Neutrino Masses and Matter-Antimatter Asymmetry

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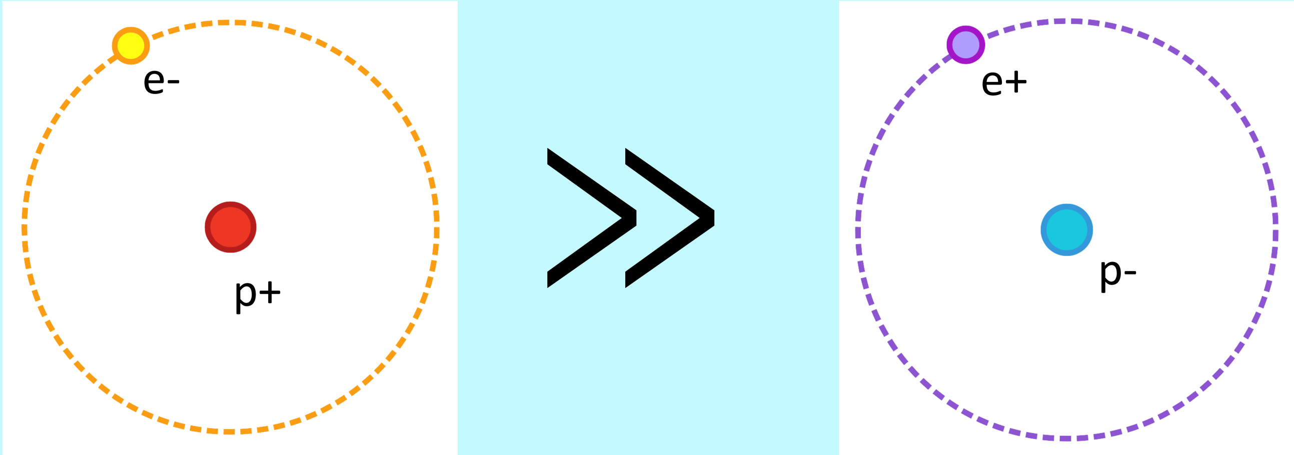
Motivation

Matter-Antimatter Asymmetry

Why is there more matter than antimatter?

JWST Deep Field image [1]



Neutrino Mass

How do neutrinos get their masses?

- *Neutrinos* are small, neutral particles that we used to think were massless.
- In the past few decades, physicists have found experimentally that they do have mass.
- However, they can't get mass in the same way other particles do under the Standard Model of particle physics.

Our project studies a model that aims to answer both these questions simultaneously.

Model

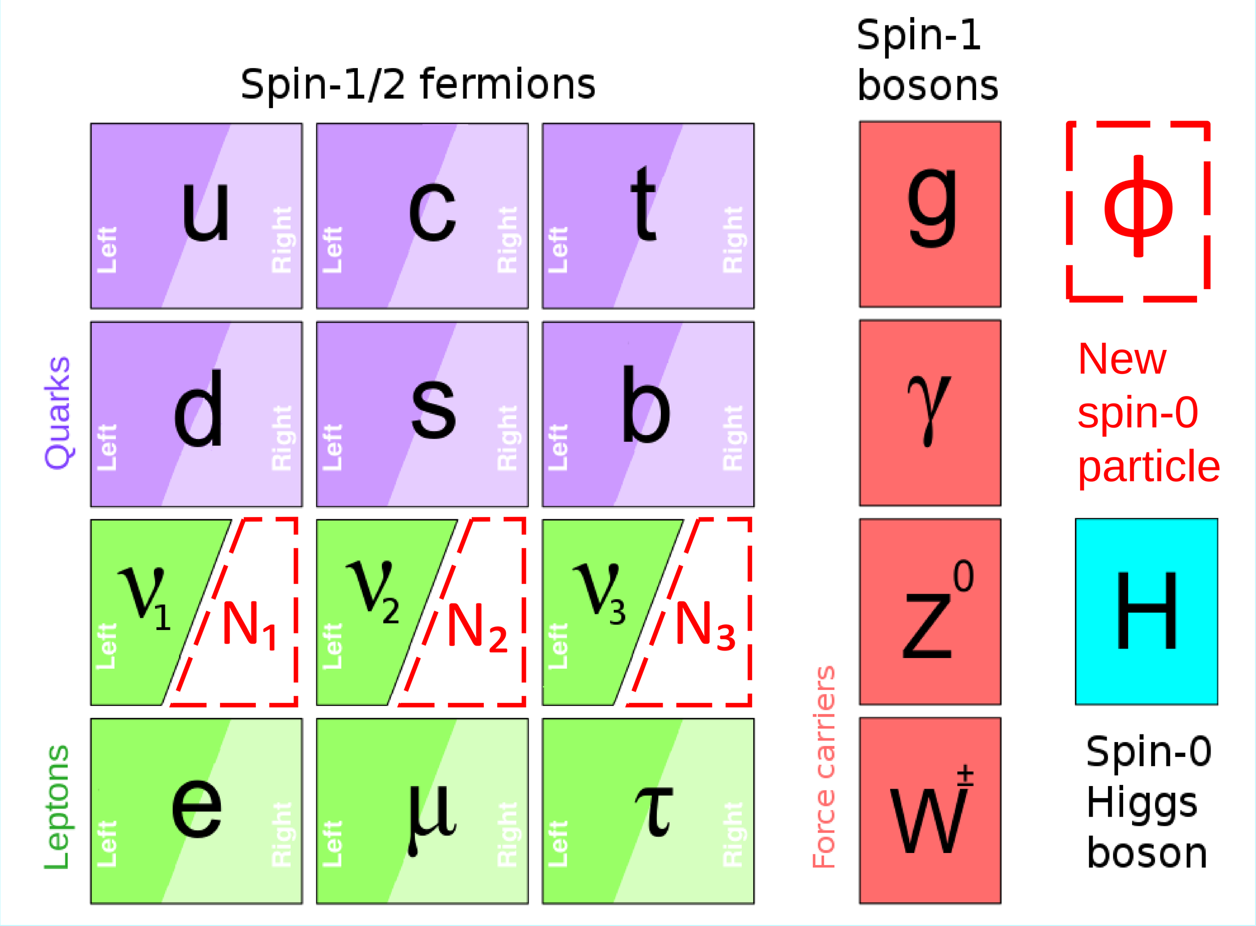
Most particles have a "left-handed" version and a "right-handed" version. We've only ever seen left-handed neutrinos, which is why they can't get mass like other particles do (via the Higgs).

Our model introduces:

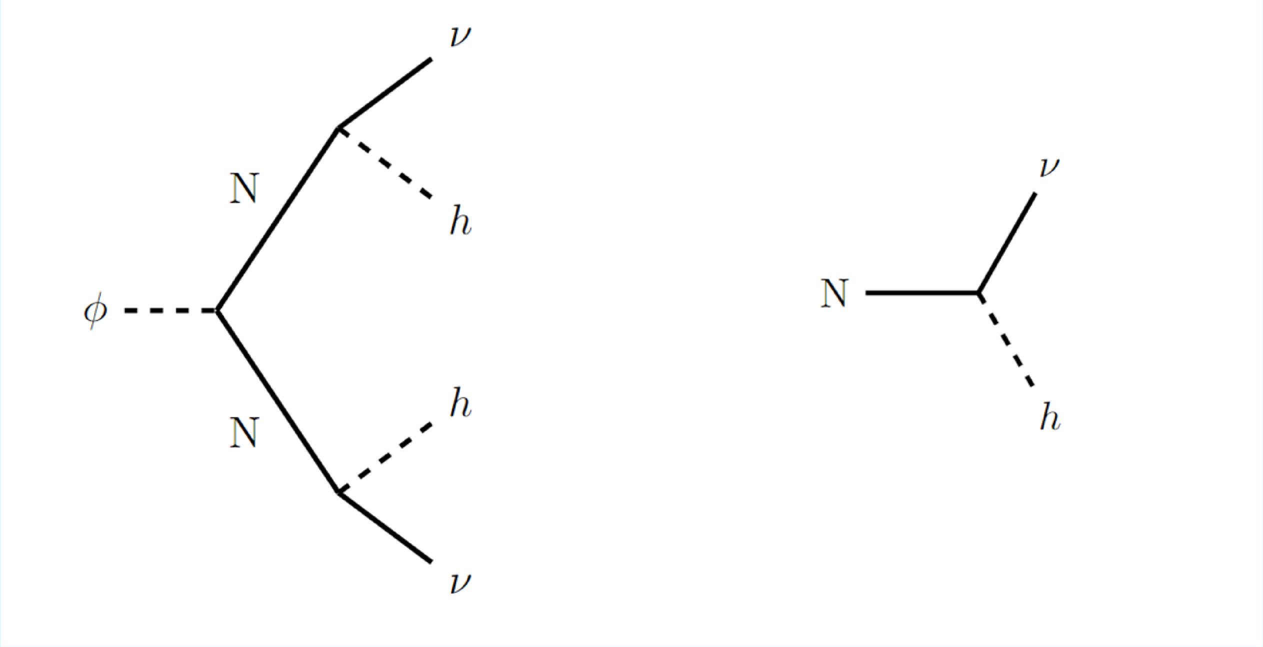
- Right-handed neutrinos (RHNs), which give neutrinos mass and can generate matter-antimatter asymmetry via decays.
- A field like the Higgs field, called ϕ, which can decay into RHNs and also create asymmetry on its own.

Previous studies neglected to consider ϕ decays producing an asymmetry [2]. It turns out to have a large effect!

These new particles could decay to BOTH matter and antimatter. If they decay to matter at a different rate than they decay to antimatter, then they generate an asymmetry.



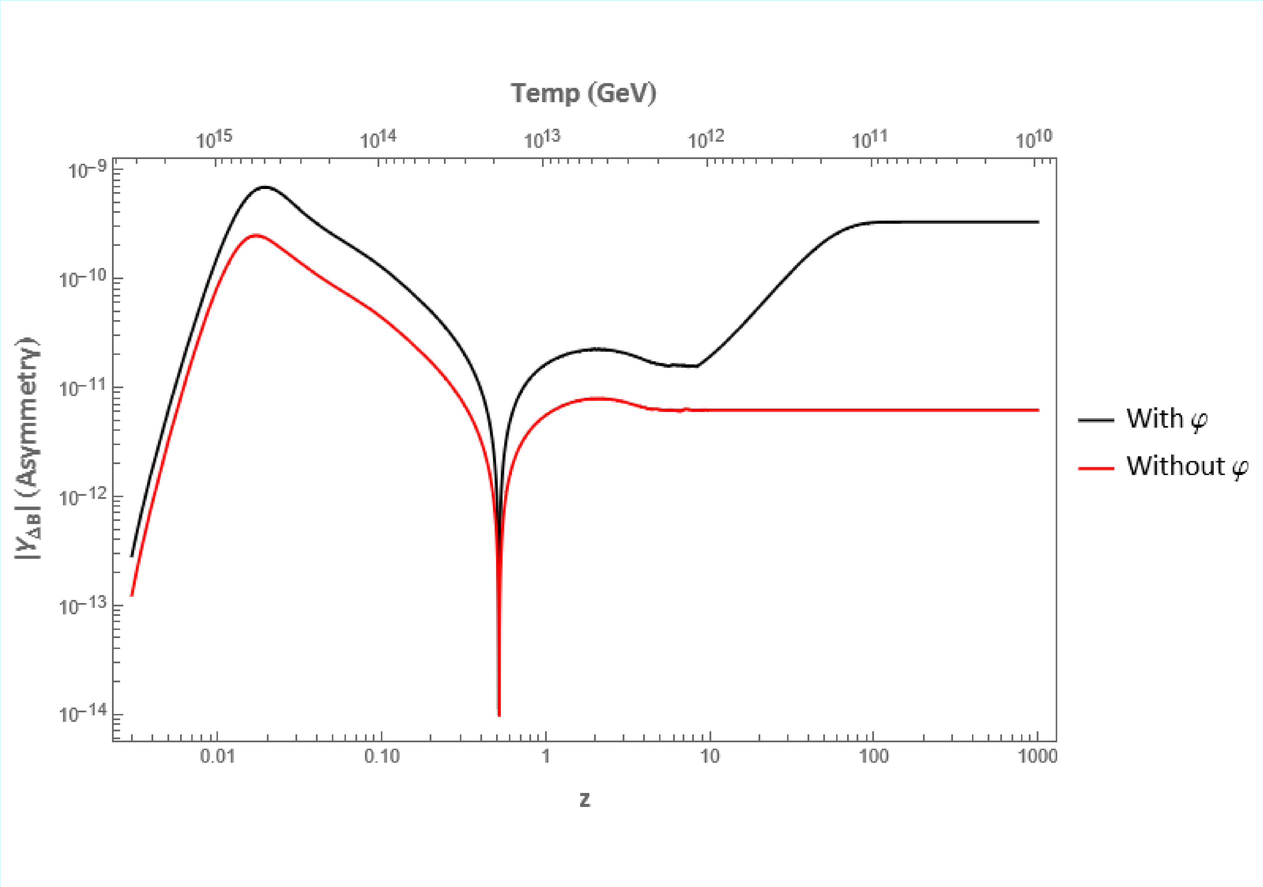
The Standard Model [3]



Results

We describe the particle decays in a system of DEs to track the creation and destruction of particles. This allows us to determine how much matter or antimatter there is at a given time, and study how different parameters affect the final asymmetry.

For some model parameters, including the decays from this new ϕ can give us a much greater asymmetry!



[1] RELEASE: NASA, ESA, CSA, STScI
[2] B. Shuve and C. Tamarit, "Phase Transitions and Baryogenesis From Decays," JHEP 10 (2017) 122, [1704.01979].
[3] Mermod, P., 2017, Right-handed neutrinos: the hunt is on!, http://arxiv.org/abs/1704.08635 (accessed July 2022).

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