Neutrinos, Thier Masses, and Large Hadron Collisions

M meets P

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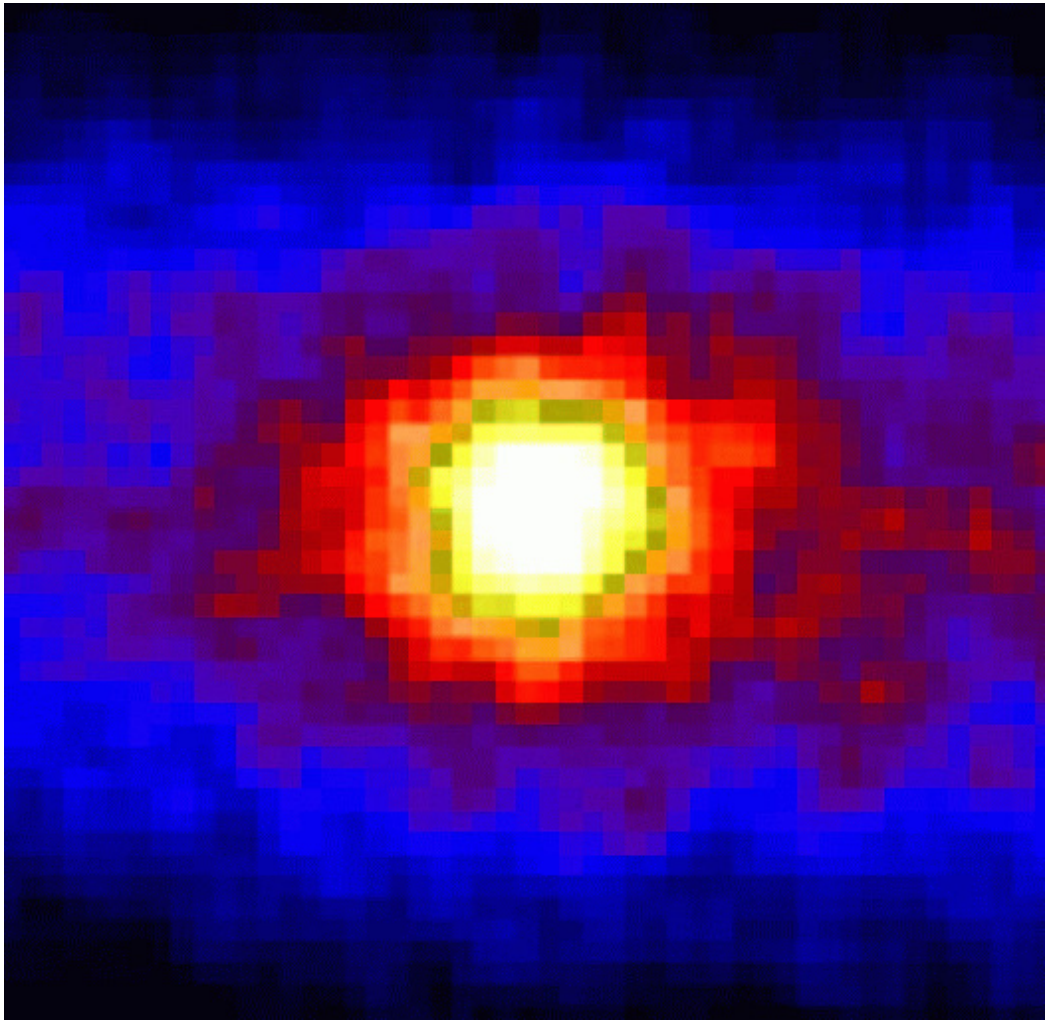
[1]Hi, I am new! MoveIn fellow as of Oct 2018

The Sun



A picture of the Sun by the Super Kamiokande expt, taken over a few (1496) nights, using neutrinos passing through Earth [astro-ph/0311343]

Neutrinos Masses and New Particles?

In 2015, Super K awarded  for discoverying nonzero neutrinos masses!

- Problematic because fermion masses usually break conservation laws

$$m_\nu \neq 0 + \text{LH currents}$$

$$\text{LH Majorana Mass} : m_\nu^L \overline{\nu_L} \nu_L^c \quad \text{and/or} \quad \text{Dirac Mass} : m_\nu^D \overline{\nu_L} N_R$$

$$m_\nu^L = y\langle\Delta\rangle \text{ or strong dynamics} \qquad m_\nu^D = y\langle\Phi_{\text{SM}}\rangle$$

$m_\nu \neq 0$ **+ renormalizability + gauge inv.** $\Longrightarrow$ **new particles!**

Heavy, Sterile Neutrinos and Colliders

"Which?" and "How many?" new particles exist in connection to ν_ℓ masses are open questions in particle physics today.

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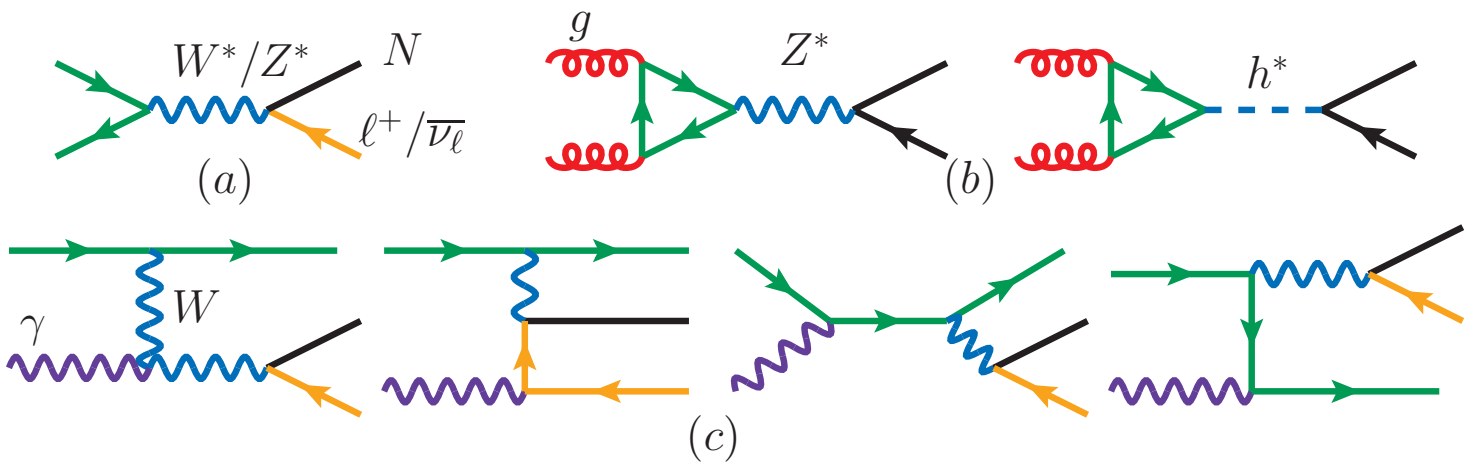
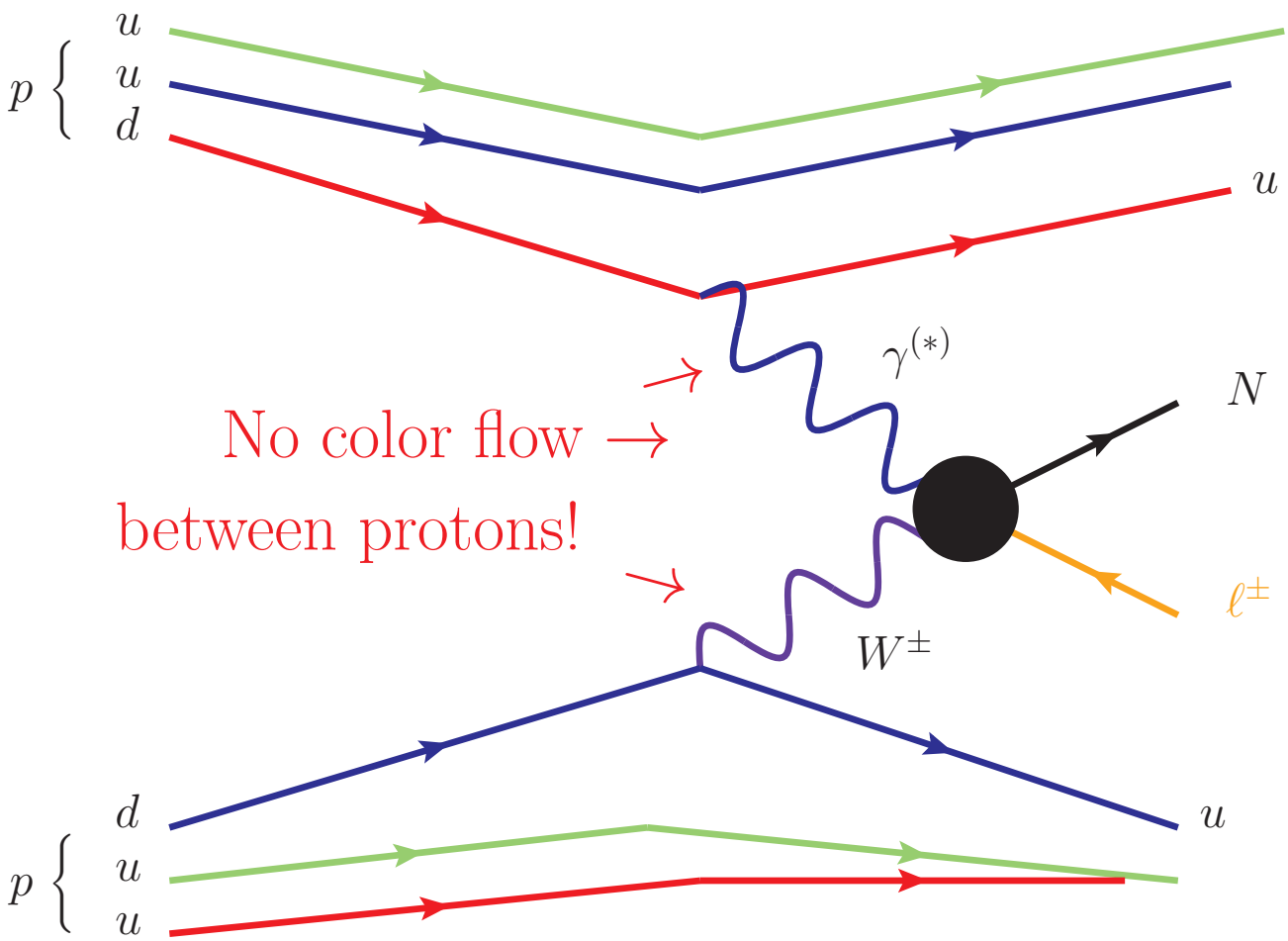
- May be related to origin of Standard Model's chiral $(V-A)$ structure
- May also be related to $0\nu\beta\beta$ decay and proton stability

ν_ℓ and N_R share a mass and the same quantum numbers $\Longrightarrow$ mixing!

- induces interactions with SM particles, allowing production at the Large Hadron Collider!



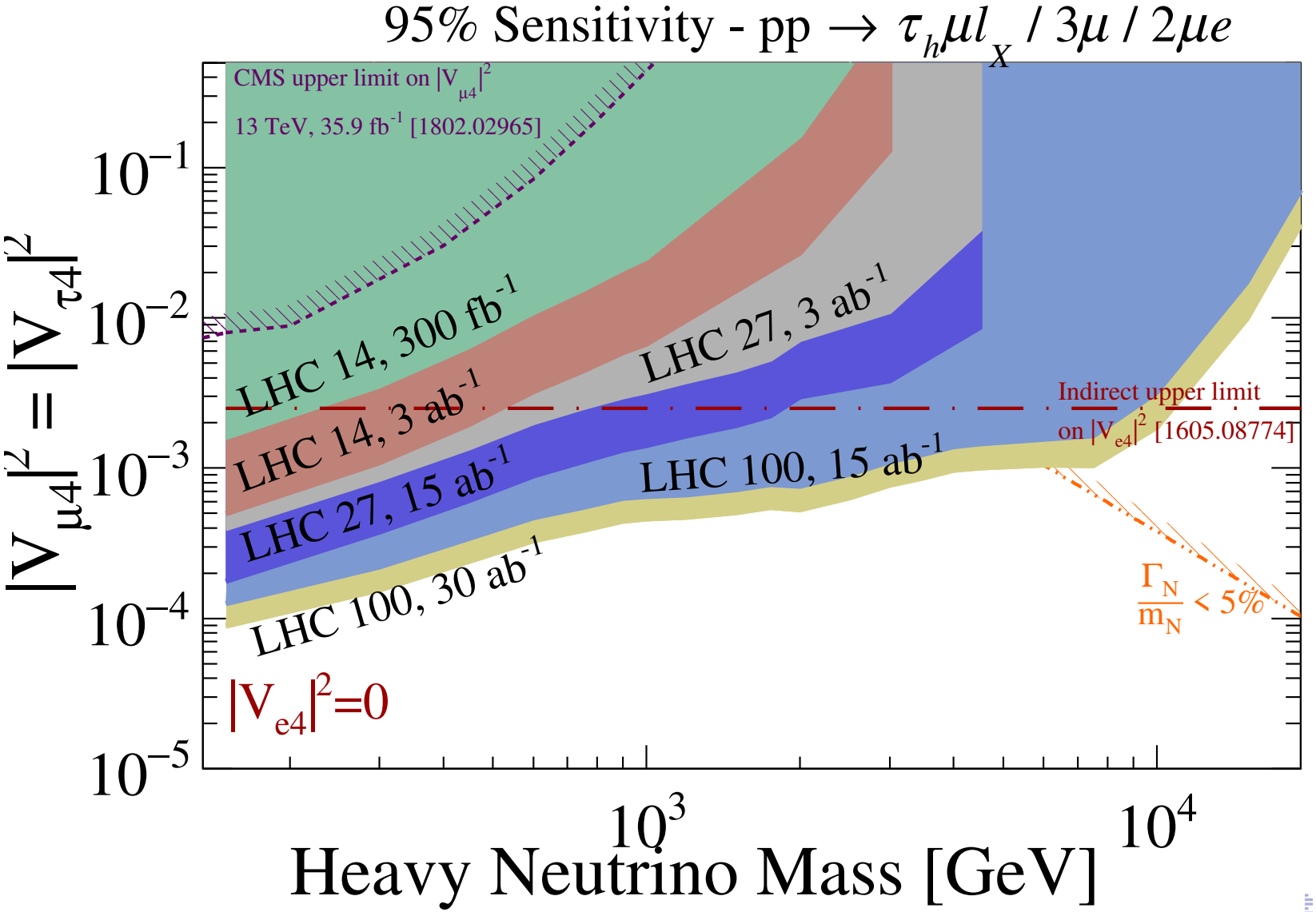
Heavy neutrino production in pp colliders can be very unsual



A lack of QCD color exchange is *very rare* in pp collisions $\Longrightarrow$ less hadronic activity in N events. Modeling this reliably is... well... hard.

PRELIMINARY

Exploiting this leads to *amazing* discovery potential at LHC and upgrades



Thank you.