

Dodging Neutrino-Mass Tension with Decays

A disagreement over neutrino-mass estimates might be resolved by assuming that neutrinos decay into hypothetical massless particles.

By **Michael Schirber**

Neutrinos have a bit of a weight problem, as various observational limits on their masses appear to conflict. This tension could be relaxed if neutrinos can decay, a new theoretical model shows [1]. Evidence of such decays might be detectable in future galaxy surveys.

Neutrinos come in three flavors (electron, muon, and tau), all of which were originally thought to be massless. But flavor oscillations—first observed in the 1990s—imply that they have mass (see **Focus: Nobel Prize—Neutrinos Oscillate**). Oscillation experiments place a lower limit on the total mass of the three types of neutrinos at around $0.06 \text{ eV}/c^2$, which is about 10 million times smaller than that of an electron.

Despite that small mass, neutrinos are big players in cosmology—the neutrino mass affects theoretical predictions of how and when galaxies formed. Recent galaxy-distribution measurements from the Dark Energy Spectroscopic Instrument (DESI) have produced an upper bound on the total neutrino

mass of $0.06 \text{ eV}/c^2$. Because this value coincides with the lower bound inferred from oscillation experiments, the two results are in tension, leaving little room for the neutrino masses allowed by both measurements. Several hypotheses exist for relaxing this tension, such as a time-dependent dark energy, but these solutions lack a clear connection to fundamental physics, says Guillermo Franco Abellán from the University of Valencia in Spain. His solution is to assume that neutrinos decay—a prediction that arises in several models explaining the origin of neutrino masses.

Abellán considered different decay scenarios, one of which involves neutrinos decaying over 1-billion-year timescales into hypothetical massless particles. When plugged into a cosmological simulation, these decays raise the DESI bound to $0.23 \text{ eV}/c^2$, relaxing the tension. Upcoming surveys by the Vera C. Rubin Observatory in Chile and the Euclid satellite could potentially see a signature of these decays in galaxy evolution, Abellán says.

Michael Schirber is a Corresponding Editor for *Physics Magazine* based in Lyon, France.

REFERENCES

1. G. Franco Abellán, “Neutrino decays as a natural explanation of the neutrino mass tension,” *Phys. Rev. D* **113**, 123527 (2026).



Figure 1:
Credit: APS/Alan Stonebraker