







# The Key to New Physics

















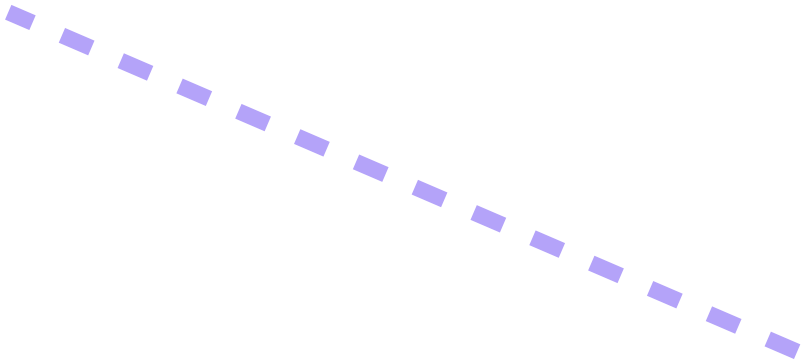


Muon

Pion



Proton





invisible neutrino

*[First photographed neutrino interaction recorded in a bubble chamber at Brookhaven National Laboratory, using neutrino beam produced by the AGS accelerator, energies of  $\sim 1\text{--}3$  GeV, November 13, 1970]*



# Neutrinos

## The Keys to New Physics

- **A Fundamental Particle:** Part of the Standard Model of Particle Physics.
  - **Unique Properties:** Electrically neutral, non-zero mass, interacts only via the *weak force* and gravity.
- **The First Major Crack in the Standard Model:**
  - The minimal Standard Model predicted massless neutrinos.
  - Their mass is the first definitive proof of physics Beyond the Standard Model.
- **Production in Extreme Environments:**
  - The Sun's core, supernovae, **Particle Accelerators**

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Invisible Neutrino

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# Large Hadron Collider

## A High-Energy Neutrino Factory

- **An Unexplored Source:** The LHC provides the highest-energy neutrinos ever produced in a laboratory, opening a new window into particle physics.
- **The Ring:** Protons travel around a **27-Km ring (LHC)**, circling it over **11,000 times every second** before they are guided into collision
- **Detection:** p-p collisions at  $\sqrt{s} = 13 \text{ TeV}$  (13.000x higher than AGS) inside detectors like ATLAS
- **Forward secondary particles:** These collisions create a massive spray of secondary **hadrons** ( $\pi$  ,  $K$ )

