

PHD PROGRAMME IN PHYSICS, ASTROPHYSICS, AND APPLIED PHYSICS
UNIVERSITÀ DEGLI STUDI DI MILANO
PhD Cycle 41 (2025-2026)

All lectures will be given in English.

Course title	Neutrino physics
Teacher in charge of the course	Andreazza Attilio
List of the teachers of the course	Vissani Francesco; INFN, Laboratori Nazionali del Gran Sasso; vissani@lngs.infn.it NB: lngs is the acronym of Laboratori Nazionali del Gran Sasso (The first letter is a lowercase consonant ell, not a capital vowel I)
Training objectives	Introduction to the methods and most important issues in neutrino physics; general overview of its status and lines of progress
Prerequisites	The course has an interdisciplinary nature, typical of neutrino physics, and touches on particle physics (the Standard Model and its extension), nuclear physics, astrophysics, and cosmology, etc. However, given its introductory nature, it requires (and only preferably) a general knowledge of the Standard Model of particle physics, classical electrodynamics, and the foundations of statistics. It is also structured to accommodate interested students, who are invited to contact the instructor at vissani@lngs.infn.it.
Detailed course program	History of neutrinos and of weak interactions. Methods to probe neutrino masses. Neutrino oscillation. Neutrino conversion in vacuum and in matter. Experimental evidence of neutrino mass and properties. Dirac and Majorana mass. Neutrino-less double beta decay. Neutrino in cosmology. Extensions of the standard model: Right-handed neutrinos, sterile neutrinos, extended matter and extended Higgs fields; Seesaw; Grand unified groups; Connections with other phenomena: $\mu \rightarrow e \gamma$, proton decay, baryogenesis. Overview of current research topics in neutrino astronomy: sun, supernovae, geoneutrinos, high energy neutrinos.
Examination modalities	The examination consists of the discussion of an essay on a research topic in neutrino physics, agreed with the PhD student.
Preliminary schedule	September 22-26, 2026 Course enrolment deadline: December 27, 2025.