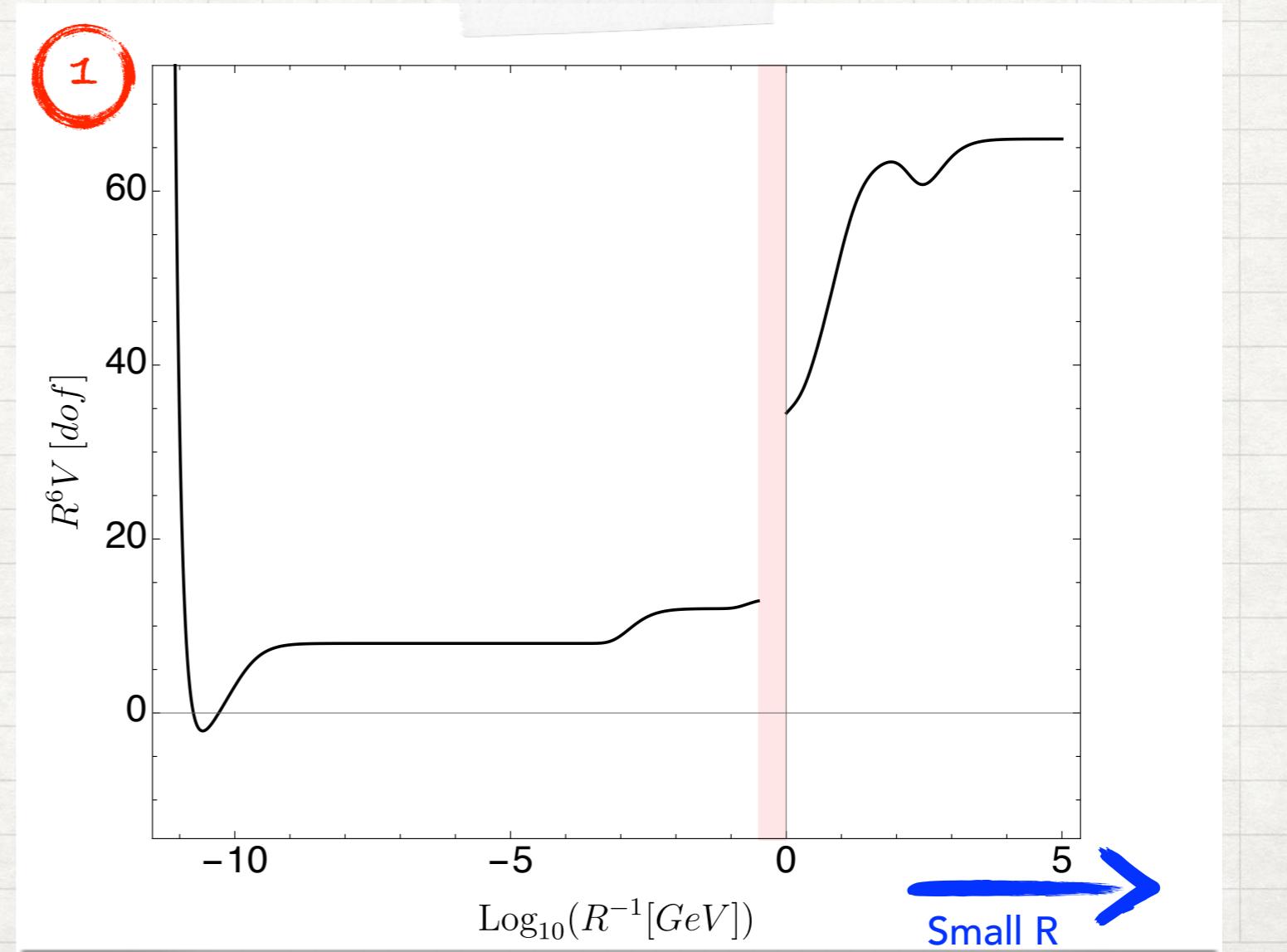
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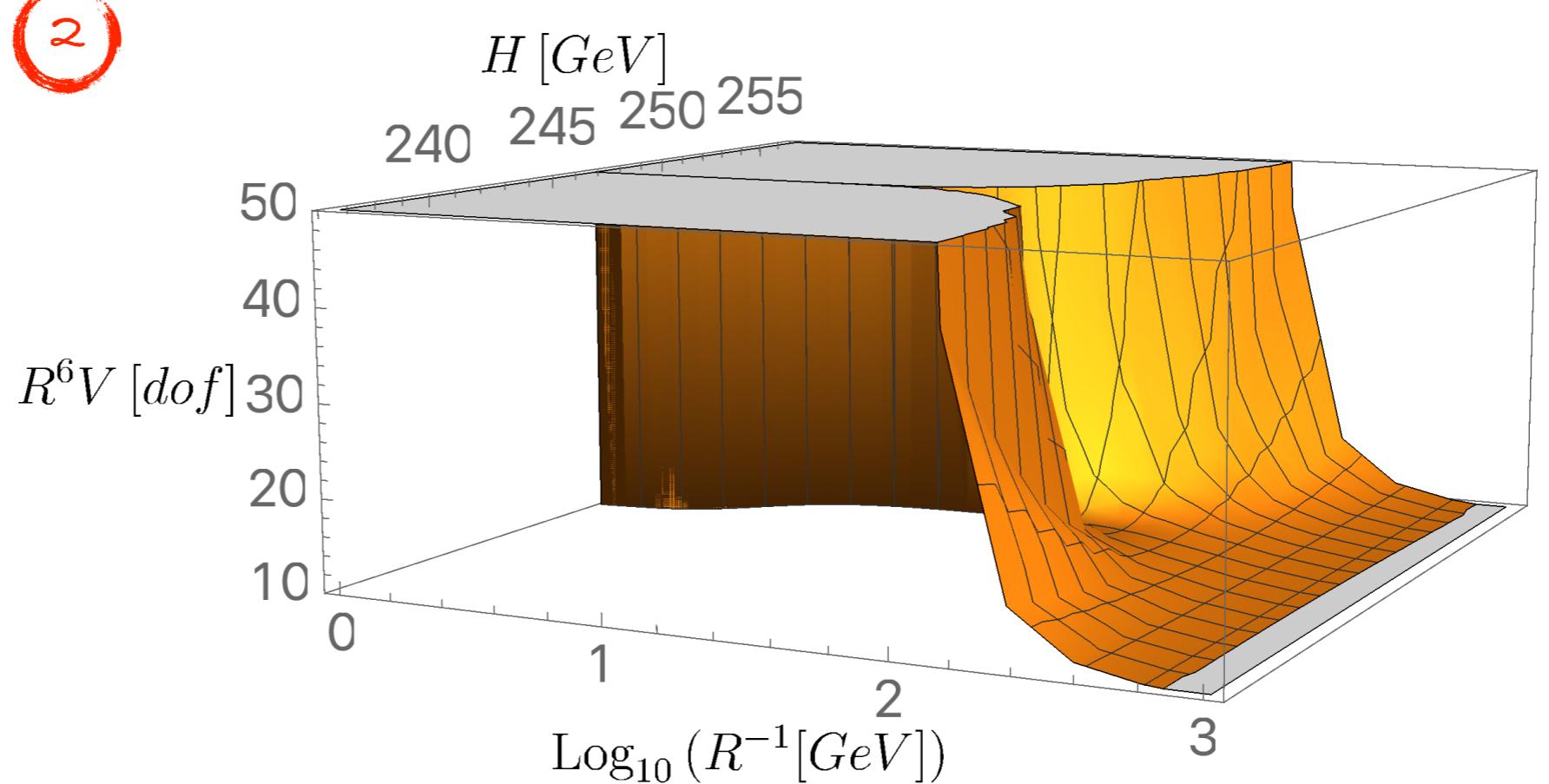
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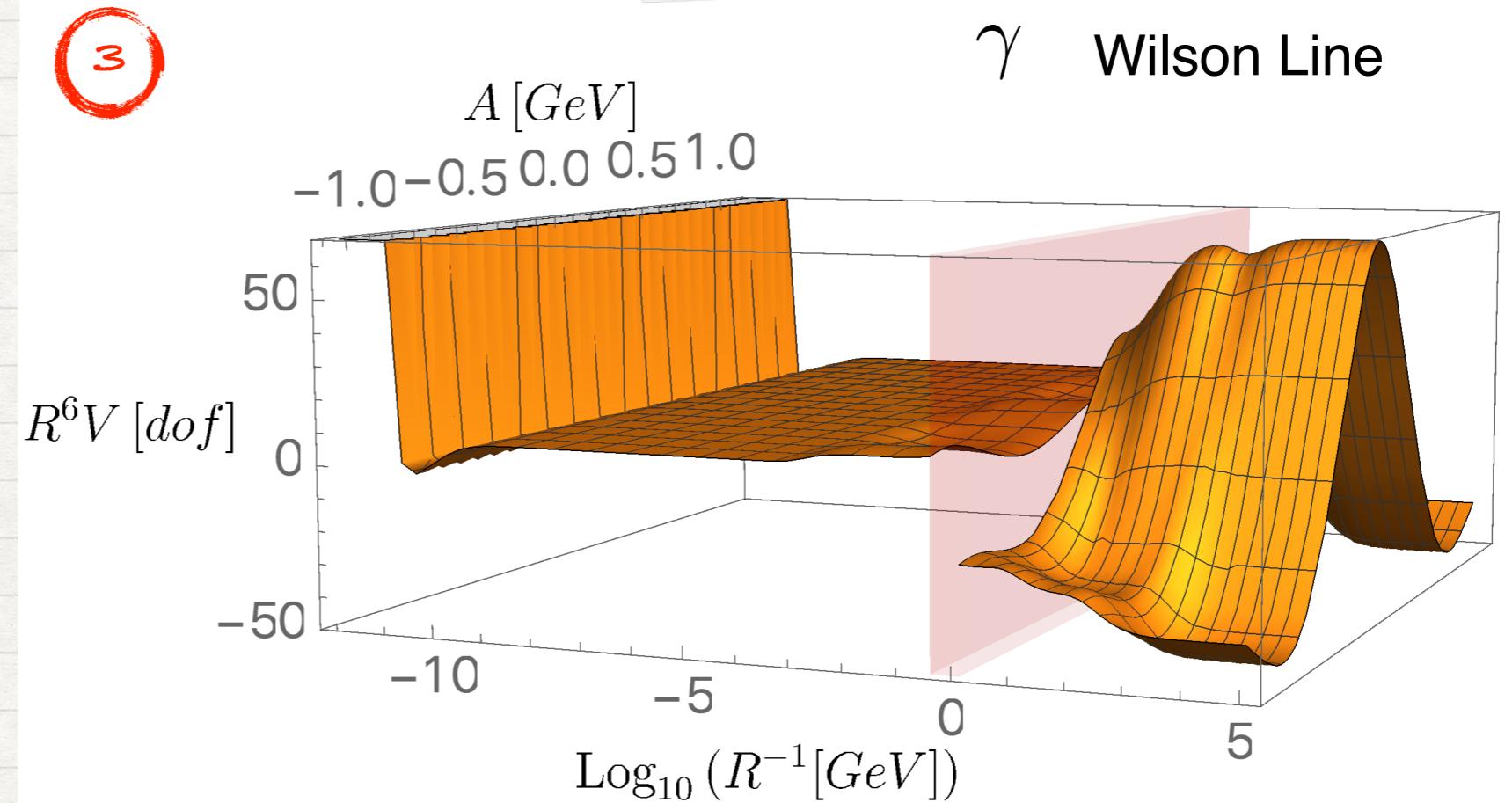
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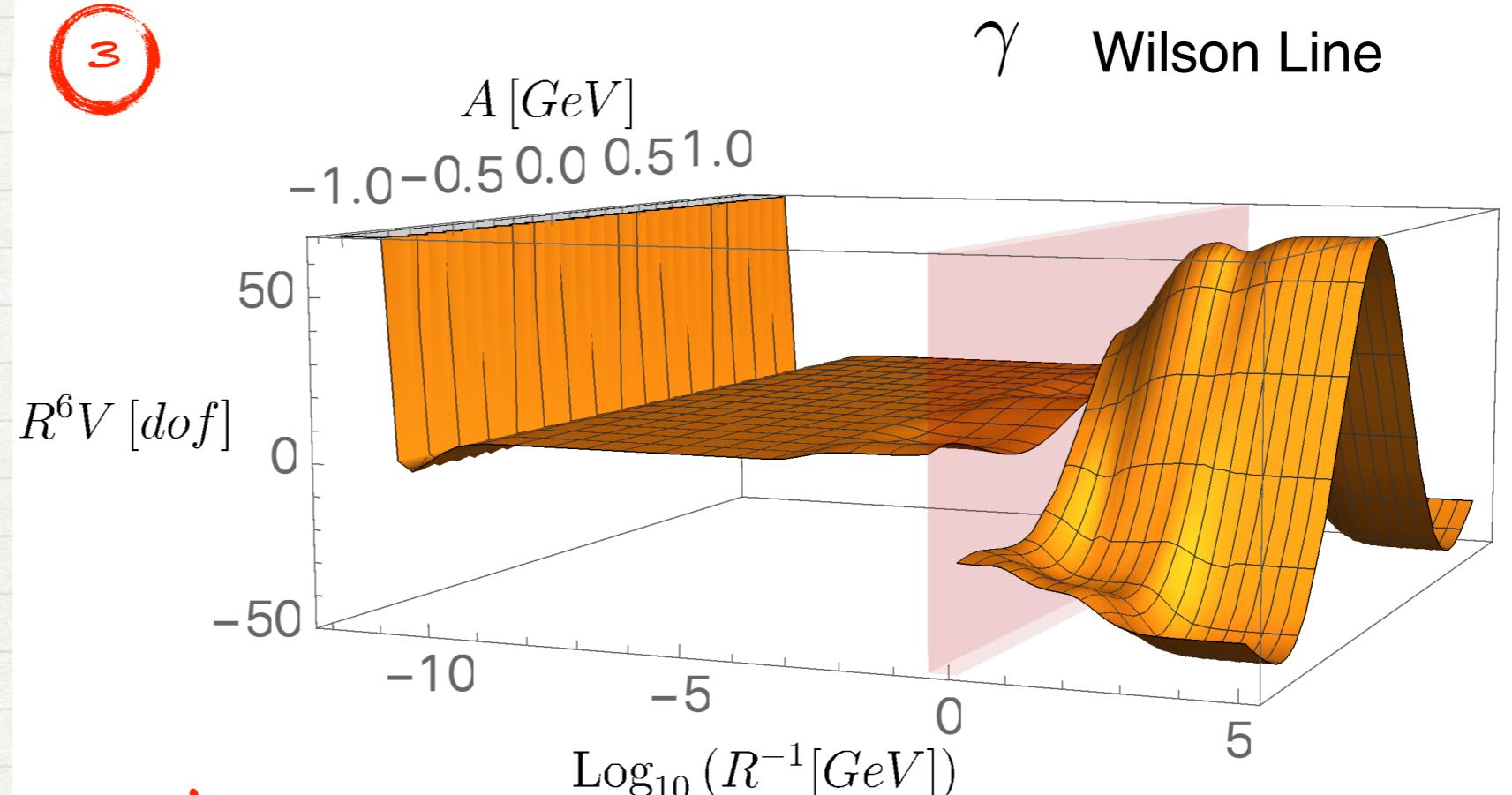
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Runaway directions → Destabilize the minima

# THE SM ON $T^2/Z_4$

- Want to find a way to fix the WL in order to have predictability  $\rightarrow$

Go to an orbifold  $\rightarrow S^1/Z_2$

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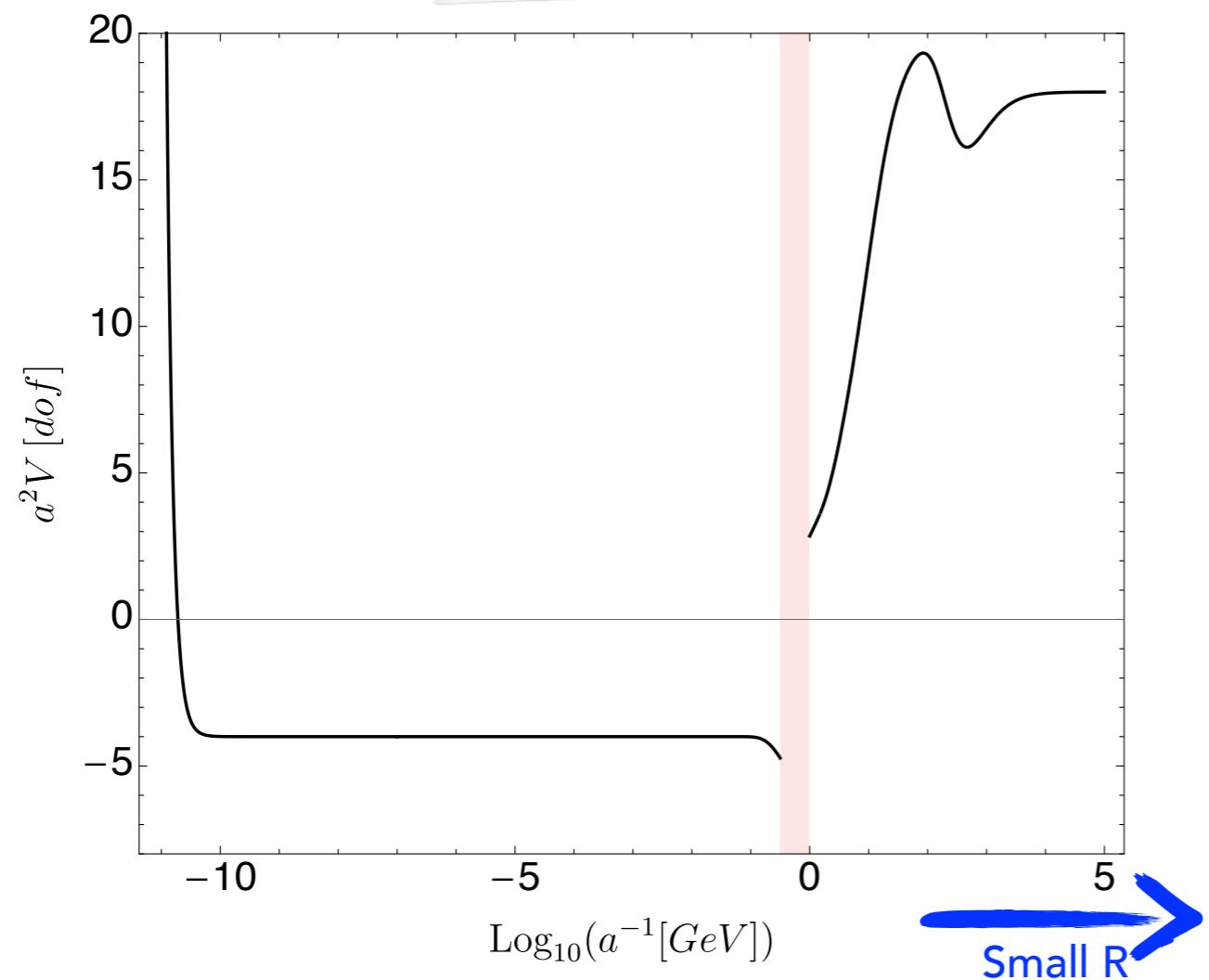
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- $Z_4$  gauge embeddings

- Cartan subalgebra of the SM:  $SU(3)_c \times SU(2)_L \times U(1)_Y$
- Gaugeable  $U(1)_{B-L}$
- R-symmetries (in SUSY extensions)

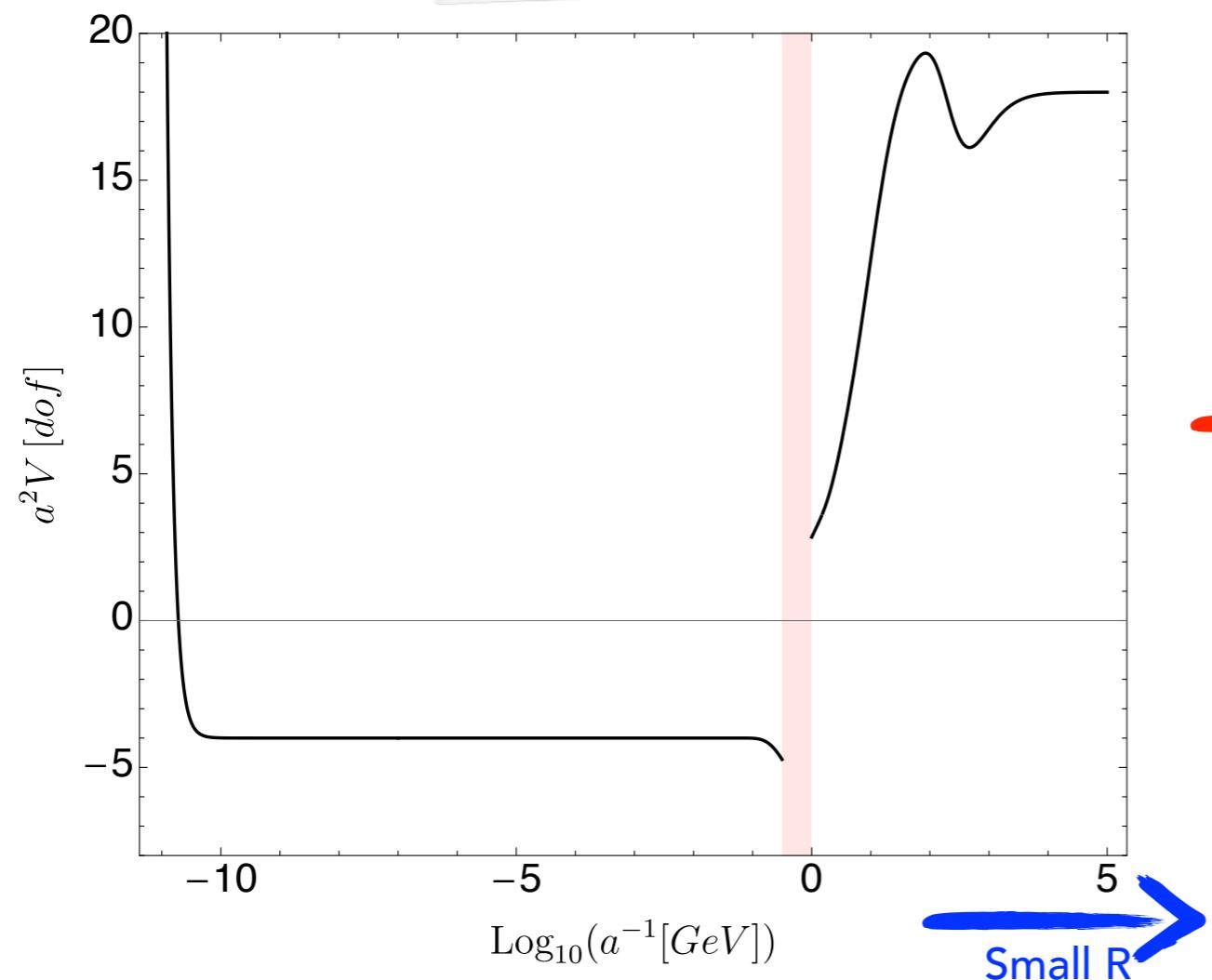
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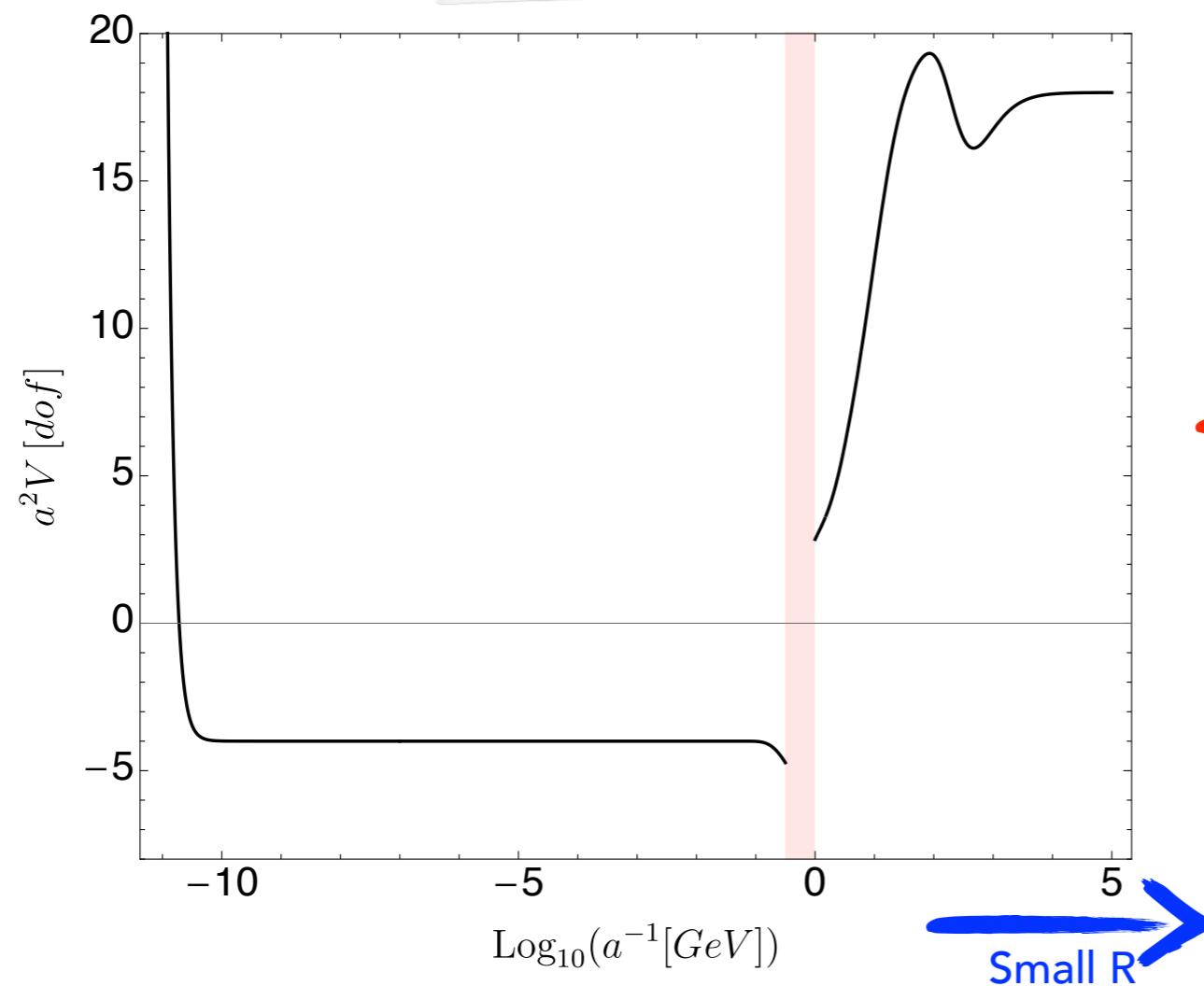
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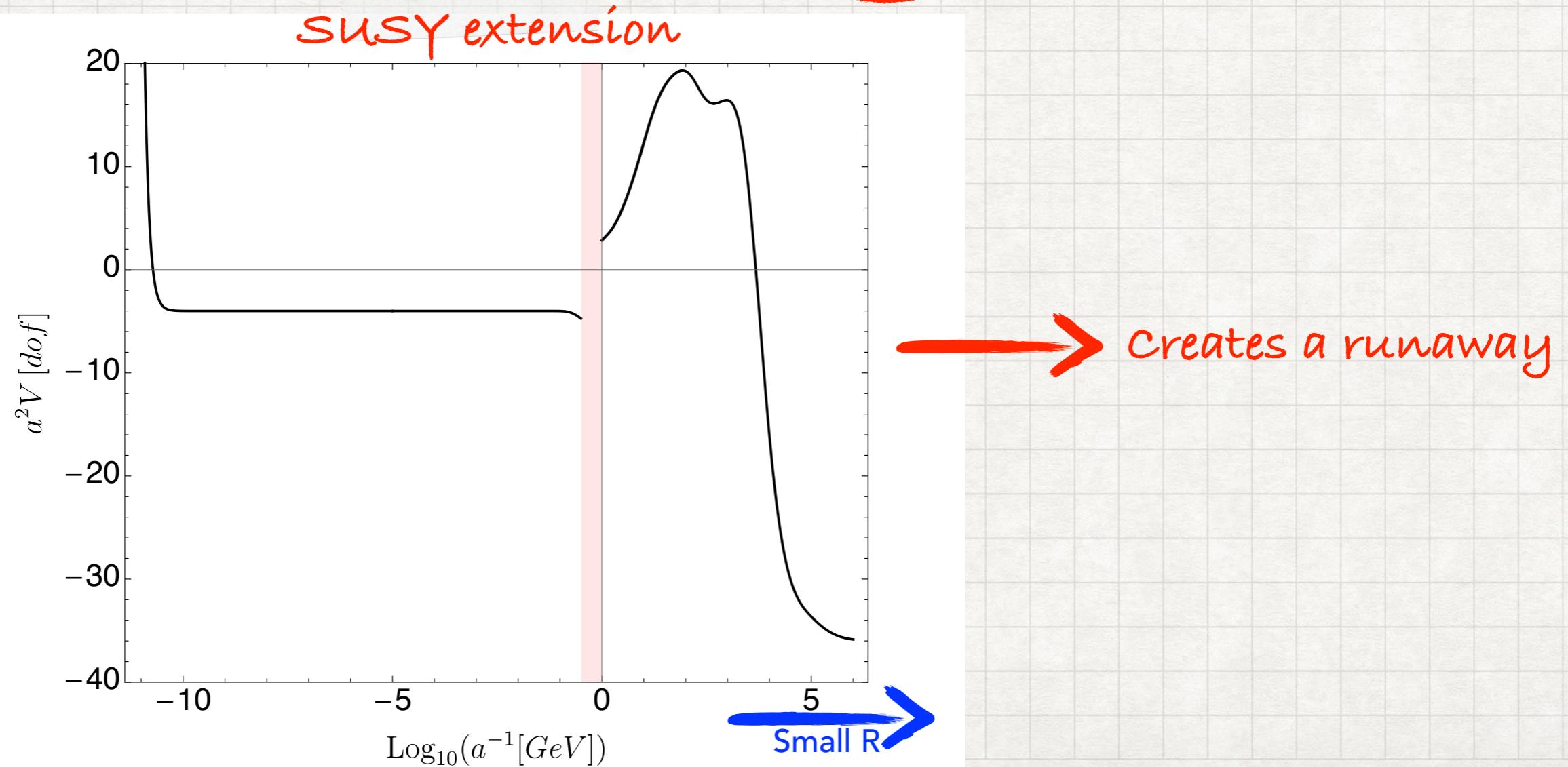
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SUSY extension

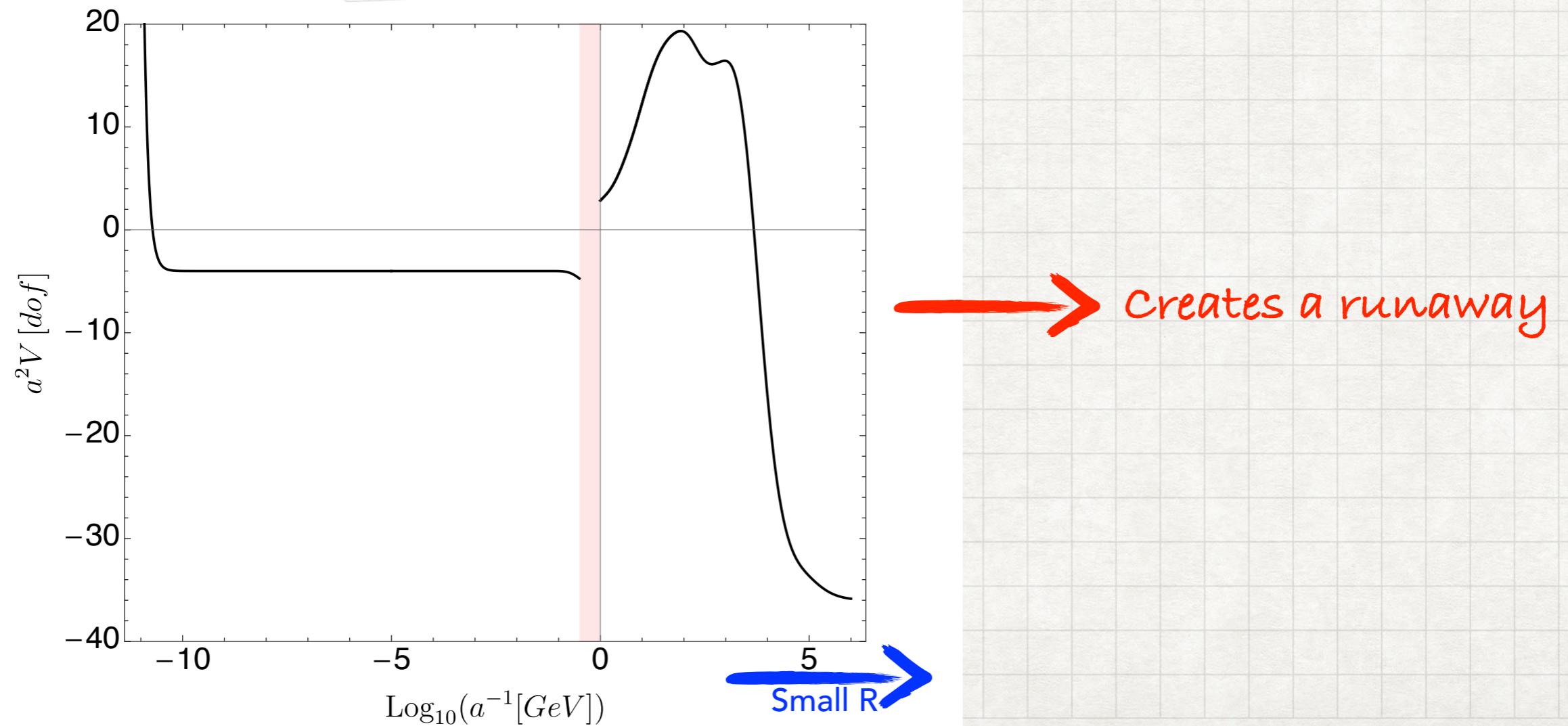
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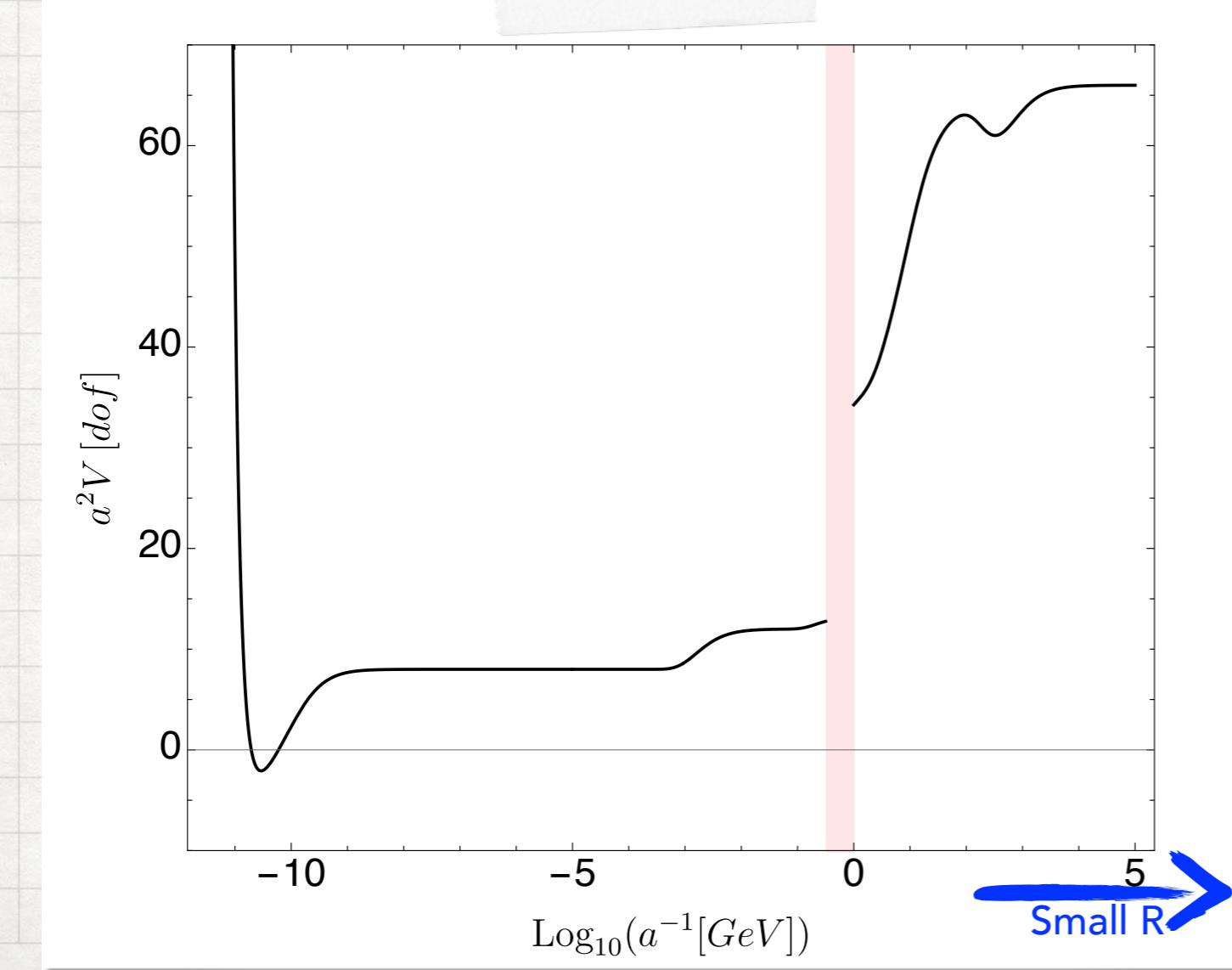
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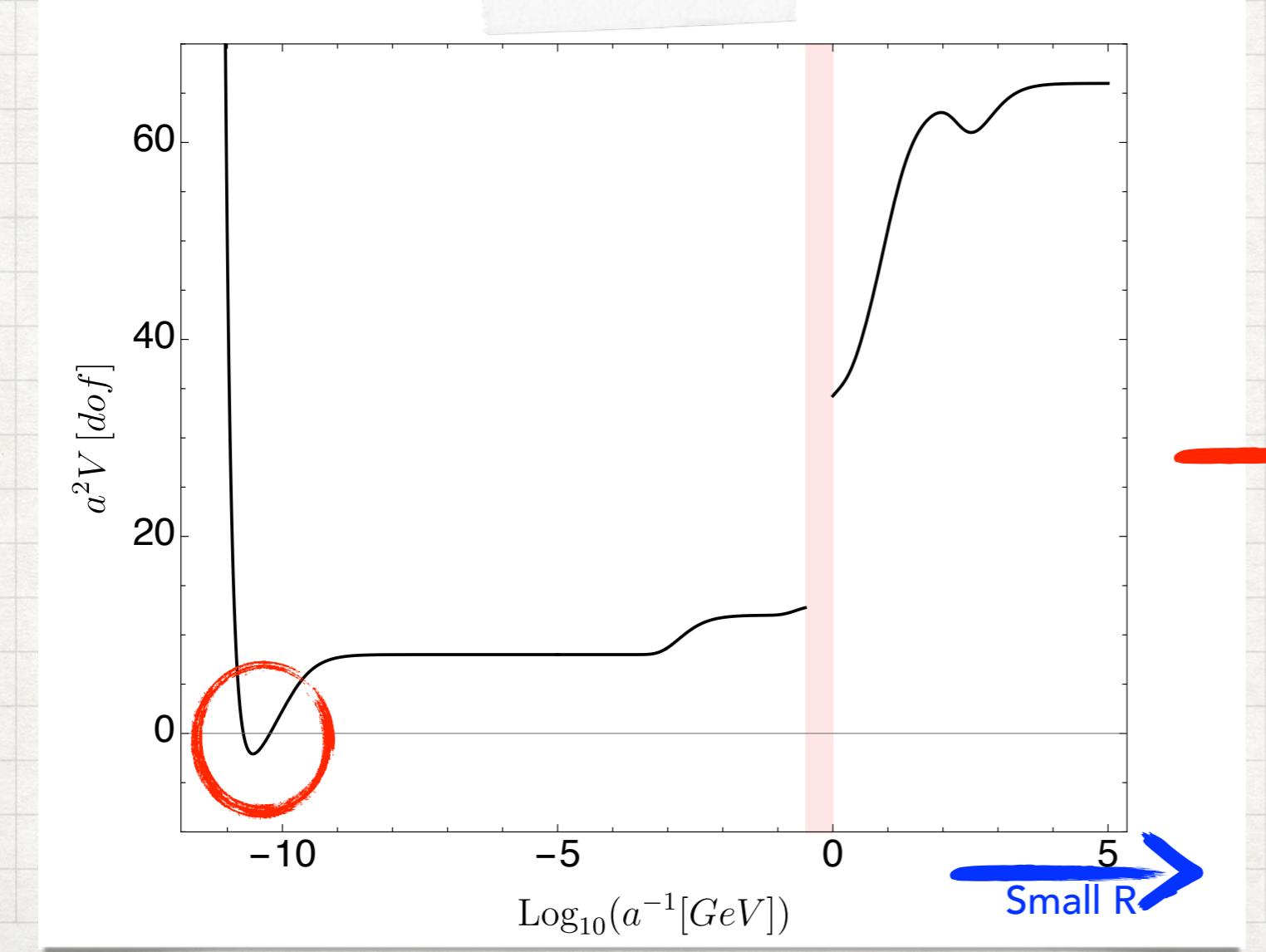
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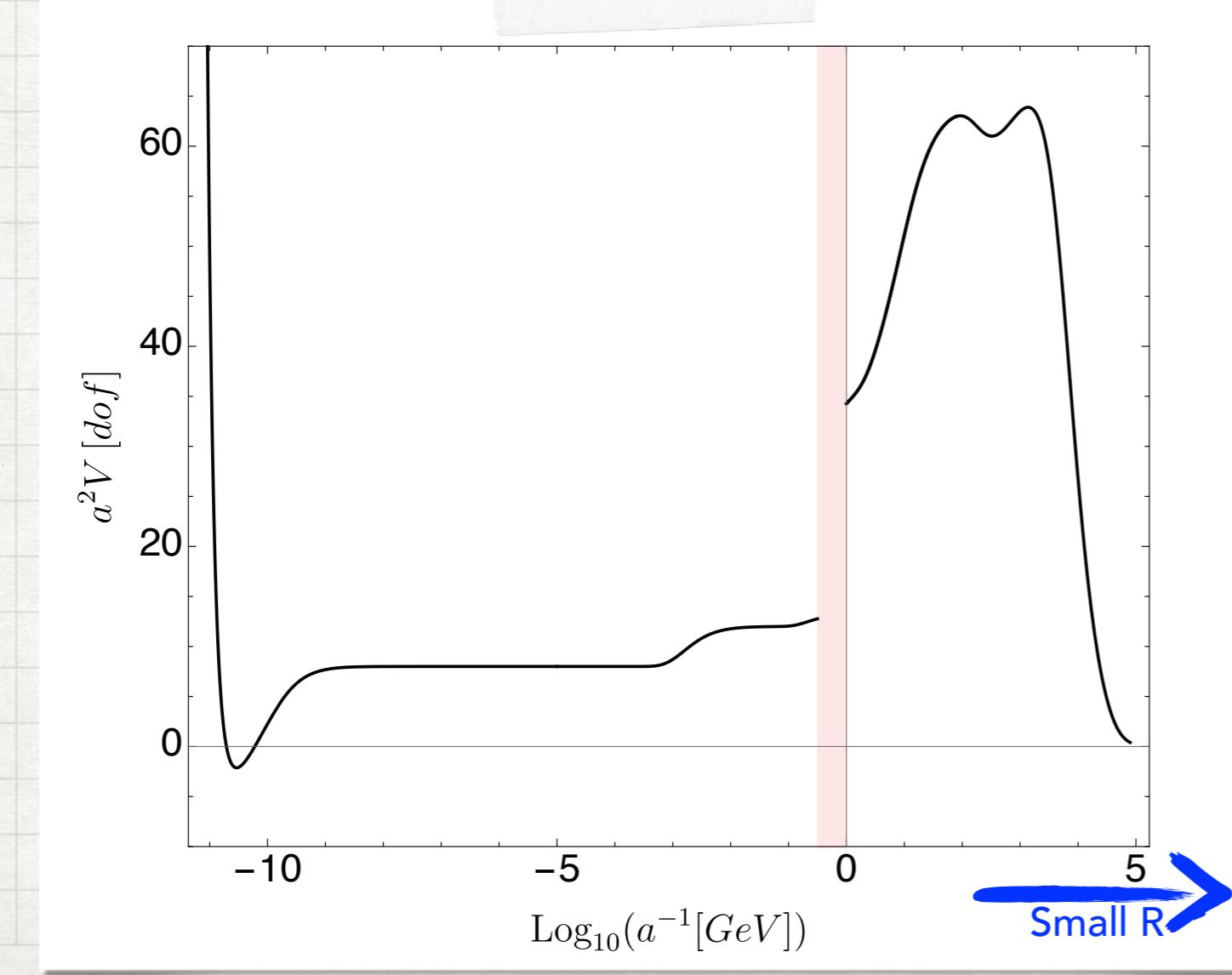
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Recover neutrino bounds

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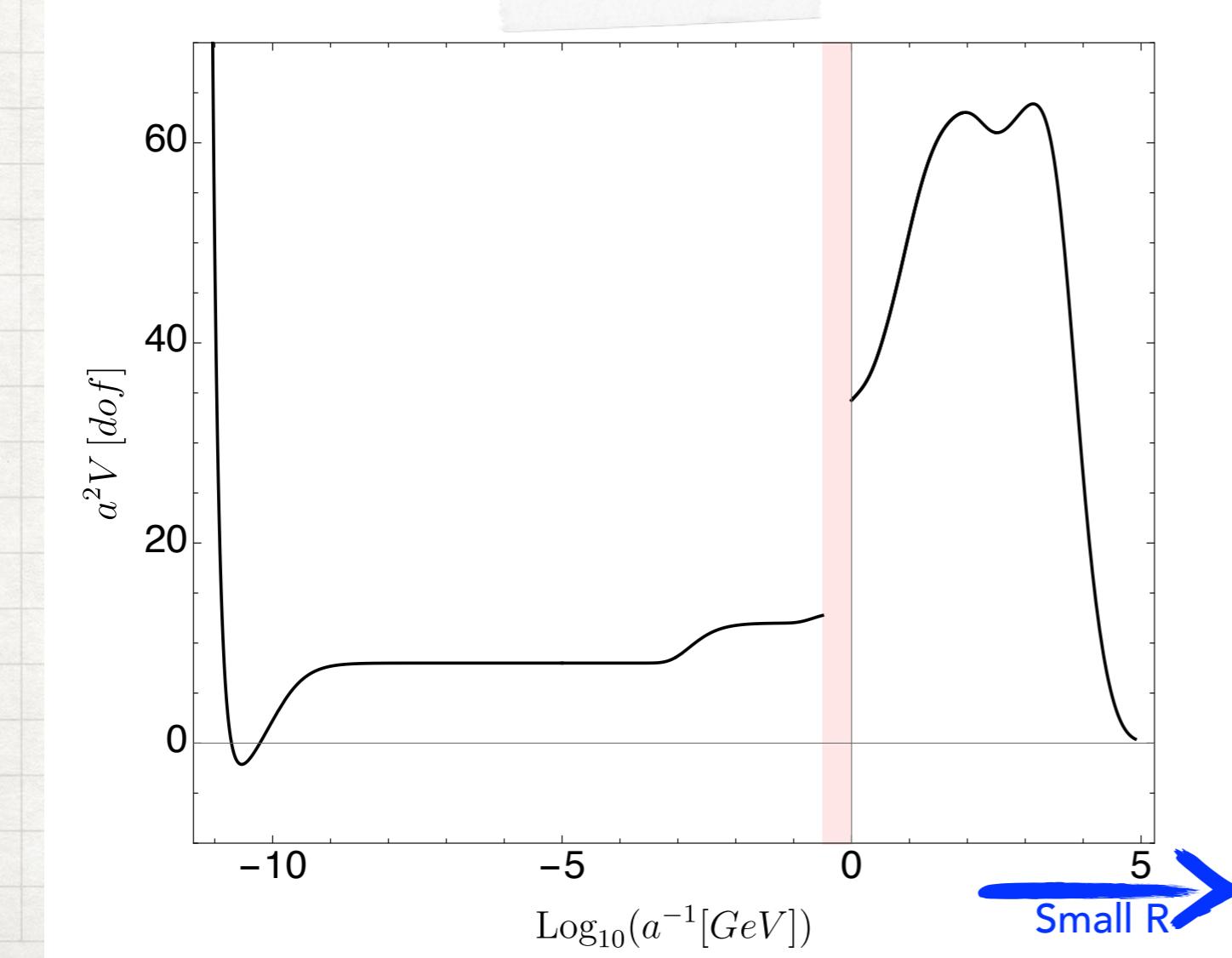
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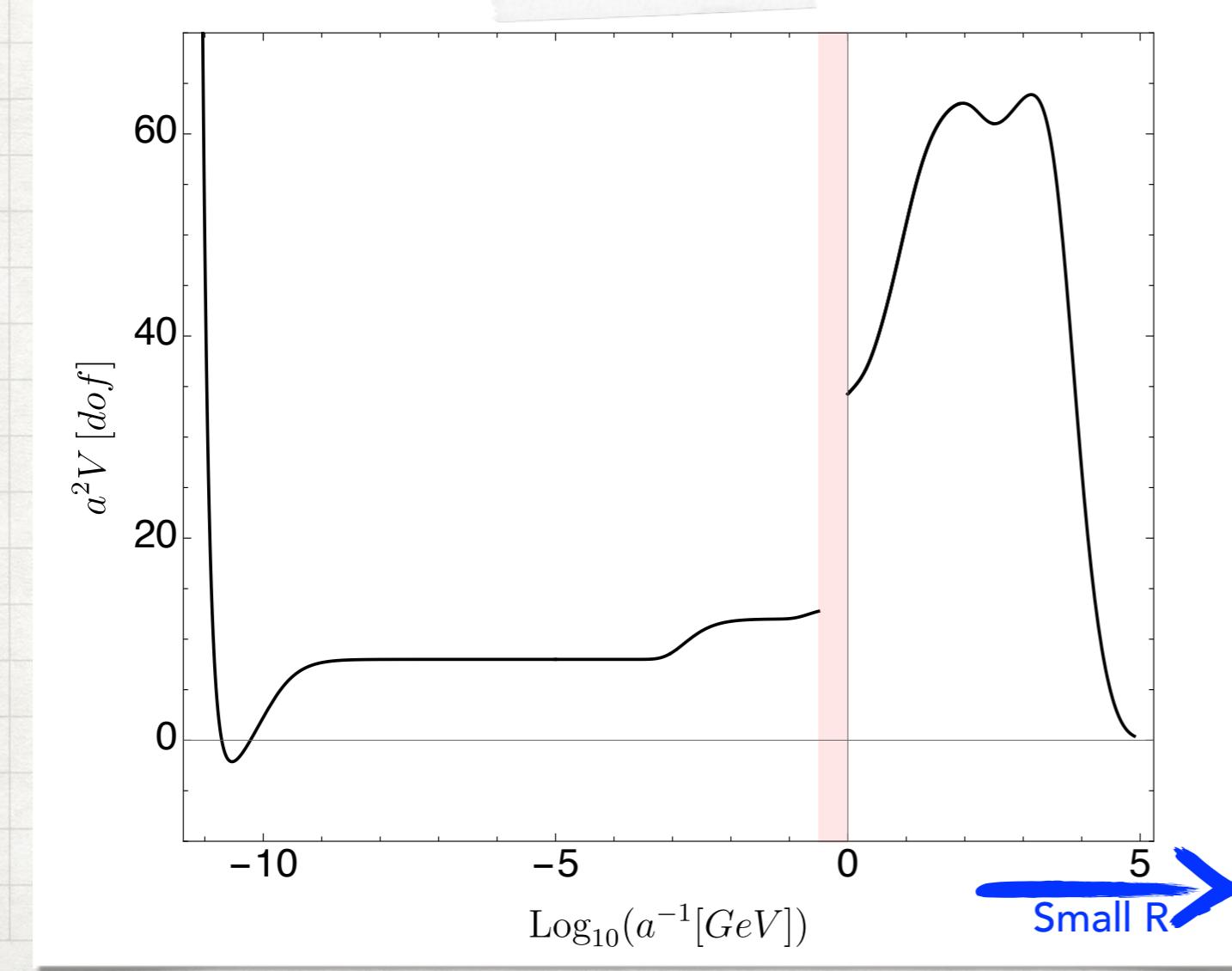
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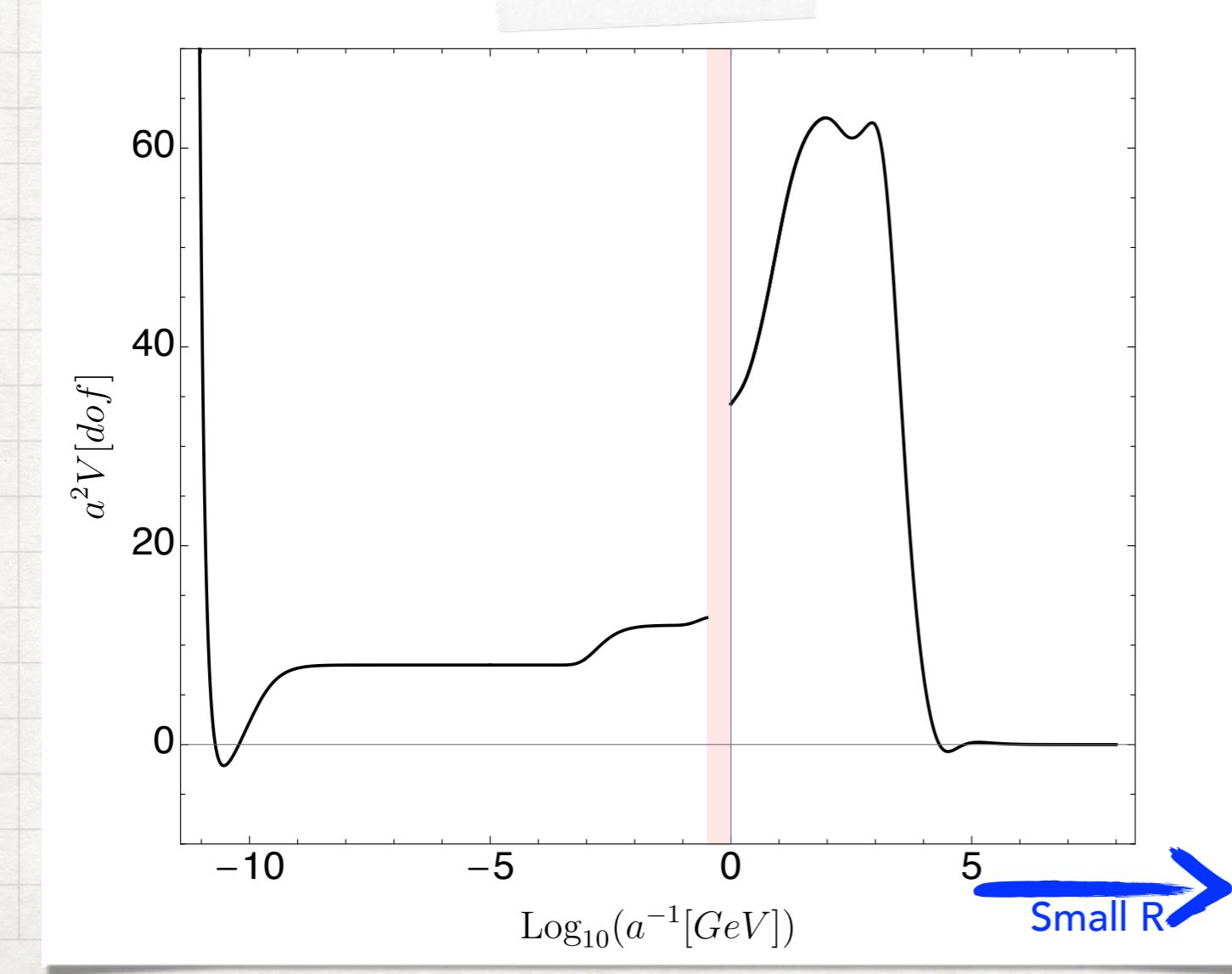
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- SM as it is has stable AdS vacua in 2d  $\longrightarrow$  SWAMPLAND
- SUSY extensions destabilise them  $\longrightarrow$  Consistent with QG
- If SUSY extension contains a gaugeable  $U(1)_{B-L}$ 
  - Majorana neutrinos  $\longrightarrow$  Swampland
  - Dirac neutrinos  $\longrightarrow$  Mass upper bound
    - $m_{\nu_1} \leq 4 \times 10^{-3}$  eV (NH)
    - $m_{\nu_3} \leq 1 \times 10^{-3}$  eV (IH)
  - Bounds for the EW scale  $\longrightarrow \Lambda_{\text{QCD}} \leq \langle H \rangle \leq 1 \text{ TeV}$   
[See E. Gonzalo's talk]
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