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Complementary Probes of Neutrino Mass Ordering at Colliders

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The ordering of neutrino masses remains an open question in particle physics. While upcoming oscillation experiments aim to resolve this using low-energy probes, complementary approaches are needed to test neutrino mass generation more broadly. In this talk, I will show how high-energy collider experiments can provide such a probe within the minimal Type-I seesaw framework. Focusing on a scenario with two nearly degenerate heavy neutral leptons (HNLs), I will explain how the structure of light–heavy neutrino mixing is constrained by the observed neutrino masses, leading to flavor specific signatures for normal and inverted mass orderings. I will demonstrate that future high-luminosity Z-pole colliders, such as CEPC and FCC-ee, can probe these flavor patterns for very small mixing strengths and, in favorable cases, distinguish between the two orderings. This highlights collider searches for HNLs as a complementary tool to neutrino oscillation experiments in addressing the neutrino mass ordering problem.

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