

THE COHERENT WEAK CHARGE OF MATTER

Alejandro Segarra

IFIC (Univ. Valencia - CSIC)



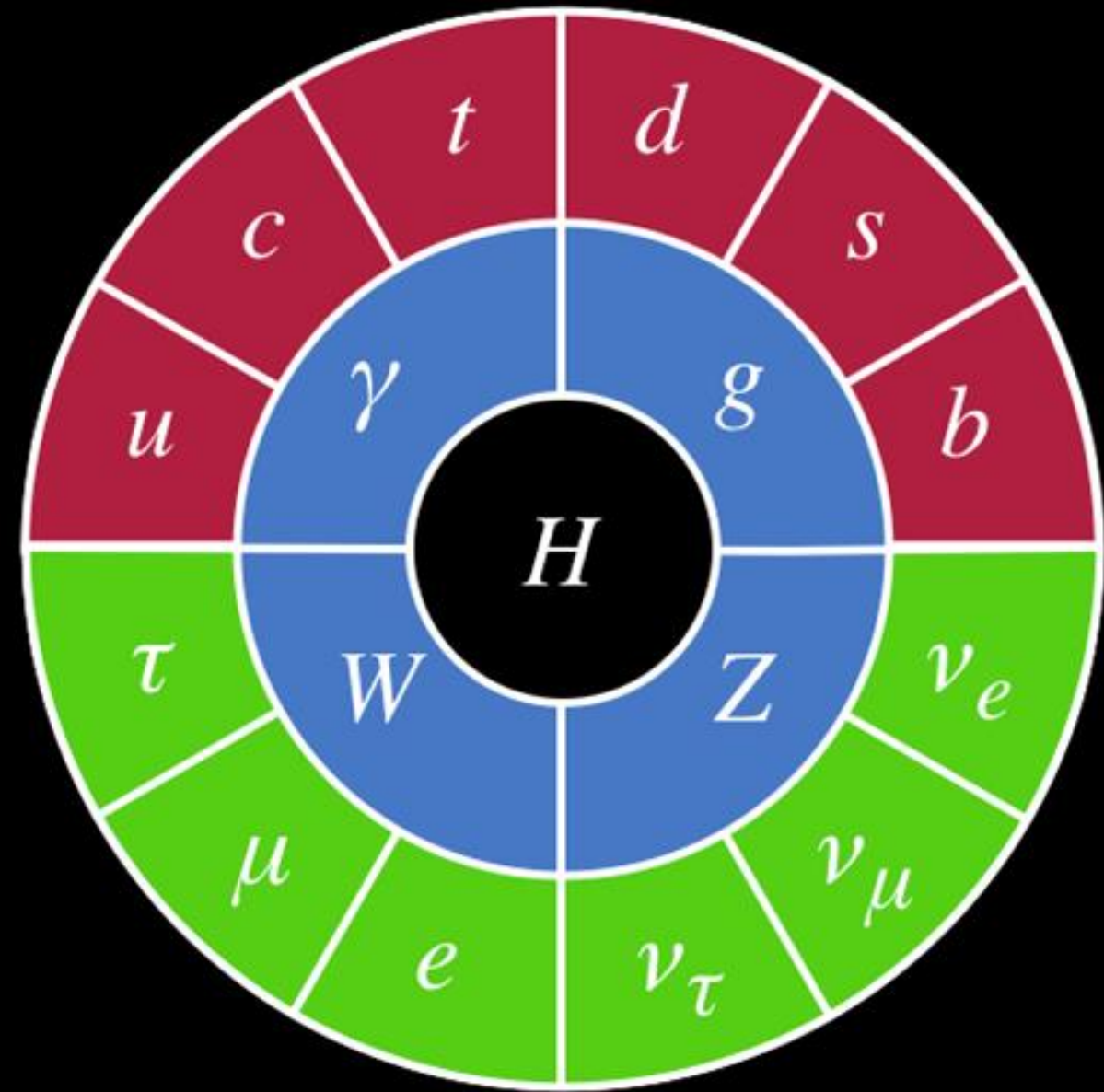
LONG-RANGE WEAK FORCES

Alejandro Segarra

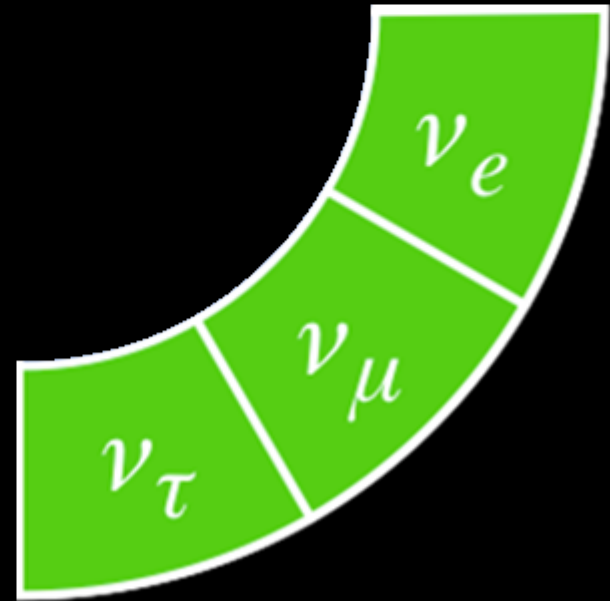
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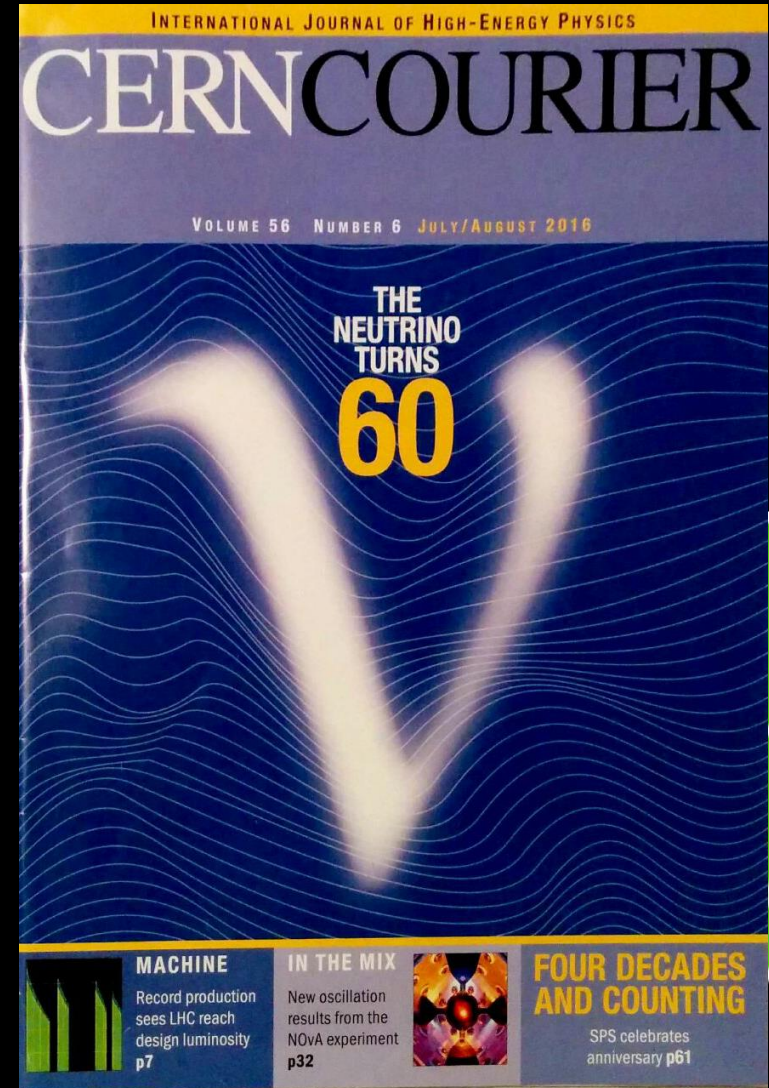
MOTIVATION



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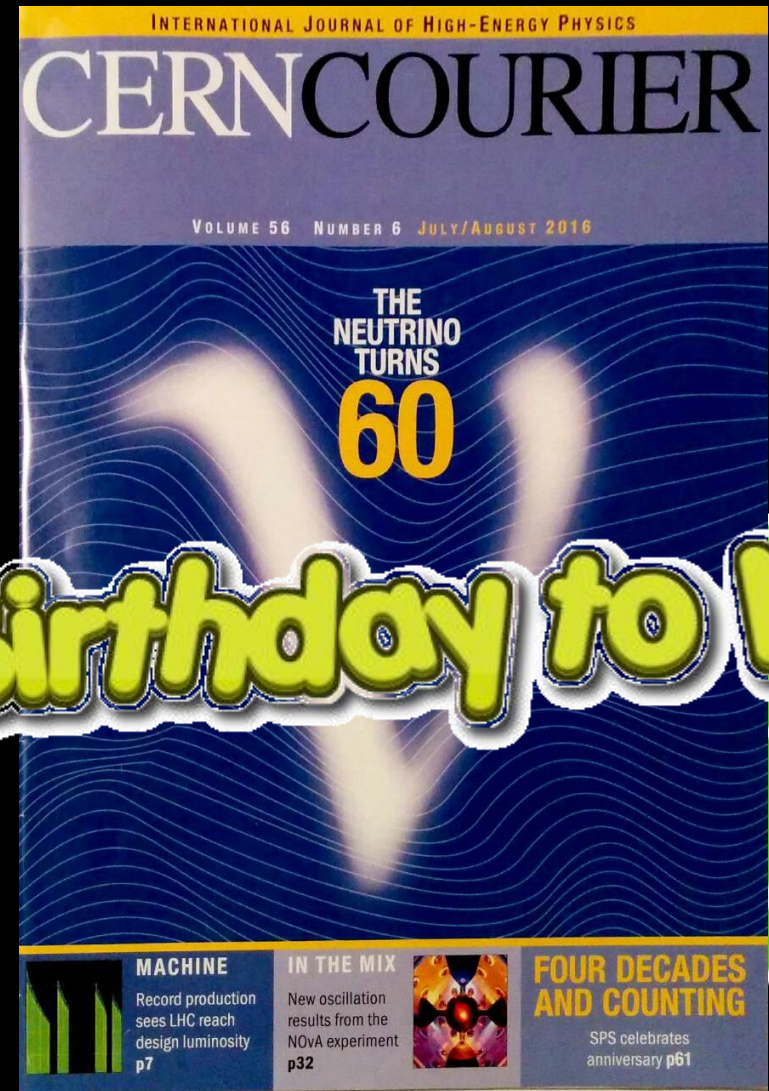
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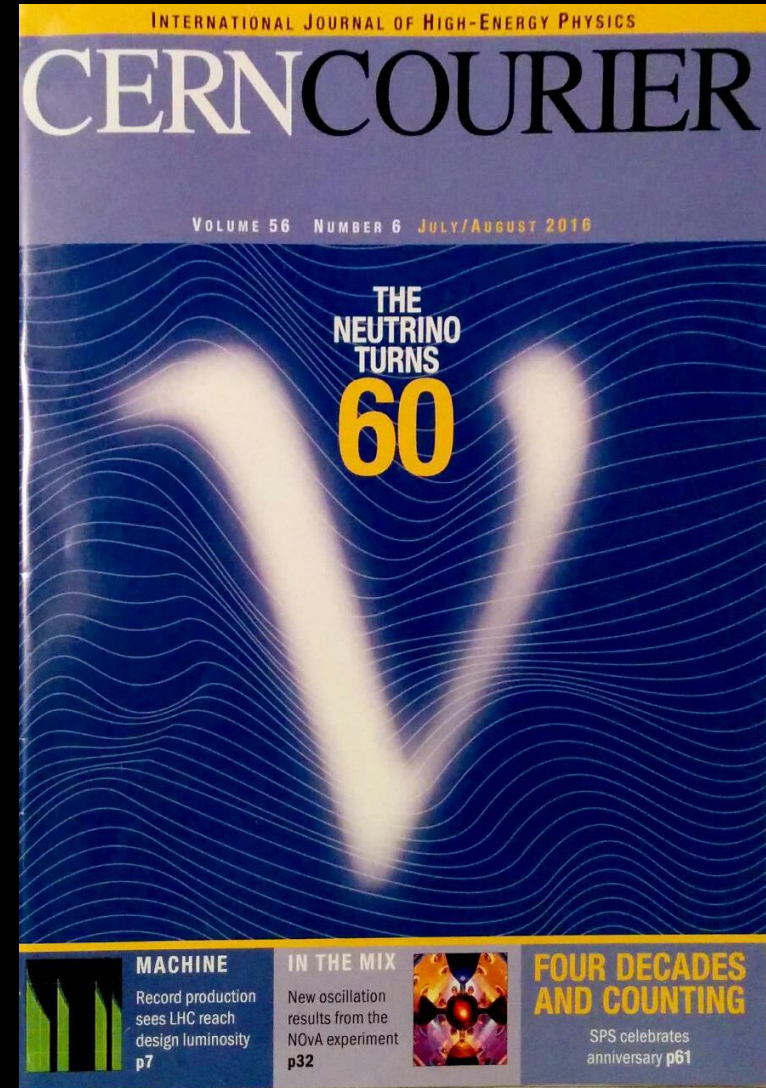


Happy Birthday to Nu



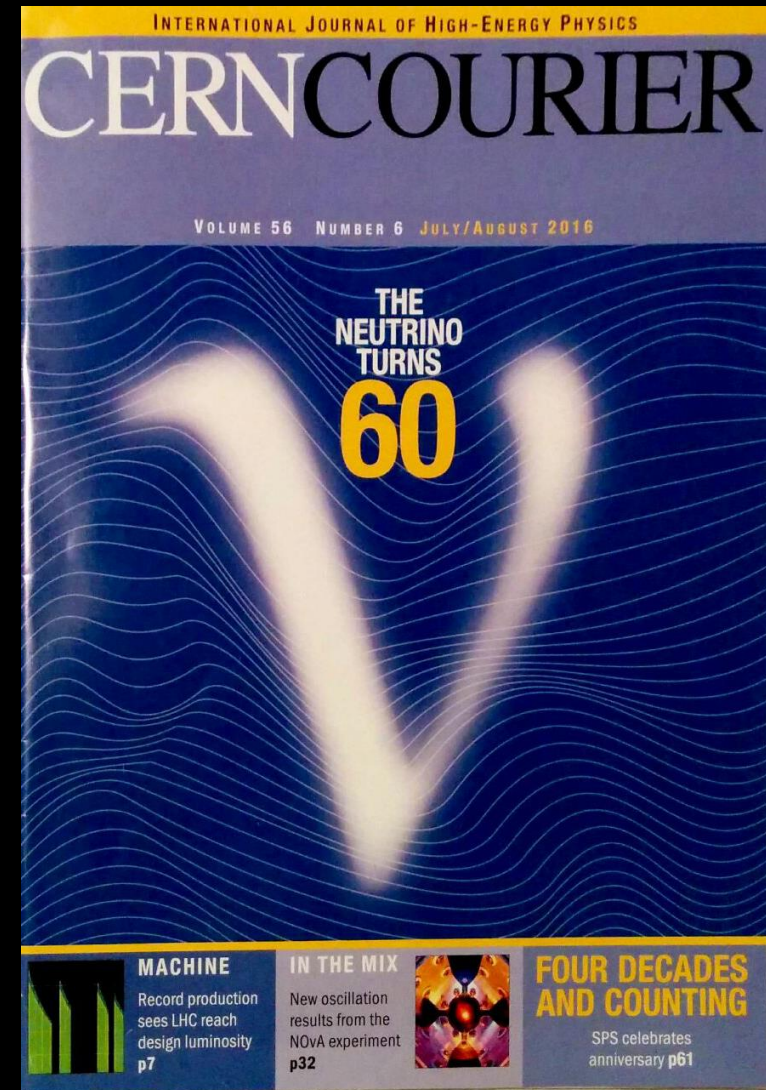
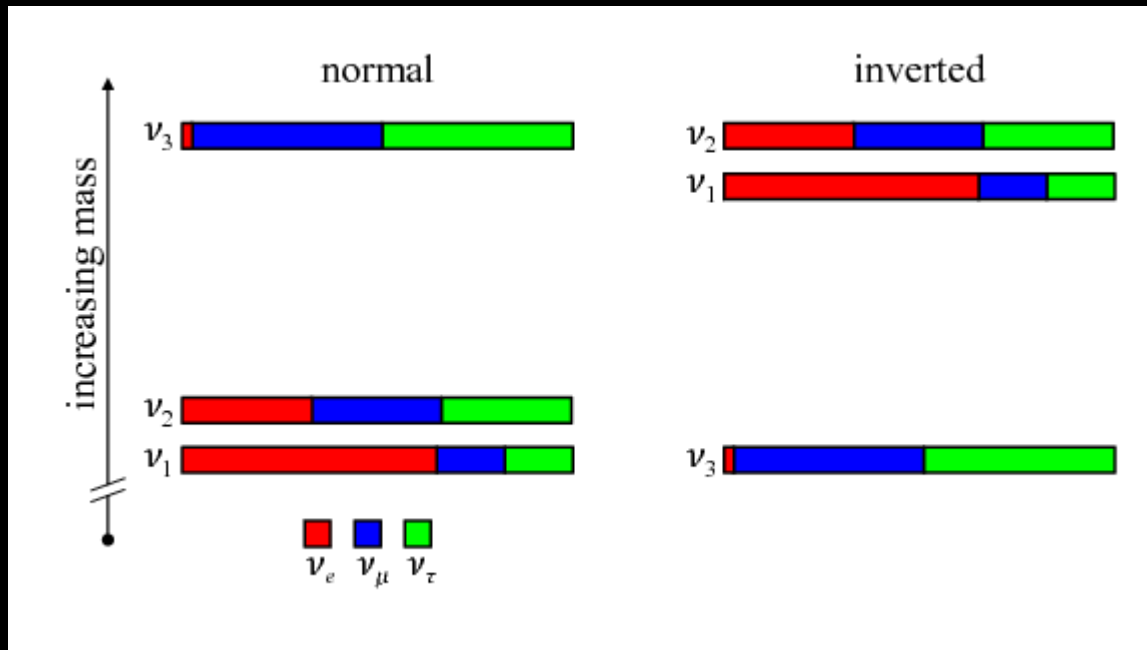
MOTIVATION

- Absolute mass scale: only Δm^2



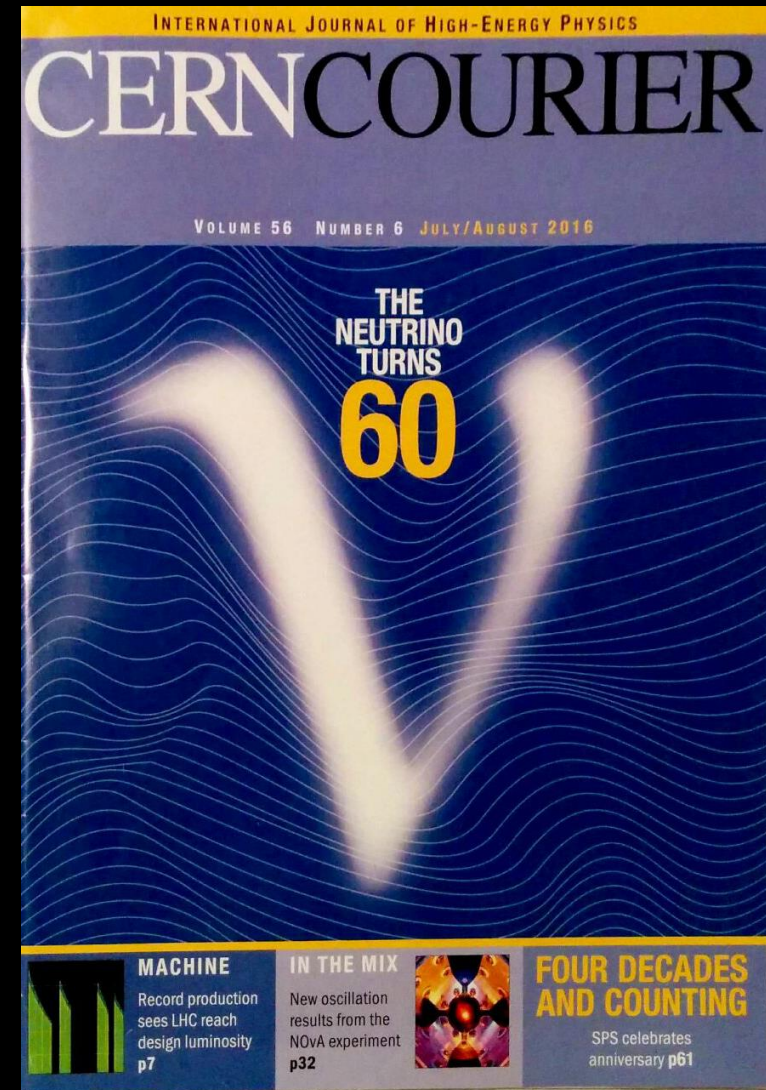
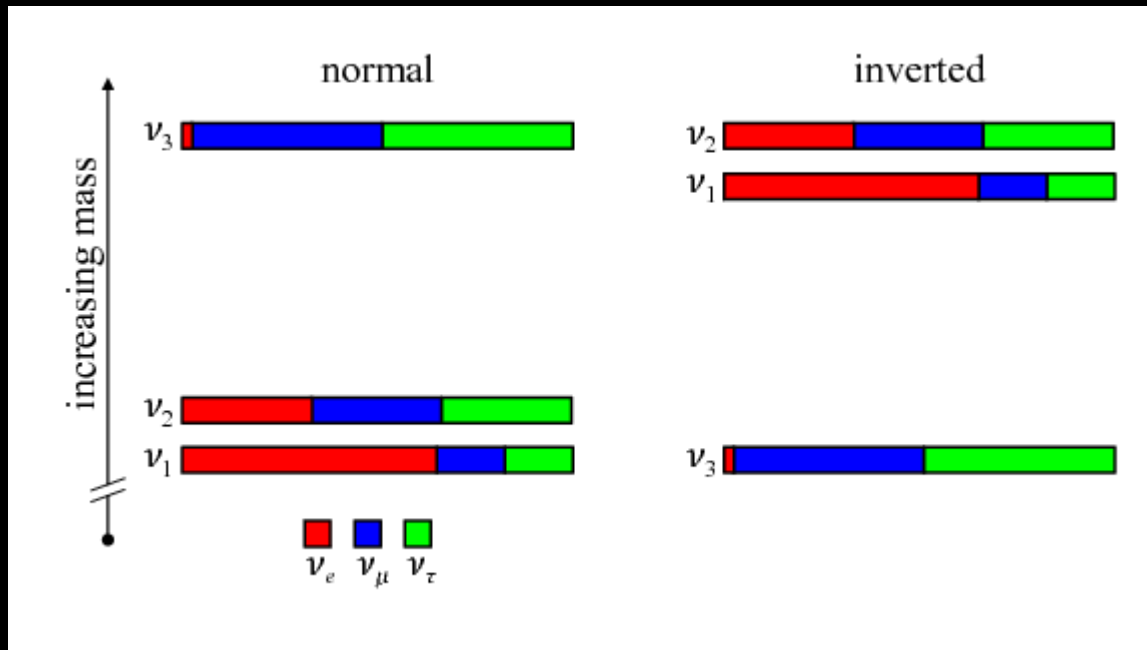
MOTIVATION

- Absolute mass scale: only Δm^2
- Mass Hierarchy



MOTIVATION

- Absolute mass scale: only Δm^2
- Mass Hierarchy
- Dirac/Majorana



MOTIVATION

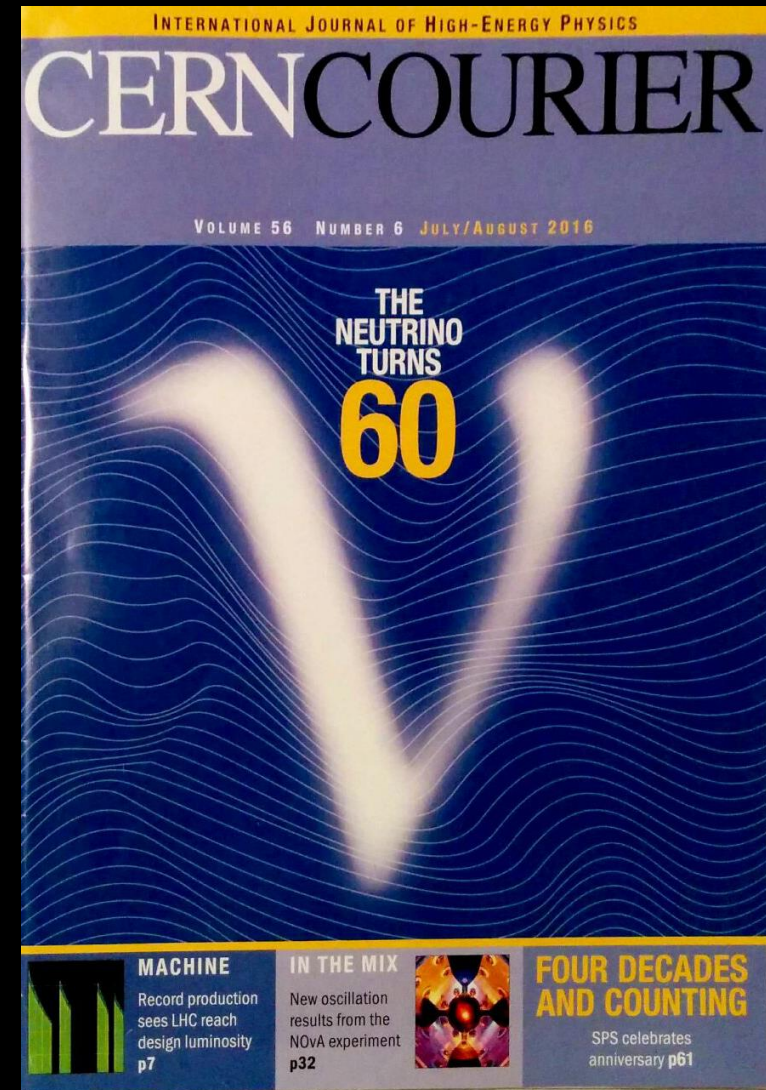
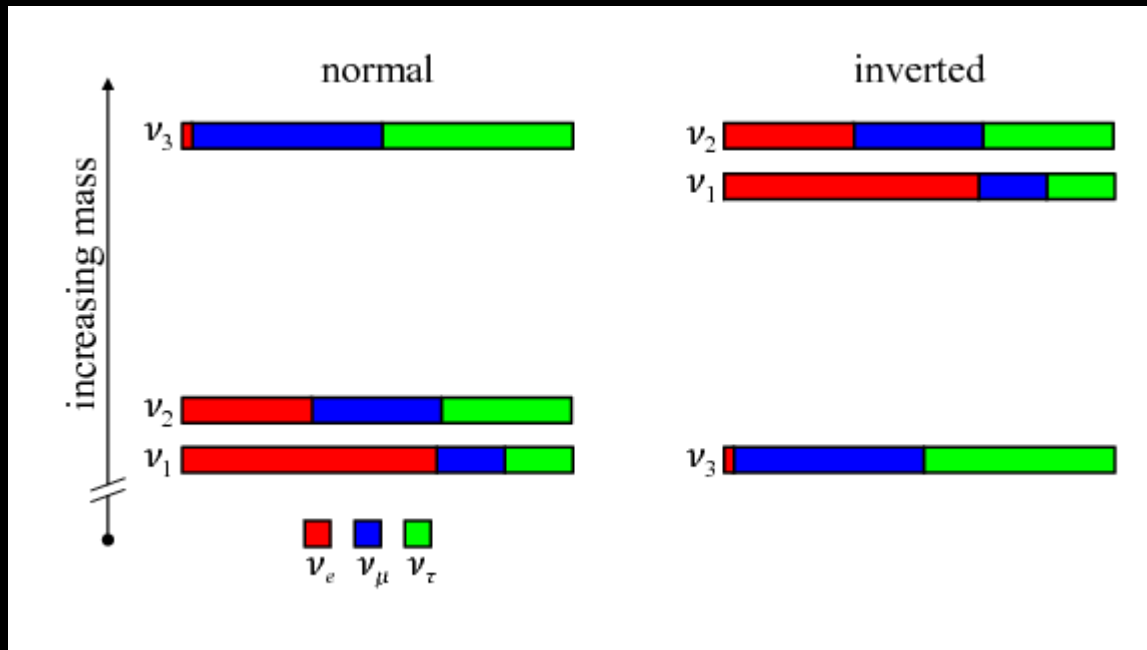
Additional generations

lepton sector

- If neutrinos were massless we could redefine the (LH) fields \Rightarrow no lepton mixing
But they have (tiny) masses because there are neutrino oscillations!
- Neutrinos are special:
they *may* be their own antiparticle (Majorana) since they are neutral
- If they are Majorana:
 - Mass terms are different to Dirac case
(neutrino and antineutrino *may* mix)
 - Intergenerational mixings are richer (more CP phases)

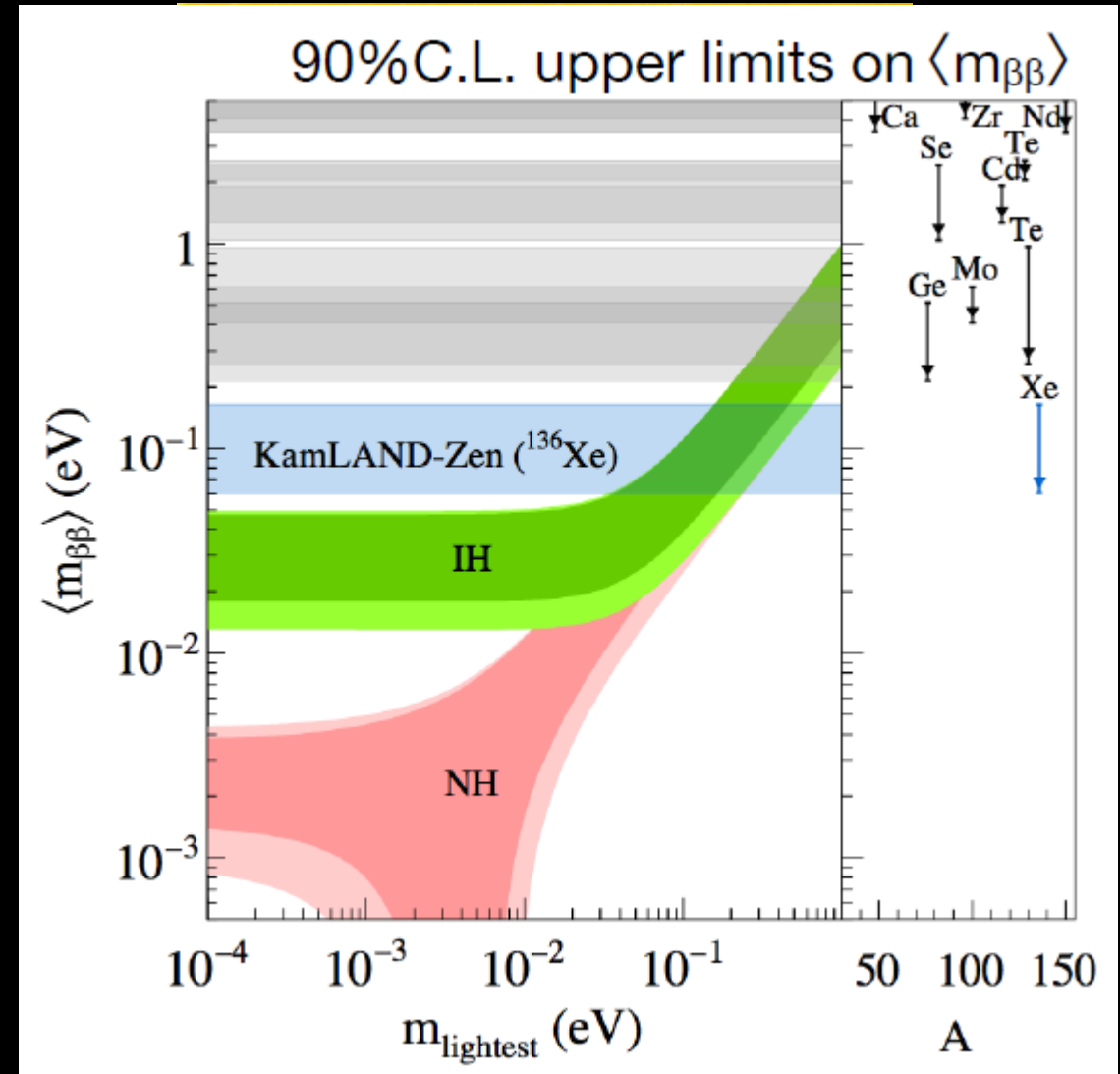
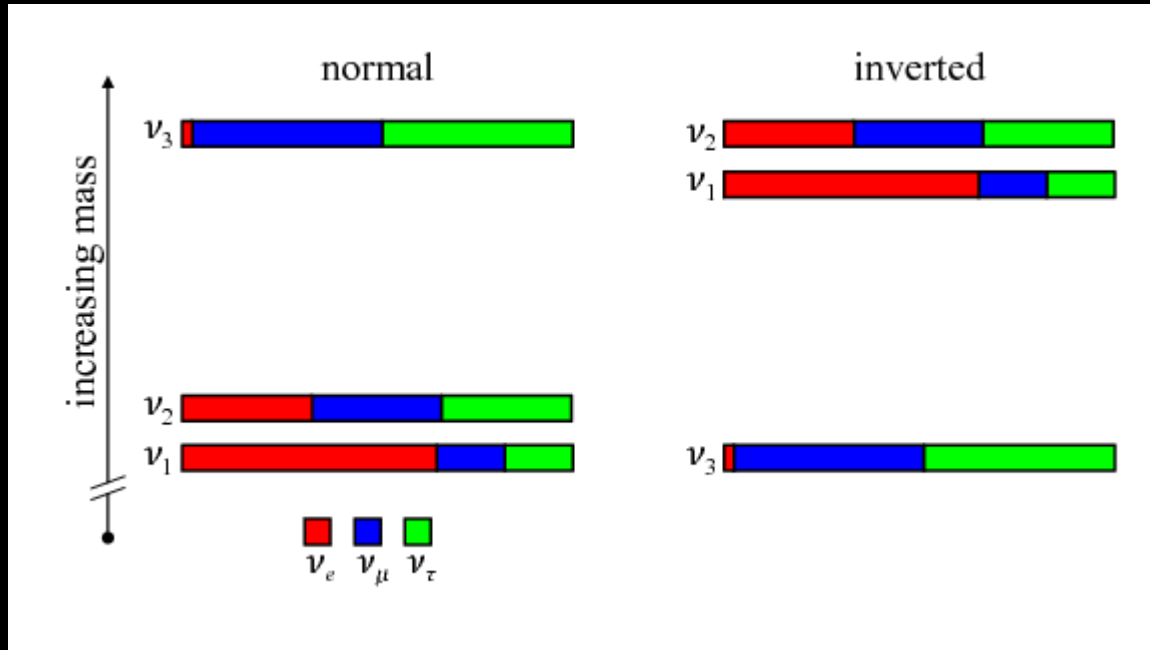
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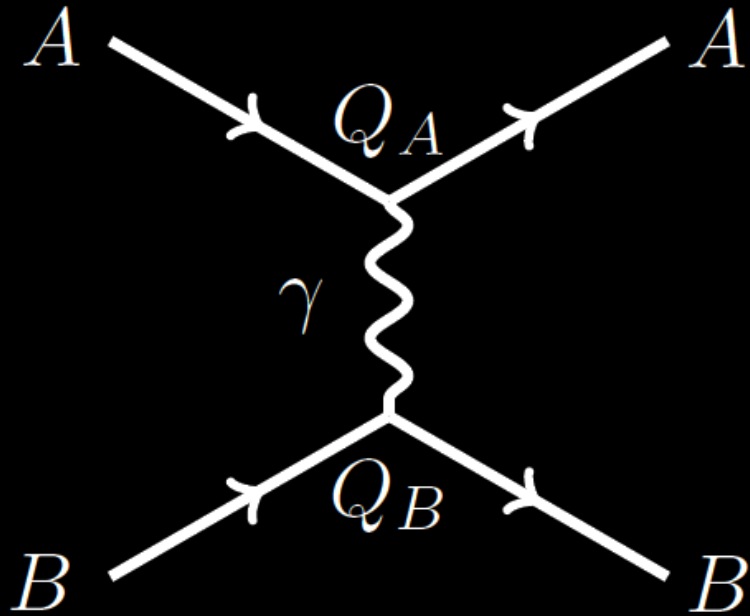


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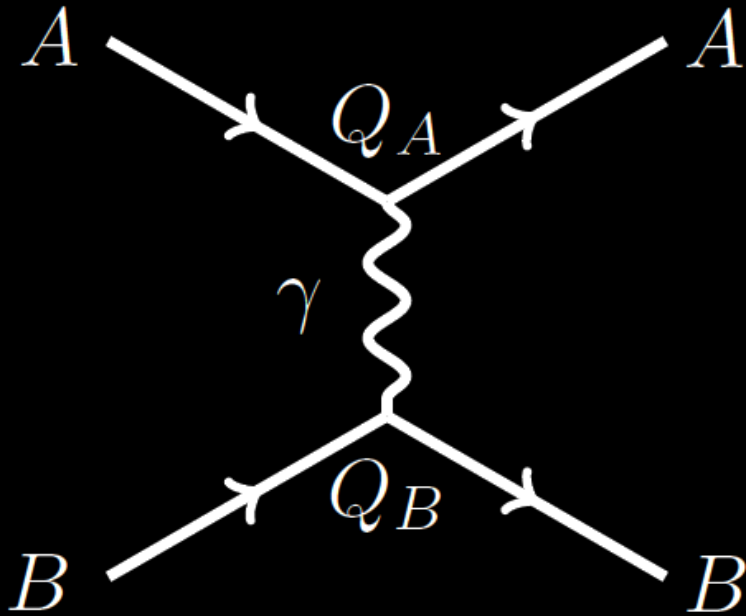


QED



$$M(q) = e^2 Q_A Q_B \frac{j_A \cdot j_B}{q^2}$$

QED



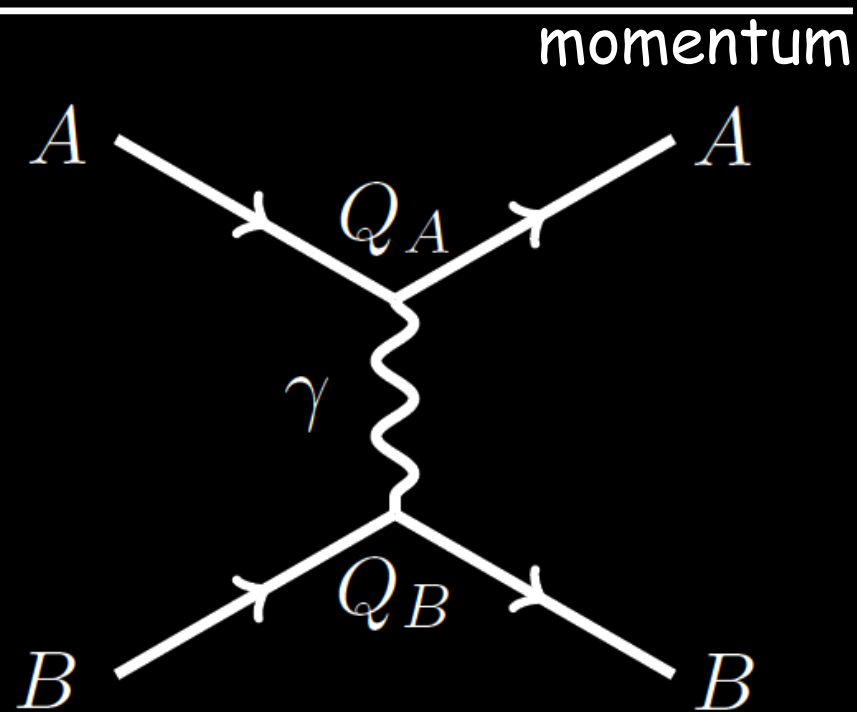
$$M(q) = e^2 Q_A Q_B \frac{j_A \cdot j_B}{q^2}$$

COULOMB POTENTIAL

$$V(r) = \frac{e^2}{4\pi} \frac{Q_A Q_B}{r}$$

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COULOMB POTENTIAL



\mathcal{F}

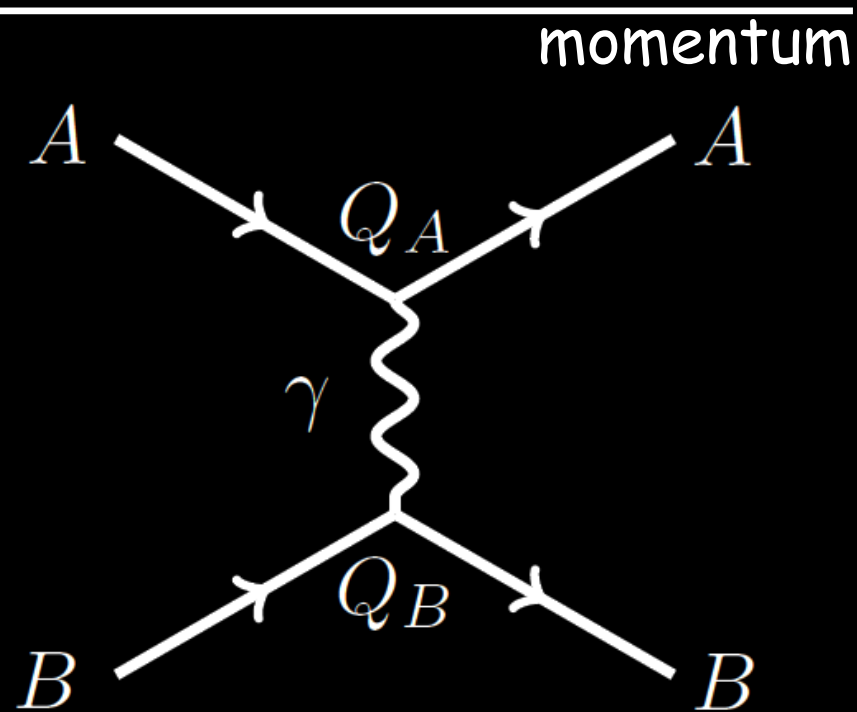
position

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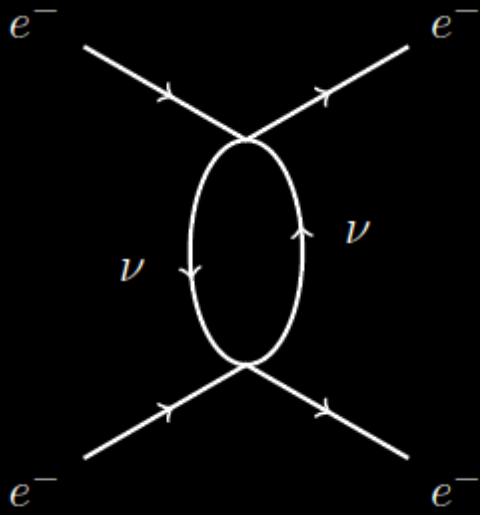
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Photon is massless \longrightarrow range is ∞

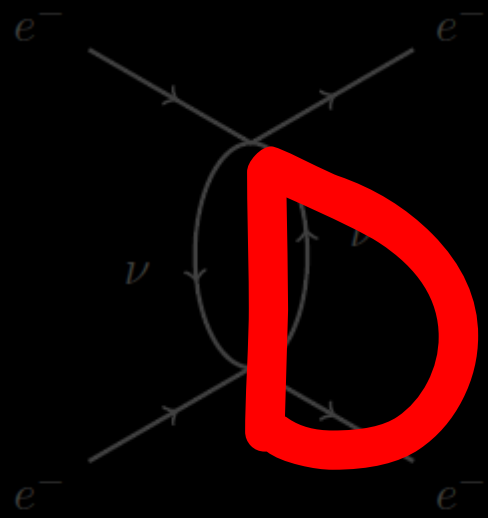
ALREADY ON THE LITERATURE...

Hsu, Sikivie, arXiv:hep-ph/9211301



$$V(r) = \frac{G_F^2}{8\pi^3} \frac{1}{r^5}$$

- Only $ee \rightarrow ee$ scattering considered
- SM: massless neutrinos



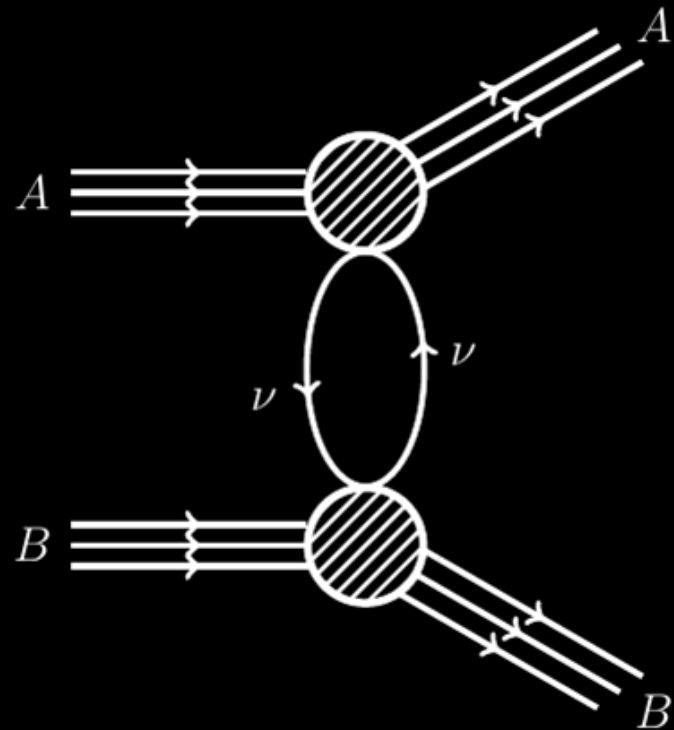
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Dismissed!

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LONG-RANGE WEAK INTERACTION

AS, arXiv:hep-ph/1606.05087



$$V(r) = \frac{G_F^2}{8\pi^3} [(2Z - N)^2 + 2N^2] \frac{1}{r^5}$$

LONG-RANGE WEAK INTERACTION

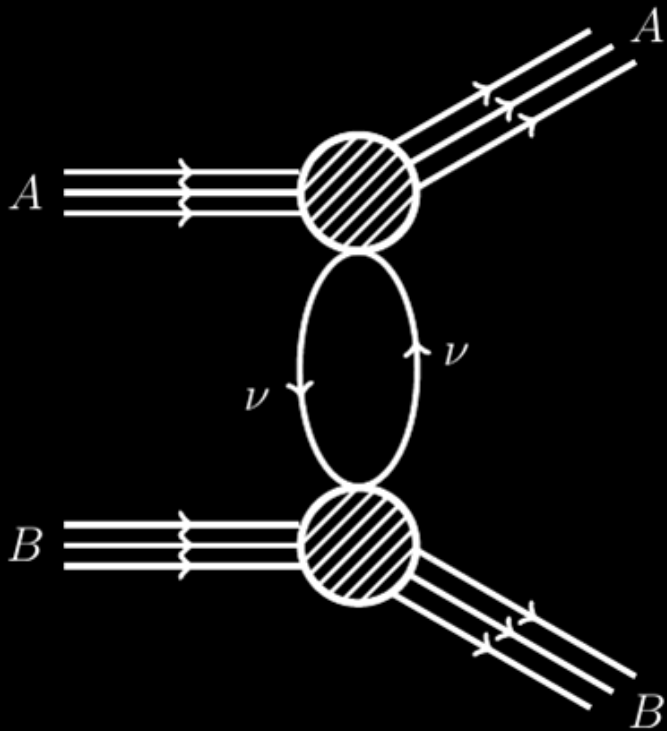
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A and B are *anything*

$Z = \#$ protons = $\#$ electrons

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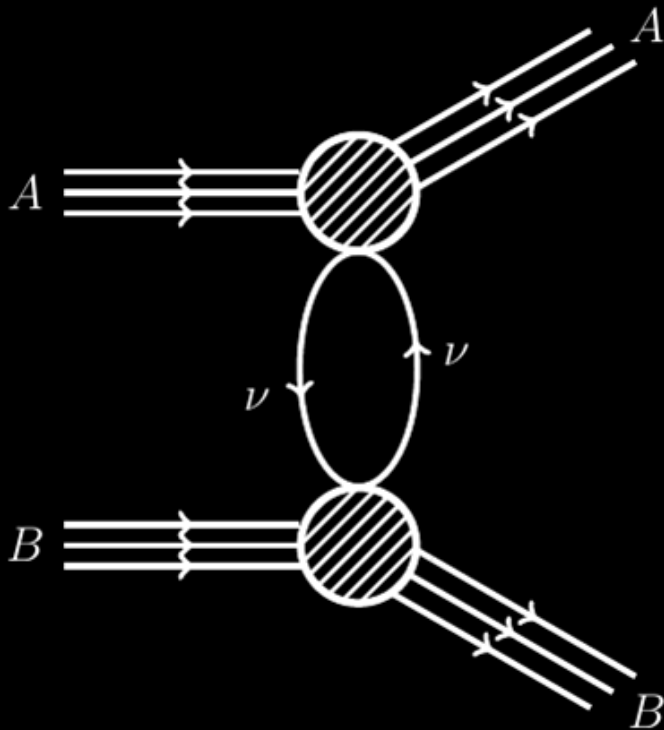
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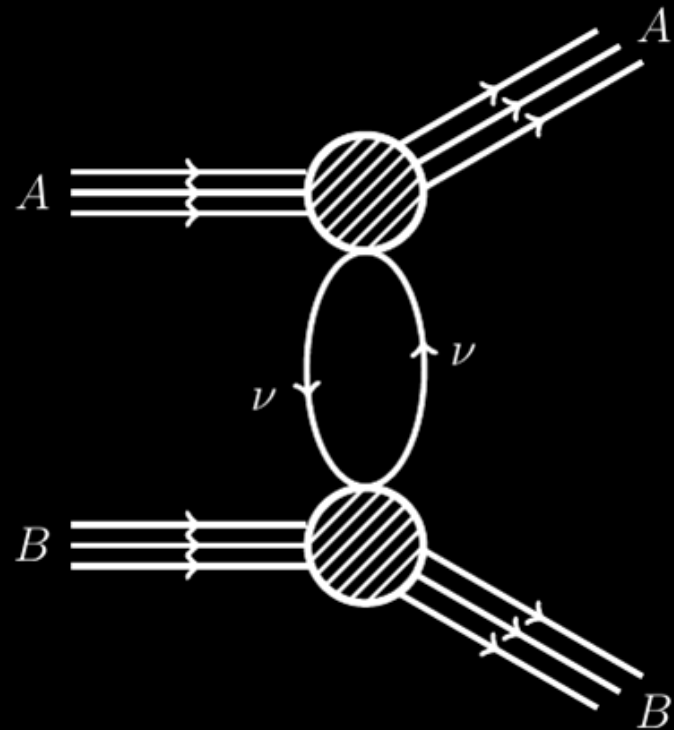
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Dispersion Relation



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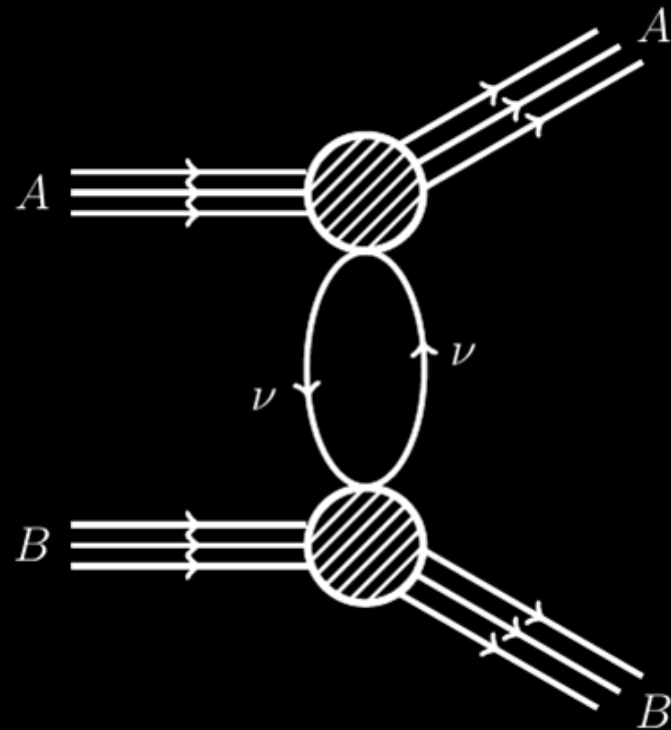
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Dispersion Relation
 S -matrix Unitarity

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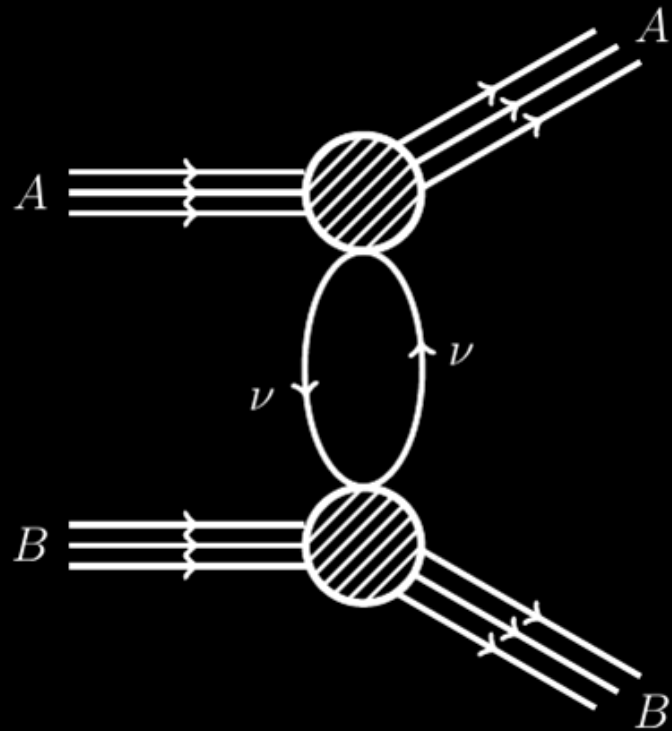
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Massless Neutrinos
Low-energy limit

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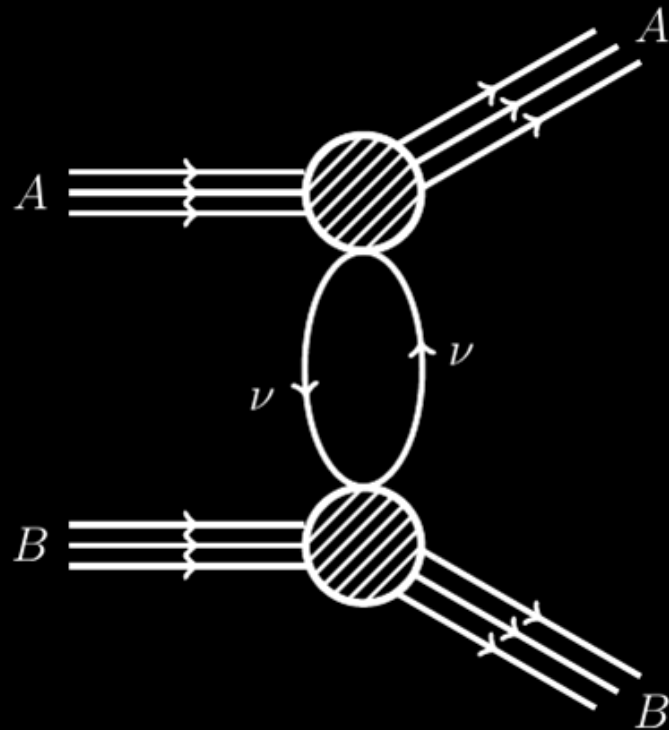
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Massless Neutrinos
Low-energy limit
Coherent limit

THE WEAK CHARGES OF MATTER

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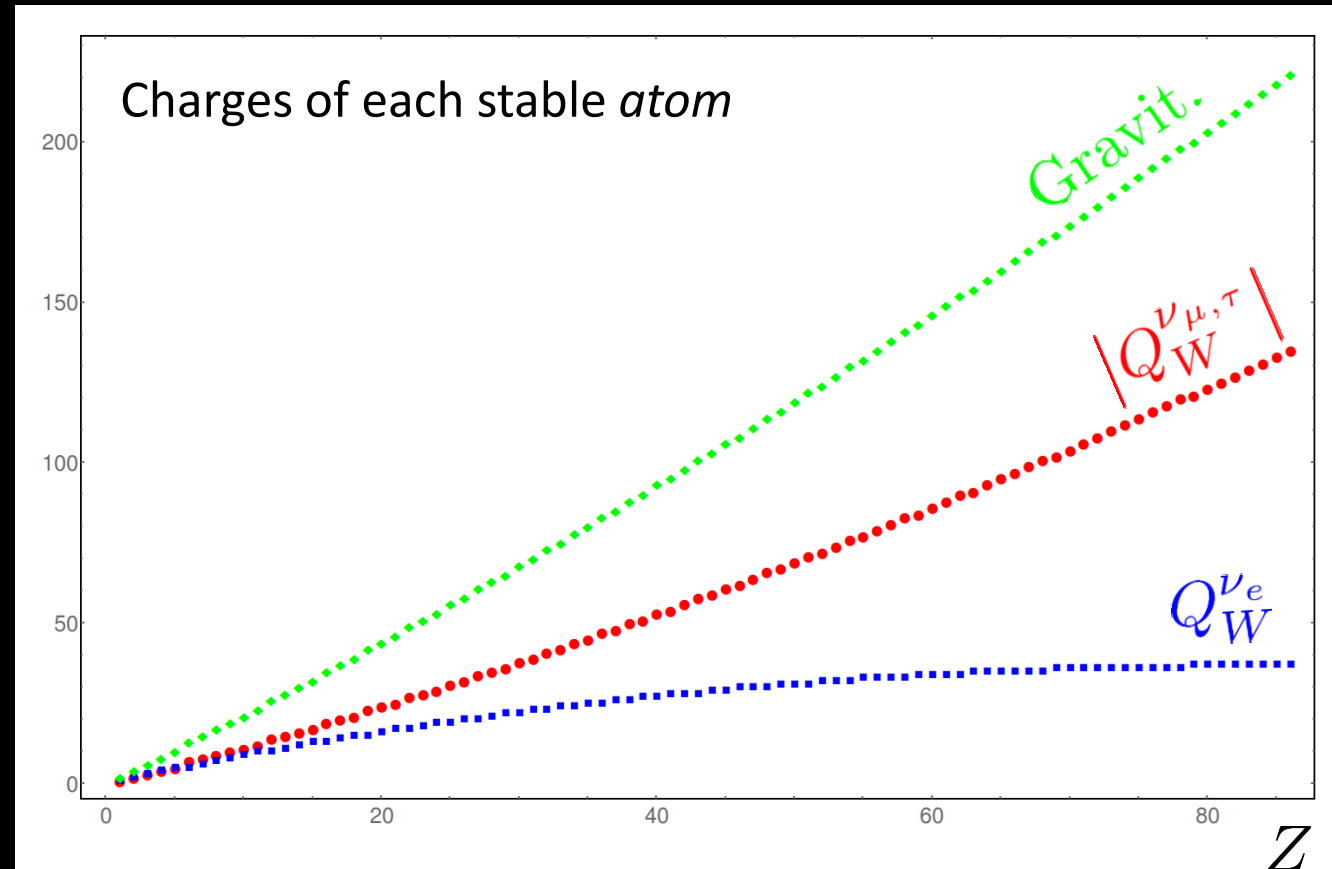
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THE WEAK CHARGES OF MATTER (CONT'D)

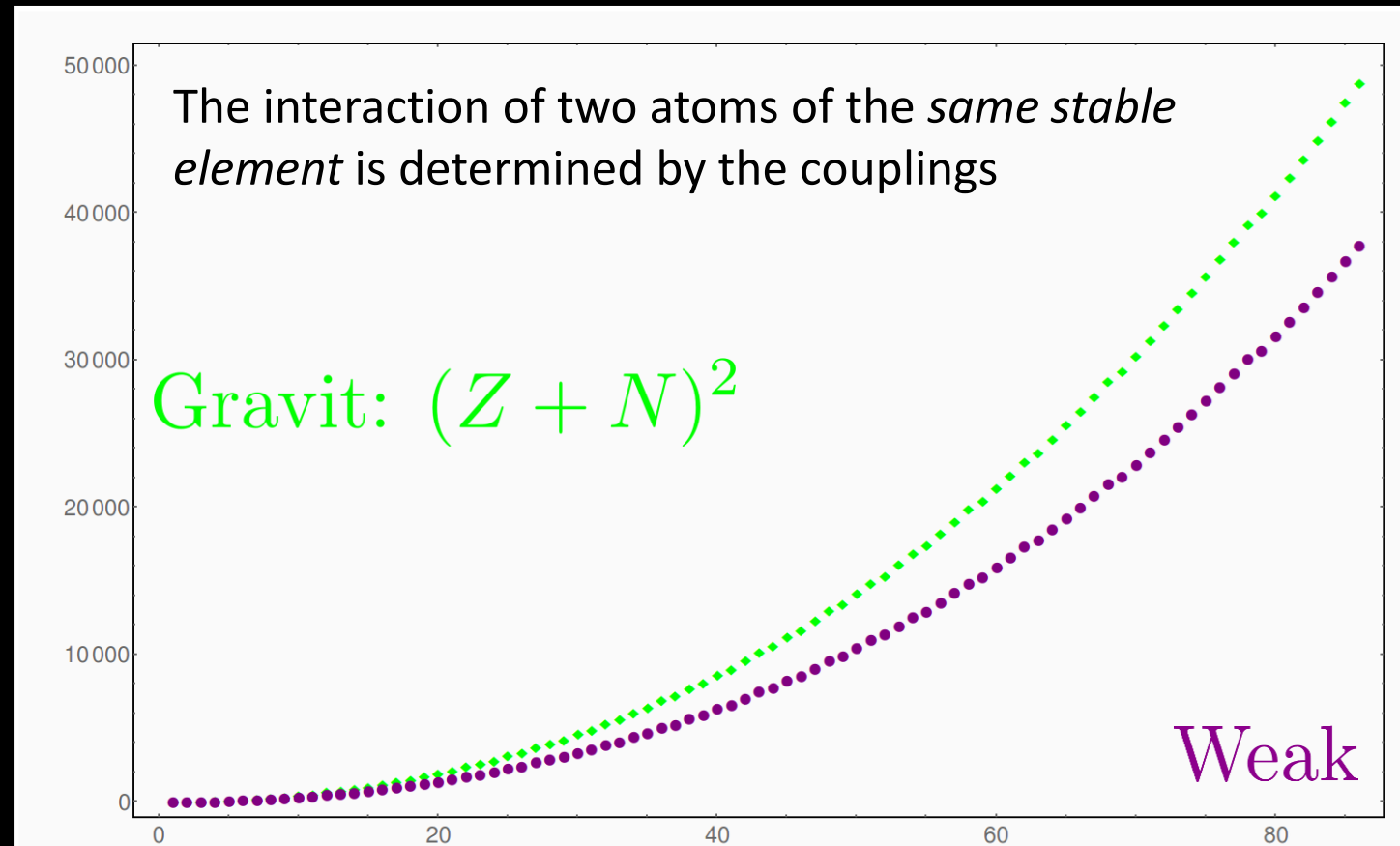
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FINAL REMARKS

✓ Interesting ranges

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$$a_0$$

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Gravitation

can be shielded

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