PhD Open Days

HEAVY NEUTRINO-ANTINEUTRINO OSCILLATIONS

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From the Missing Neutrinos to the Seesaw Mechanism

The **Standard Model** describes all known fundamental particles and their interactions

u	c	t	g	γ
d	s	b	Z	W
e	μ	τ	H	
ν_e	ν_μ	ν_τ		

Theory: No right-chiral neutrinos	Experiment: Flavour oscillations
⇓	⇓
Neutrinos are **massless**	Neutrinos are **massive**

Add **right-chiral** neutrinos

⇓

Sterile under the Standard Model's gauge group

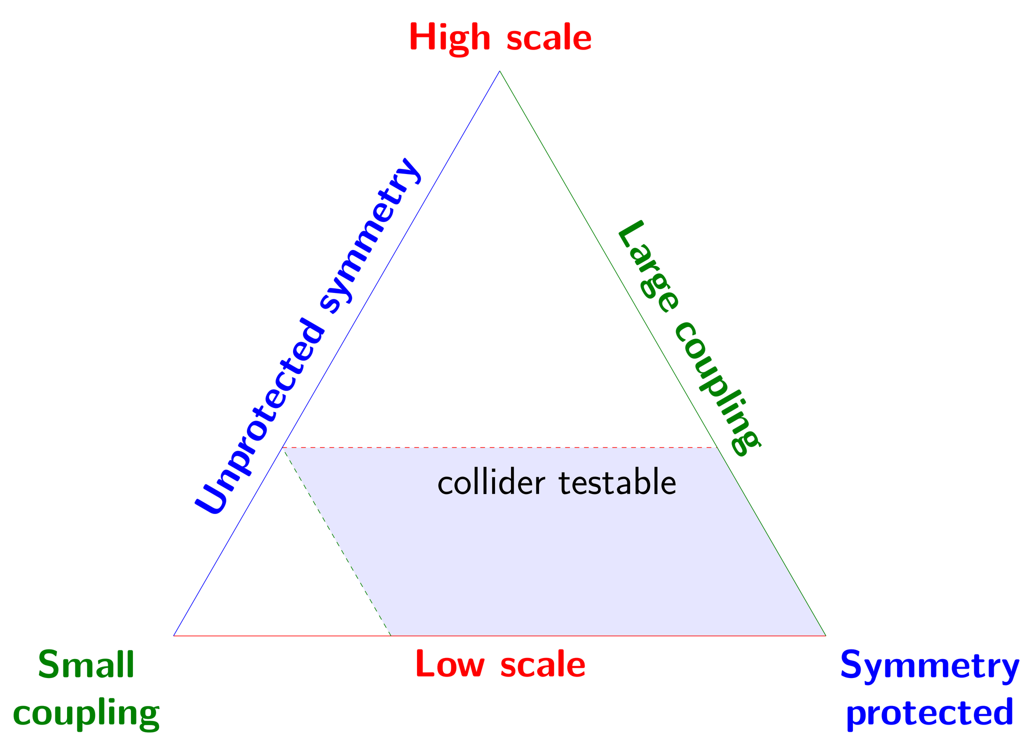
⇓	⇓
Dirac masses (M_D)	**Majorana masses** (M_M)
Left- and right-chiral fields	Right-chiral fields

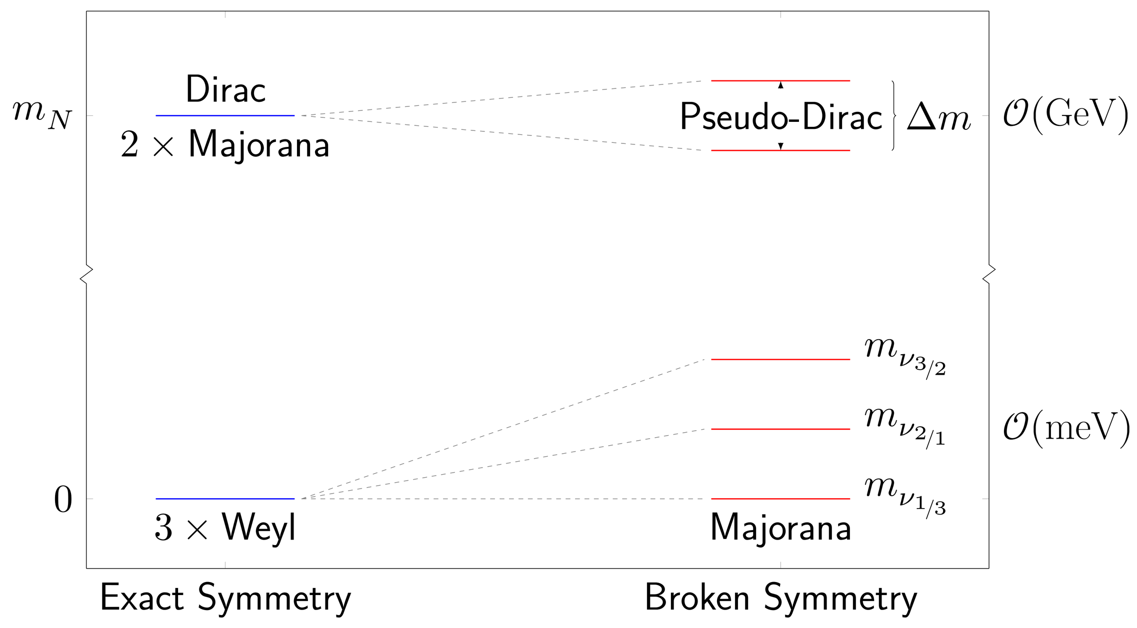
The **interplay** between the two masses gives rise to the **seesaw mechanism**

Light neutrinos ν with $M_\nu \simeq \frac{M_D \otimes M_D}{M_M}$ Heavy neutrinos N with $M_N \simeq M_M$

Symmetry Protected Seesaw Scenarios

Collider testable models require symmetry ⇒ **Mass splitting** between the heavy neutrinos

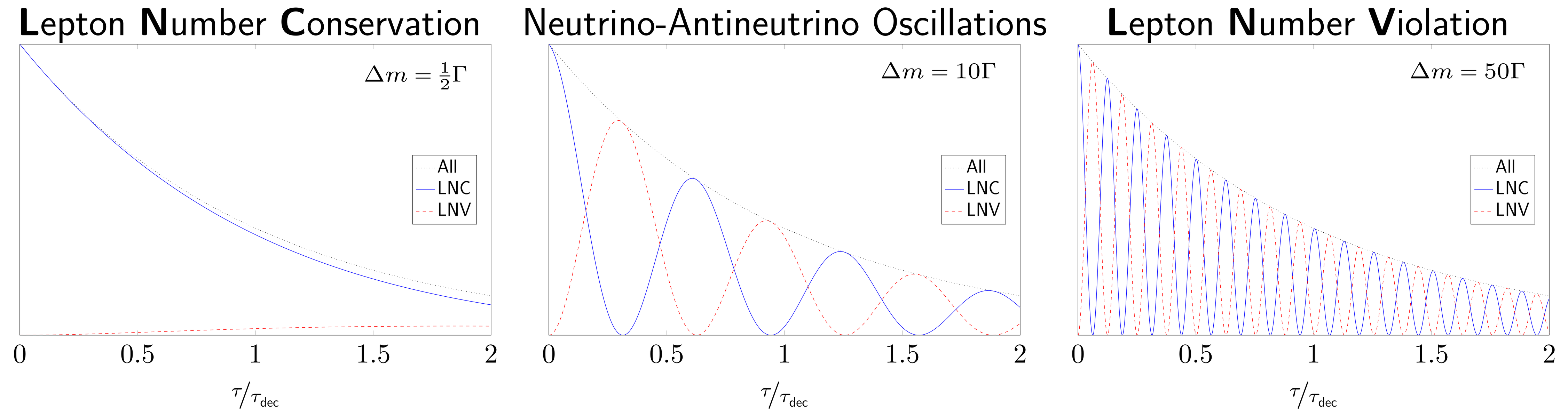




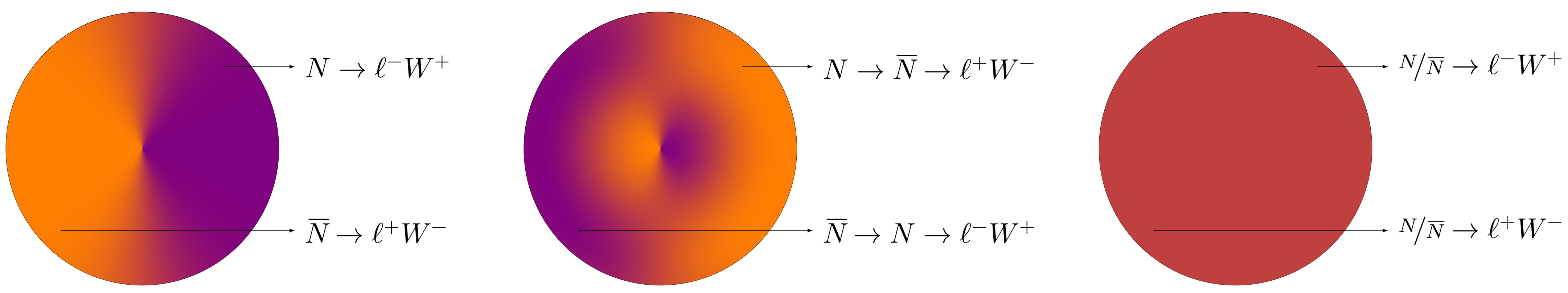
Heavy Neutrino-Antineutrino Oscillations

According to the interference induced by Δm, the heavy neutrinos are

Pure Dirac $(\Delta m \approx 0)$	**Pseudo-Dirac**	**Double Majorana** $(\Delta m \sim m_N)$
⇓	⇓	⇓
Lepton **N**umber **C**onservation	Neutrino-Antineutrino Oscillations	Lepton **N**umber **V**iolation



Asymmetries in the production, result in oscillatory signatures



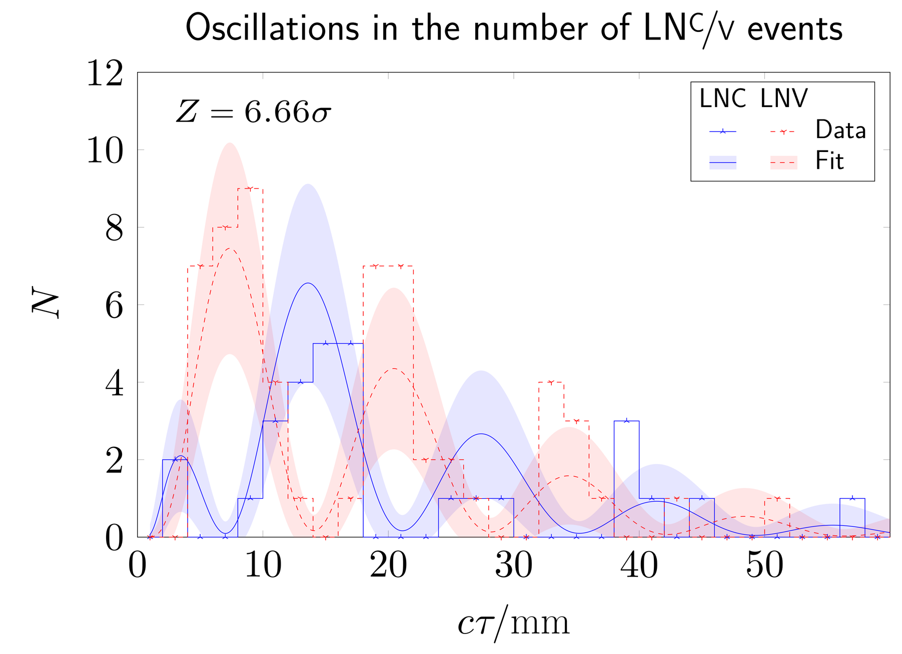
Proton Colliders

Detectable final state leptons

⇓

Measure LNC/V directly

Oscillations in the number of LNC/V events



Resolvability limited by number of events

Lepton Colliders

Invisible final state leptons

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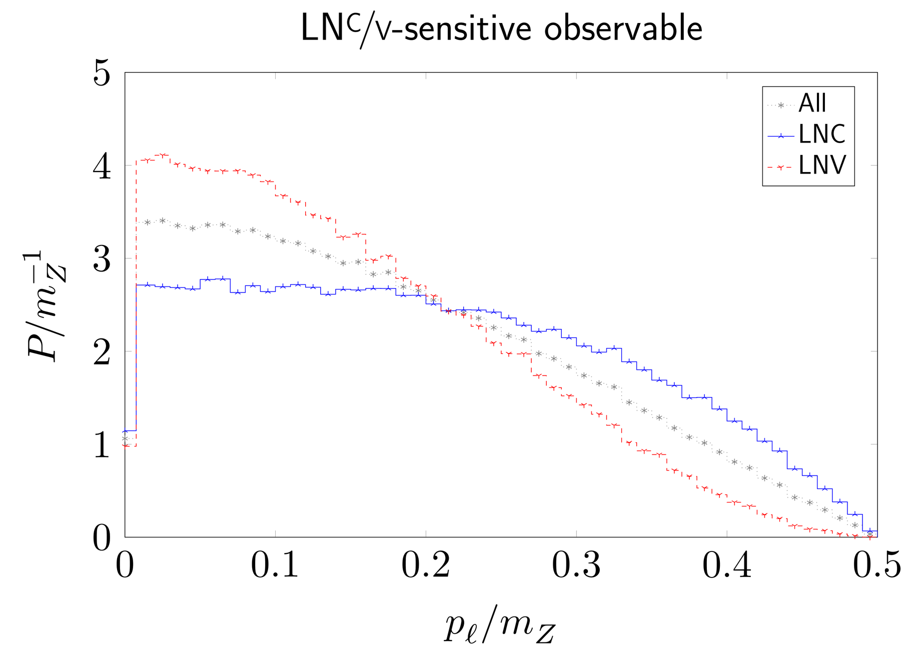
Cannot measure LNC/V directly

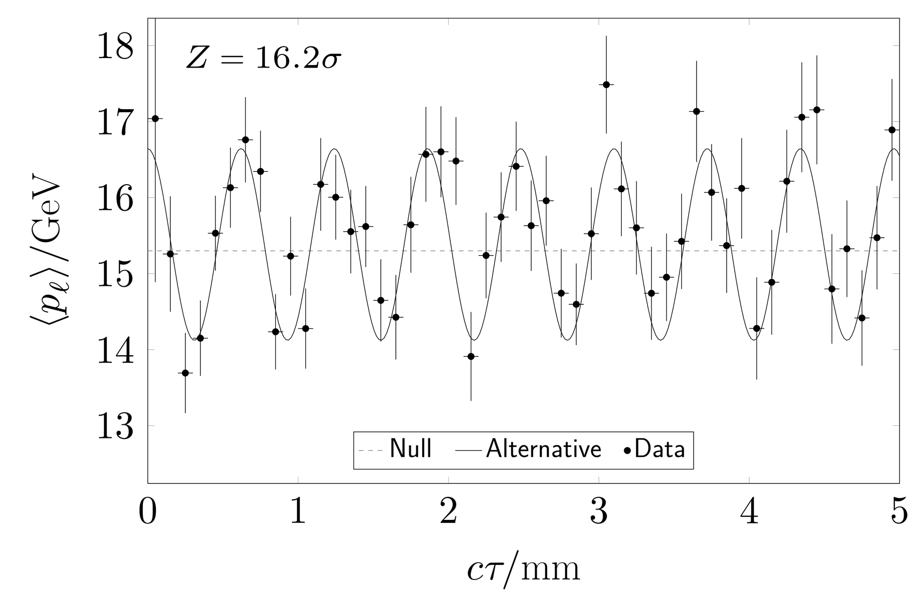
⇓

Assess from final state observables

LNC/V-sensitive observable

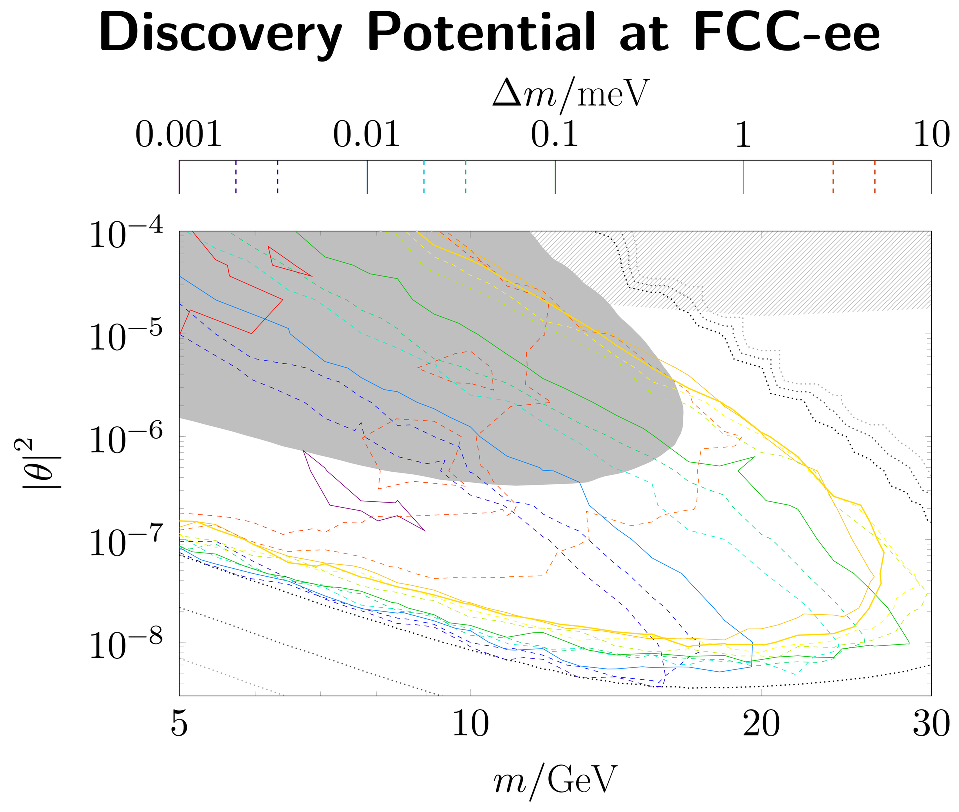


Oscillations in observable



Resolvability limited by analysis power

Discovery Potential at FCC-ee



While the existence of heavy neutrinos has been excluded within the grey region, the FCC-ee shows great potential for discovering of heavy neutrino-antineutrino oscillations inside the coloured boundaries

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Advanced Studies Diploma in Physics