Rethinking the origin of neutrino masses: the role of gravity

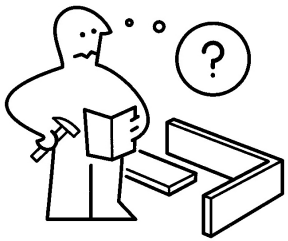
Lena Funcke

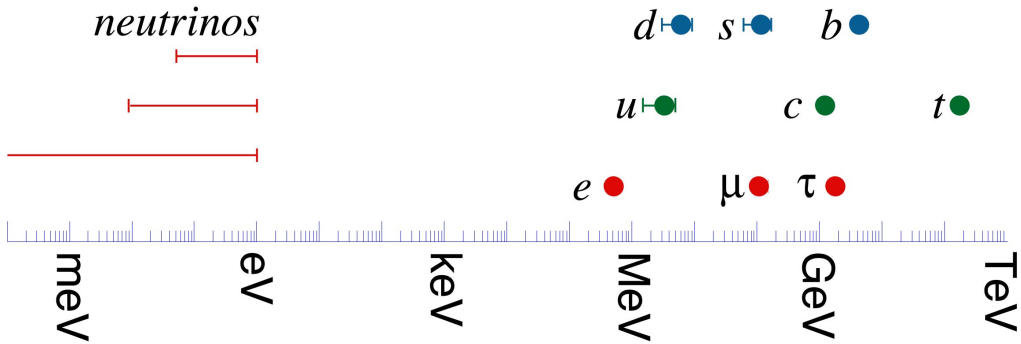
in collaboration with Gia Dvali *et al.*

(1602.03191, 1811.01991, 1905.01264)

CoEPP Webinar, 25 September 2019

Question: Origin of Small Neutrino Masses?





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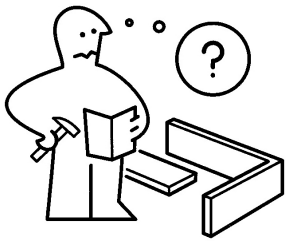

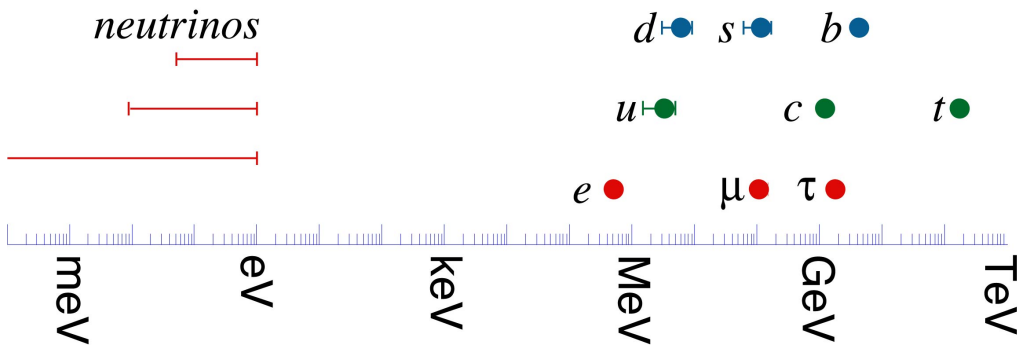

UV

Seesaw mechanisms,
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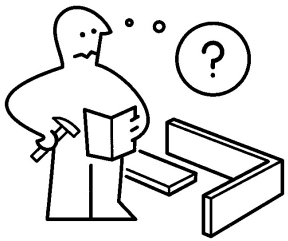

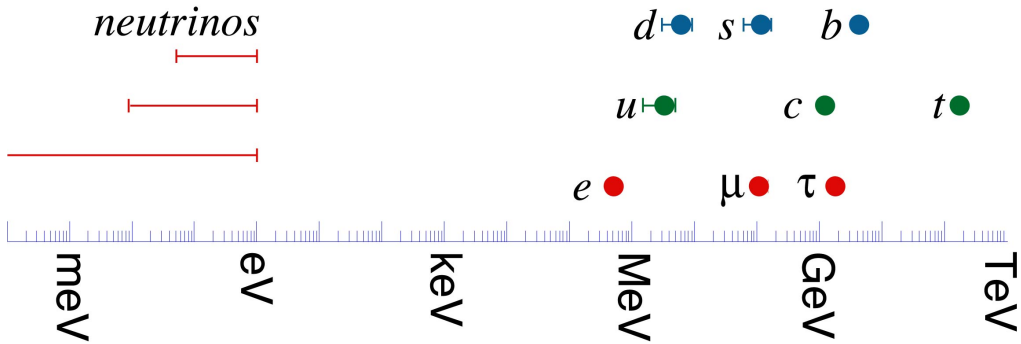

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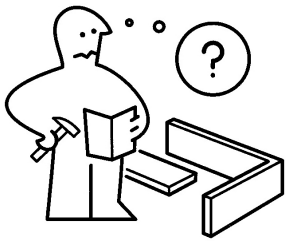

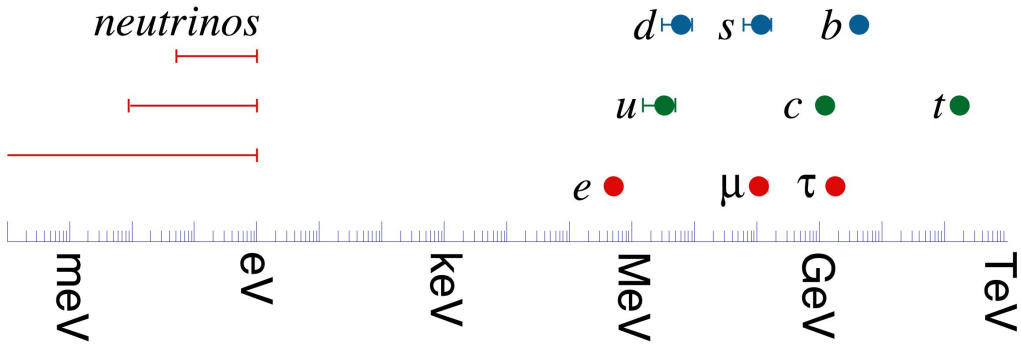

IR

Small neutrino masses from gravitational θ-term.

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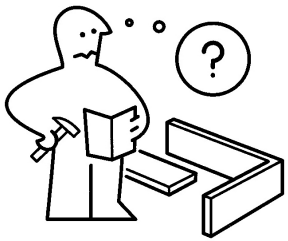

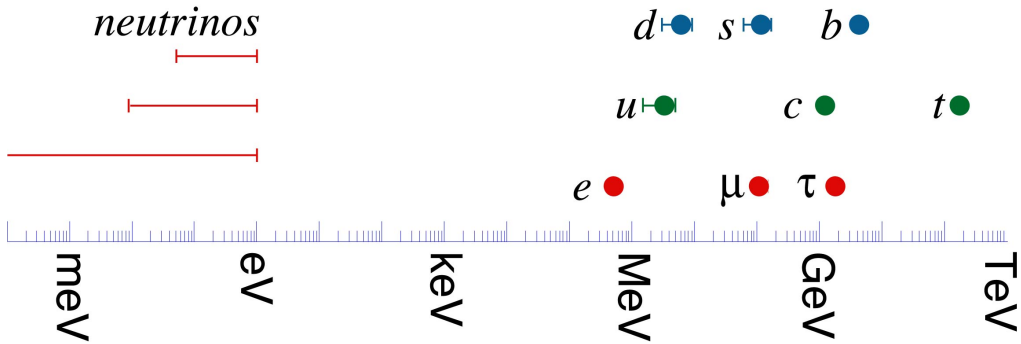

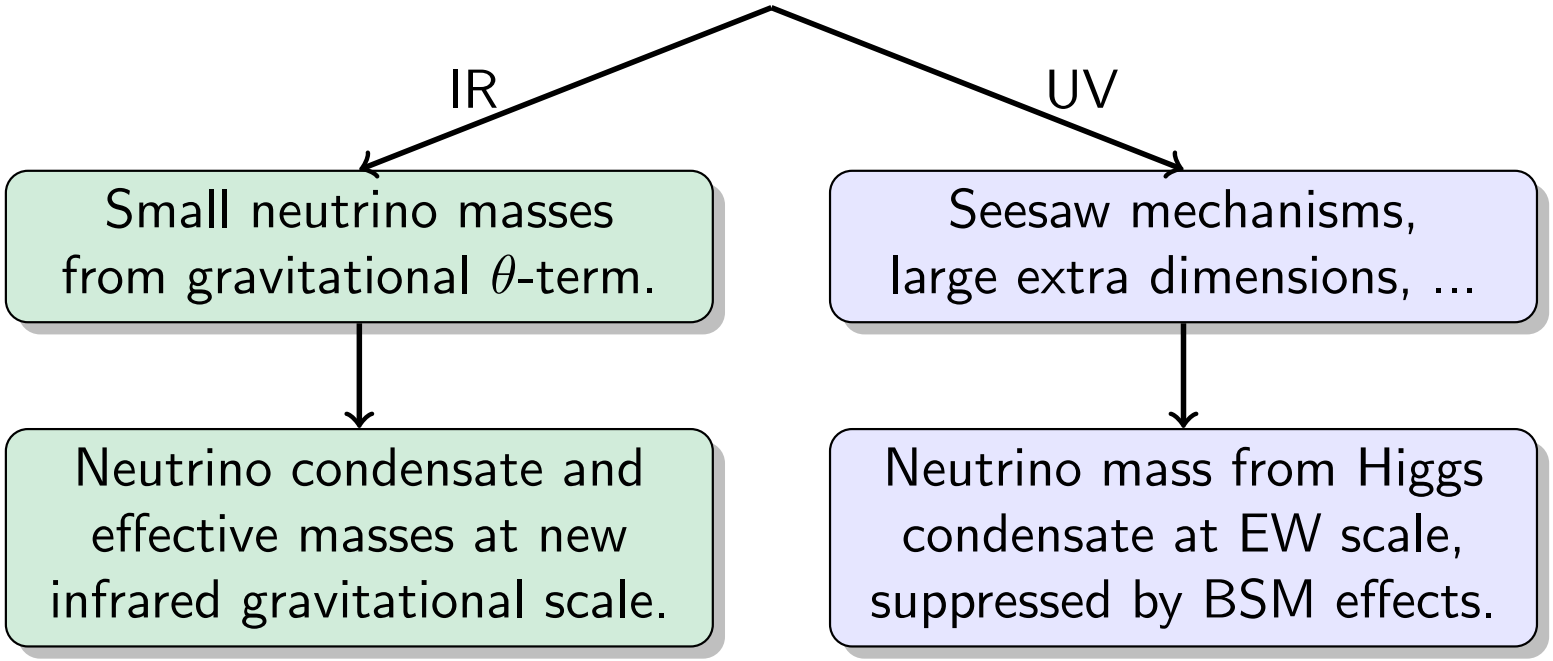

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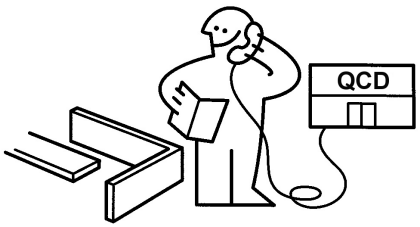
Analogy: Non-Perturbative QCD Vacuum



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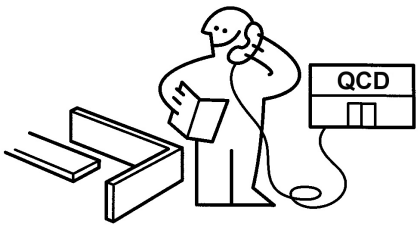

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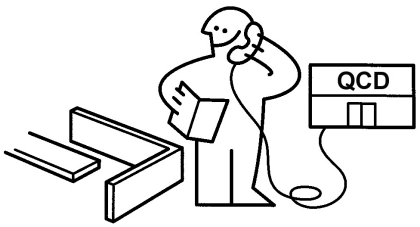

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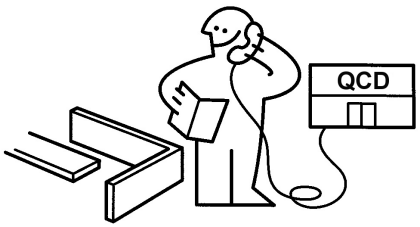

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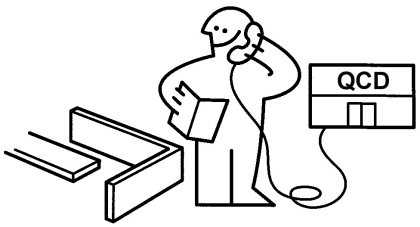

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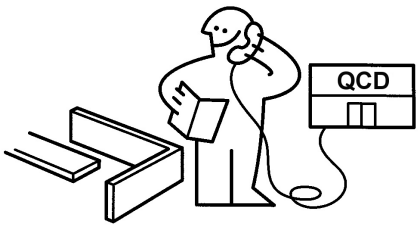

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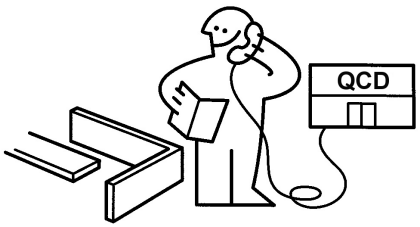

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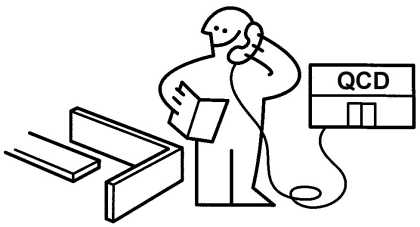

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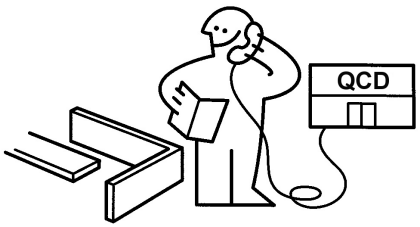

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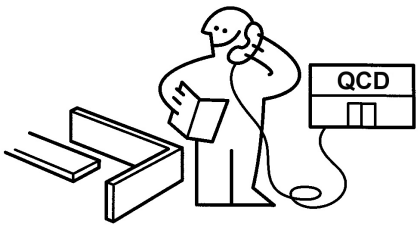

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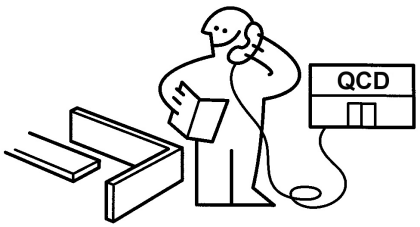

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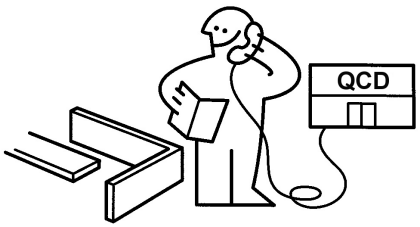

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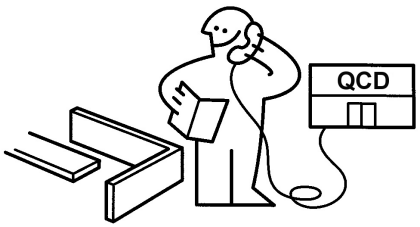

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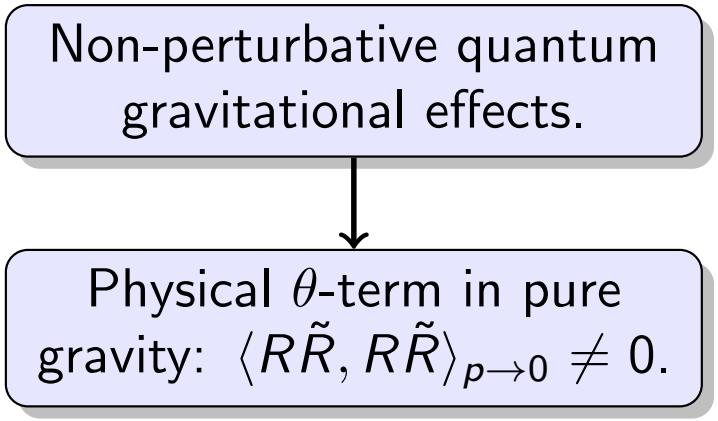

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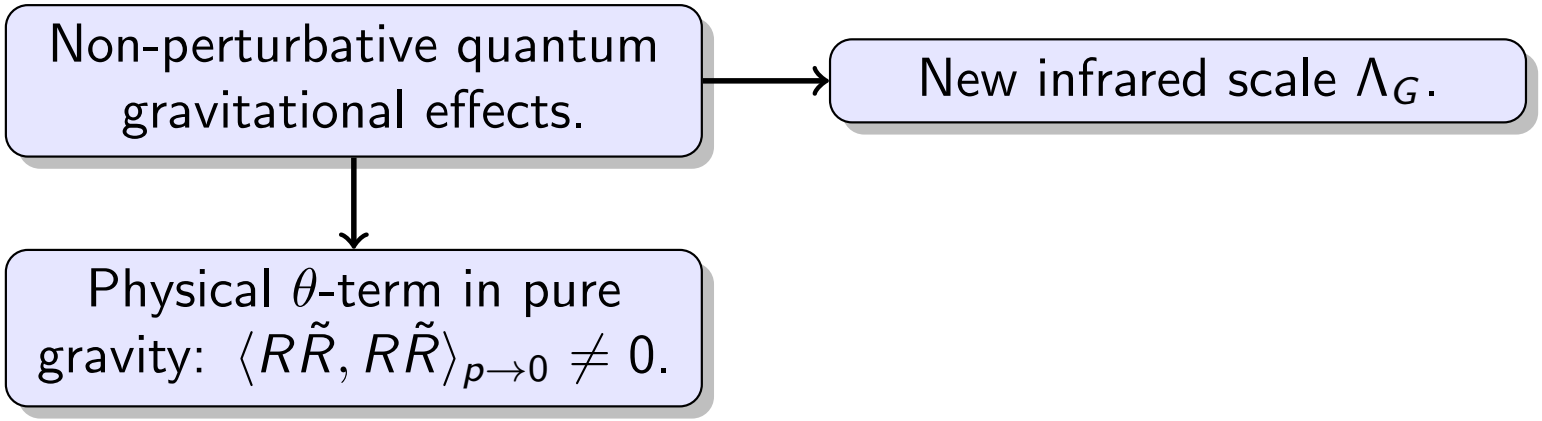

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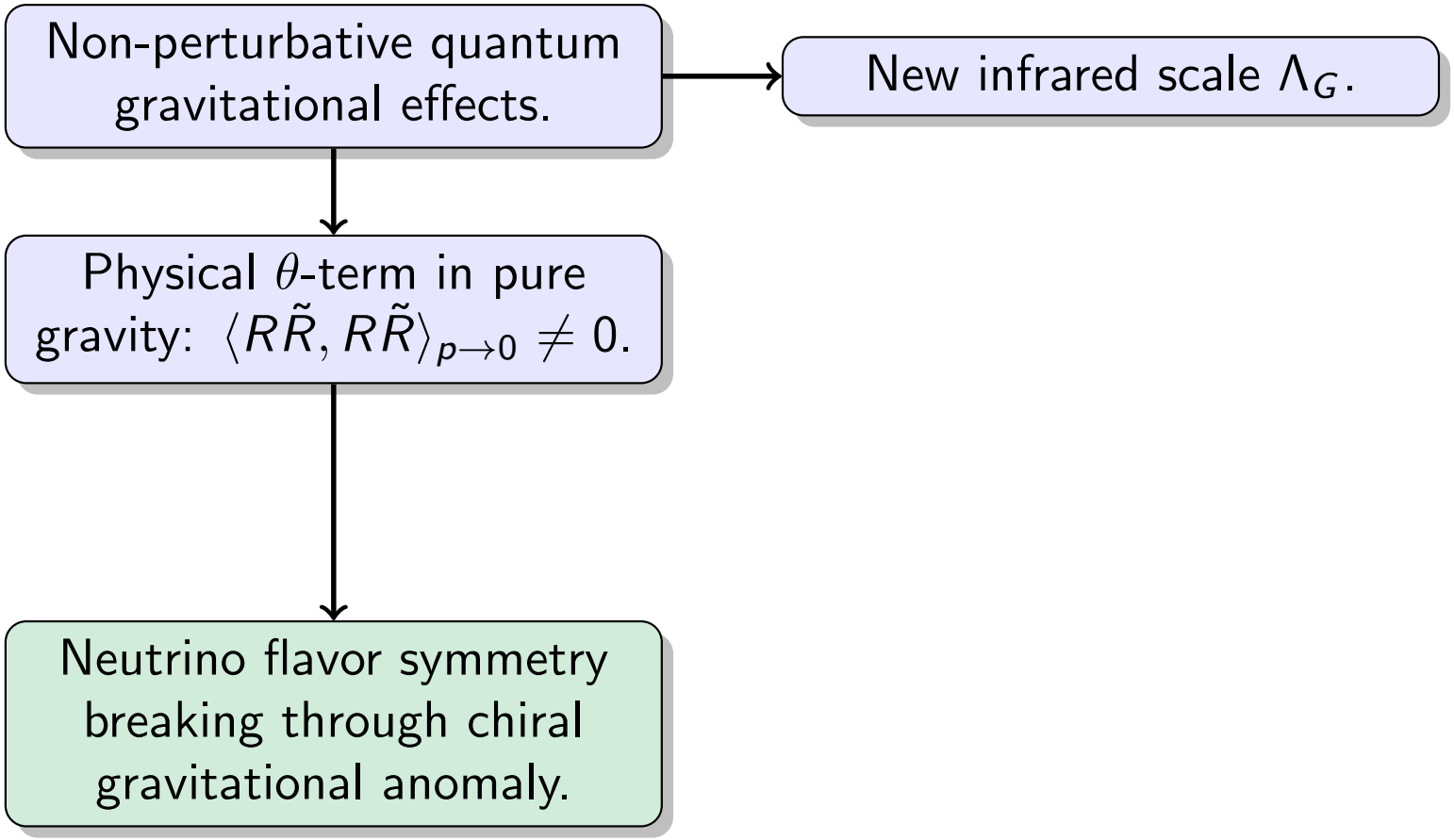

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Non-perturbative quantum gravitational effects.

→ New infrared scale Λ_G.

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Physical θ-term in pure gravity: $\langle R\tilde{R}, R\tilde{R}\rangle_{p\to 0} \neq 0$.

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Neutrino flavor symmetry breaking through chiral gravitational anomaly.

→ Condensation of neutrinos below scale Λ_G: $\langle \bar{\nu}\nu \rangle \neq 0$.

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→ Emergence of η_ν and 14 massless Goldstones ϕ_k.

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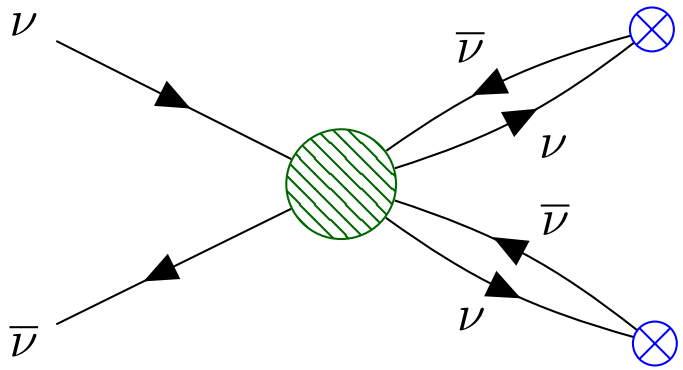
- Small effective neutrino mass generation through non-perturbative coupling to neutrino condensate.



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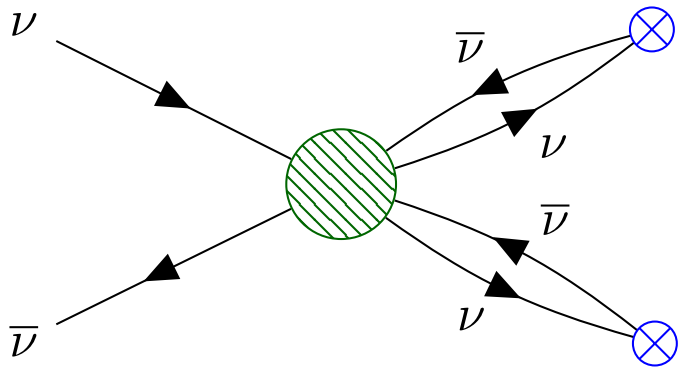

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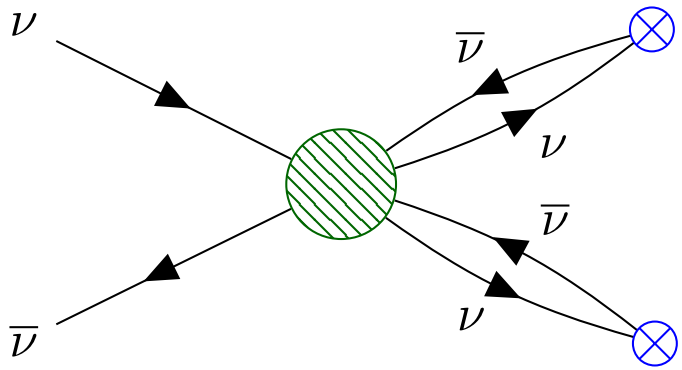

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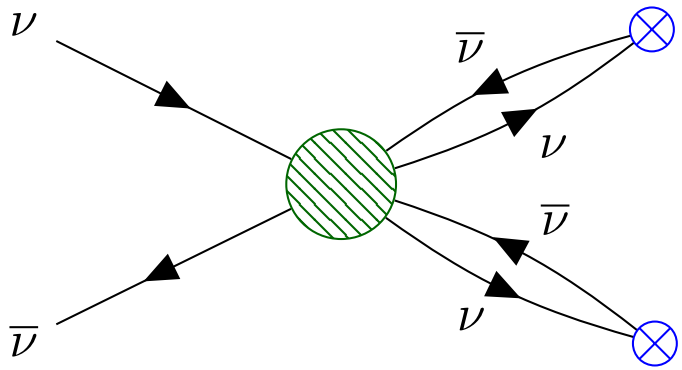

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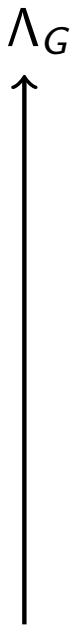

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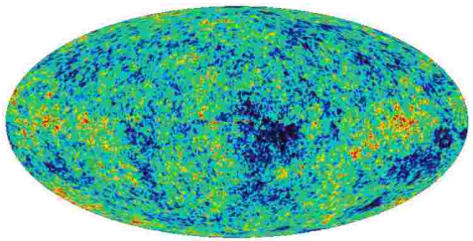

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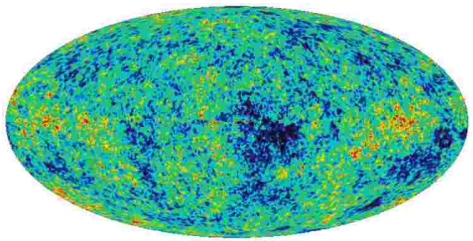

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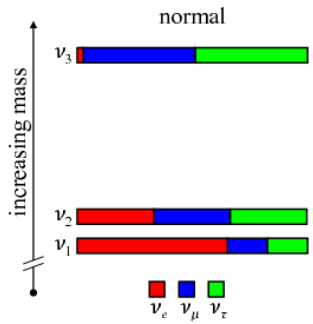

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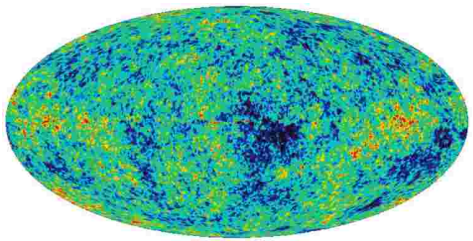

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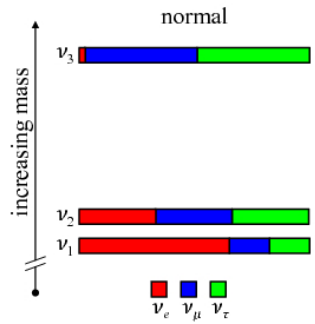

$\rightarrow$ Neutrino vacuum condensate $\langle\bar{\nu}\nu\rangle$ on dark energy scale.

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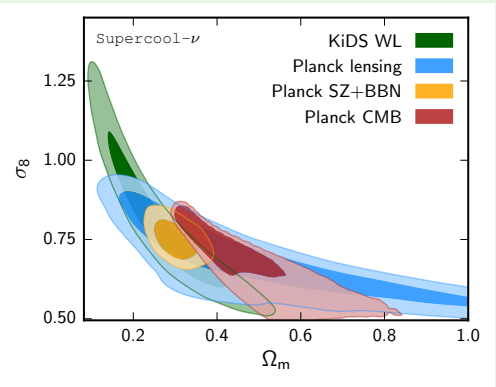
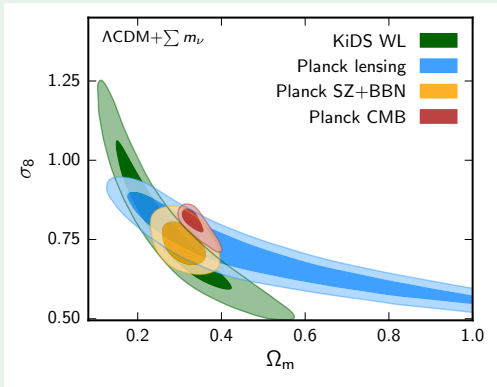


$\sigma_8(\Omega_m)$ for late m_ν



vs. $\sigma_8(\Omega_m)$ for ΛCDM

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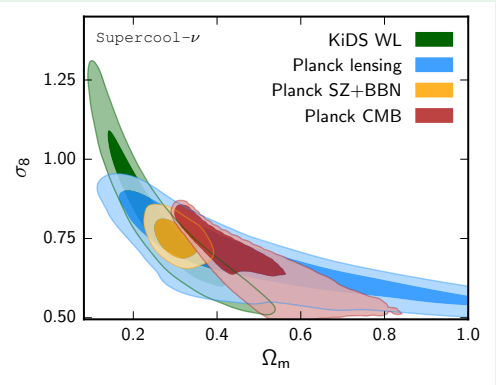

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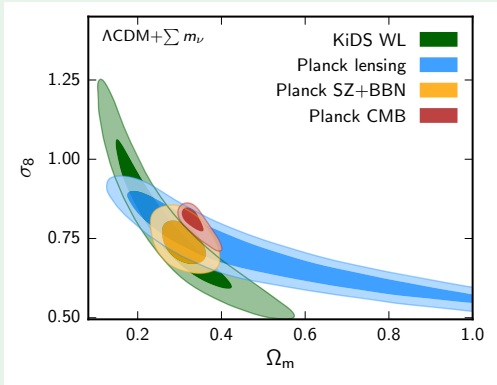

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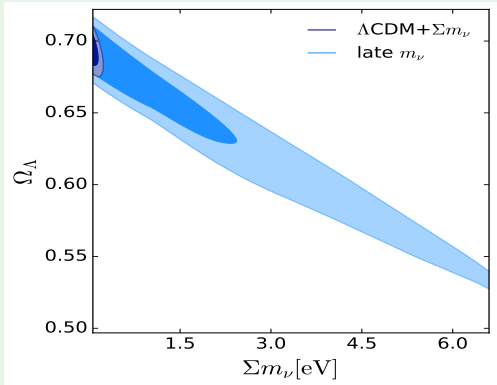

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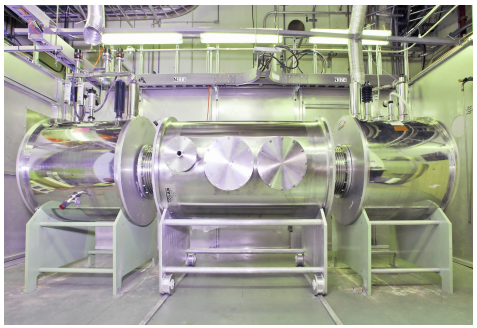

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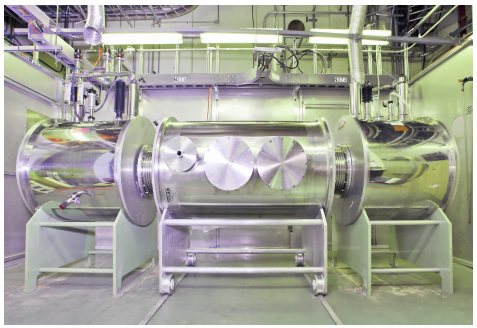

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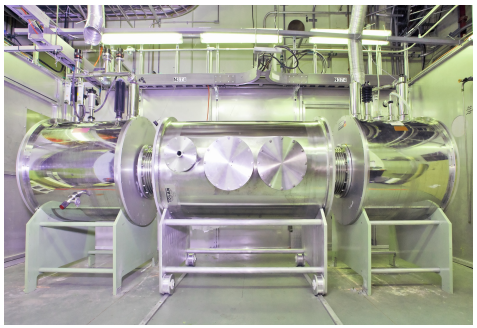

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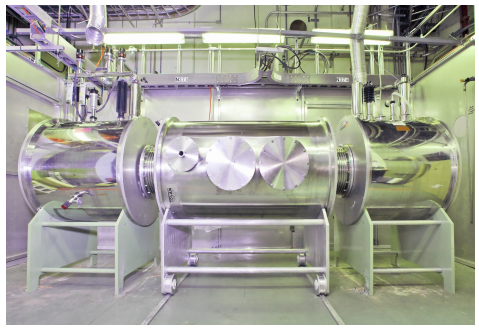

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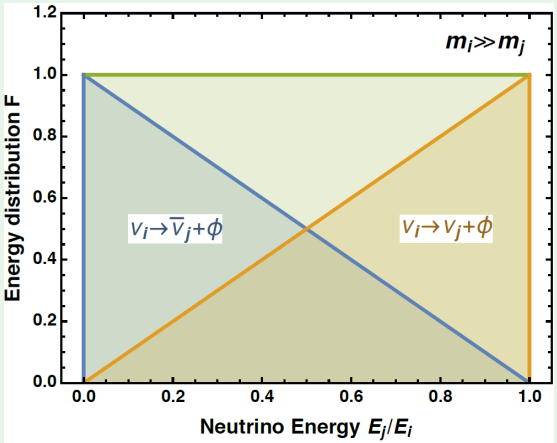

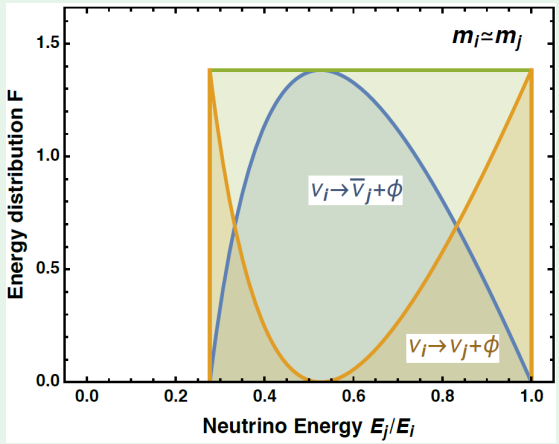

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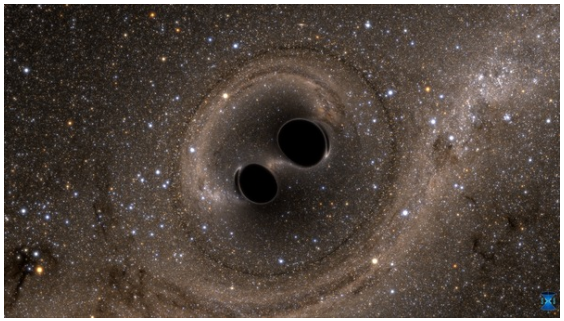

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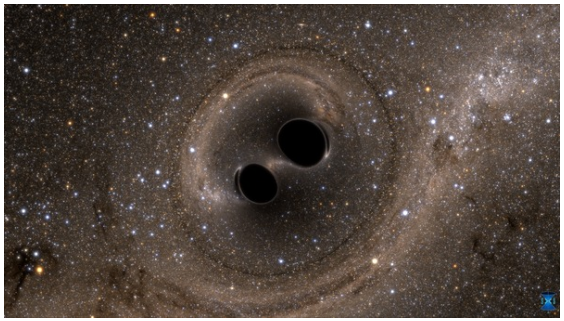

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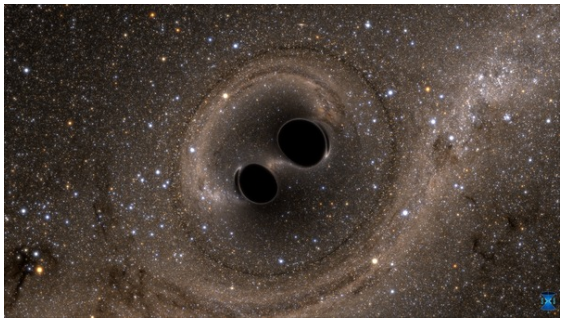

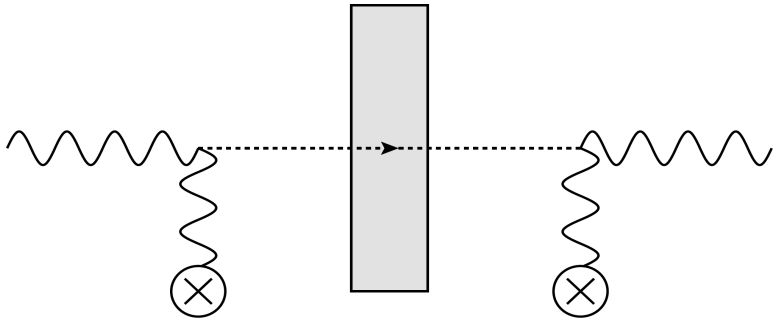

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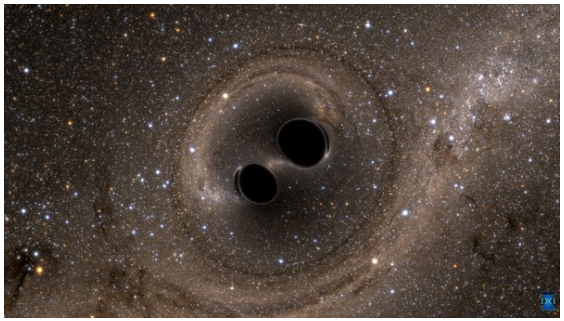

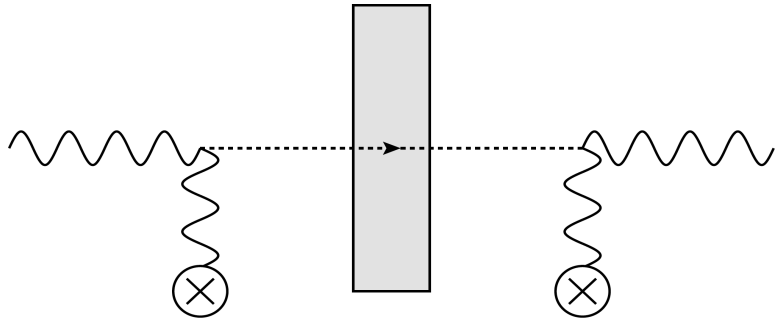

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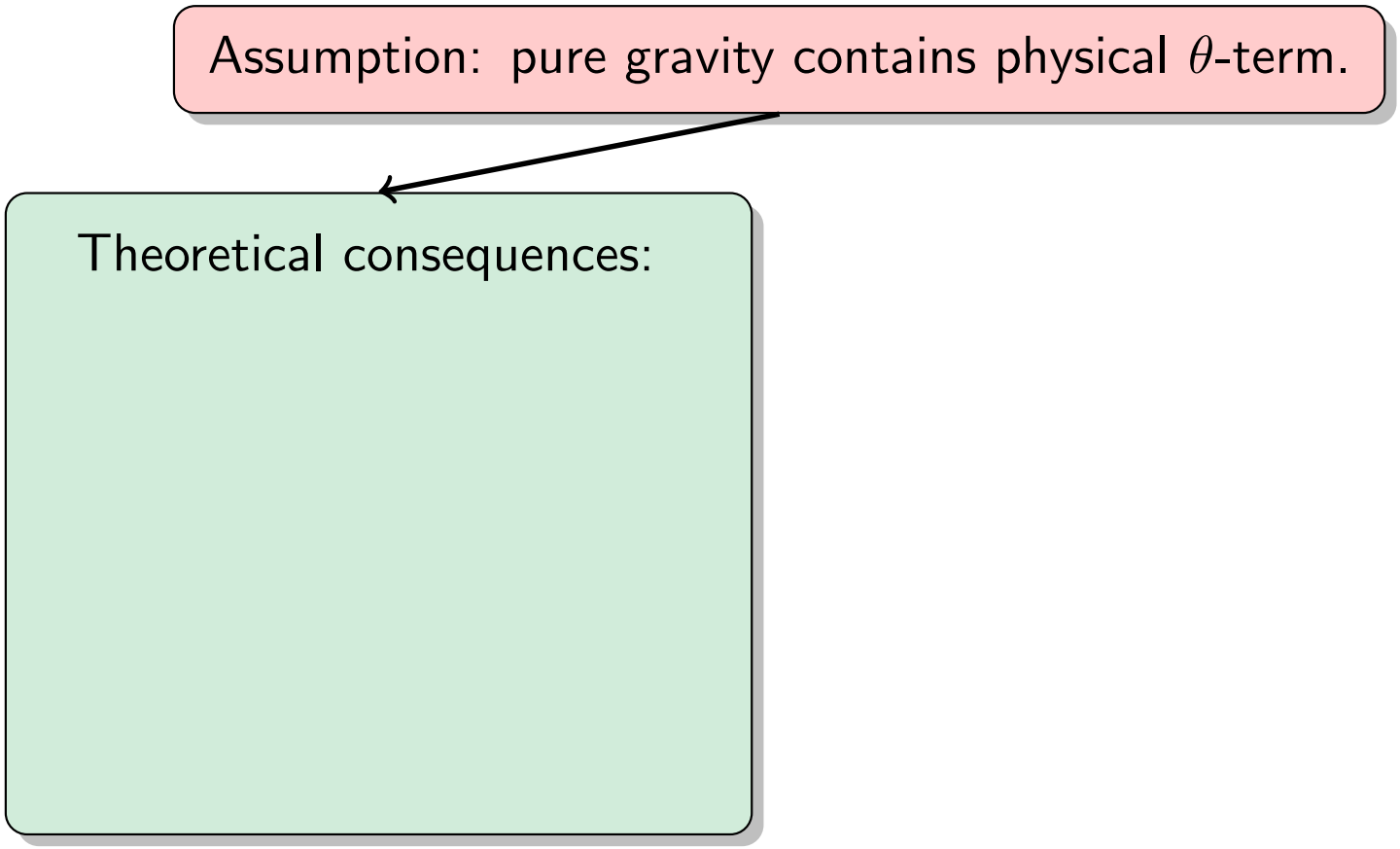
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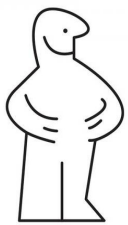

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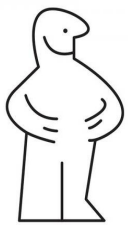

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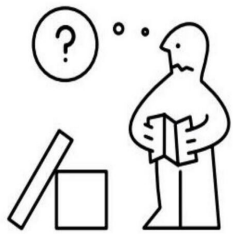

Do you have any questions?