

NEUTRINOS AND NUCLEAR ASTROPHYSICS

Teachers: C. Biggio(Univ. Genova), S. Zavatarelli (INFN Genova)

- **Neutrino masses and mixing in the Standard Model and Beyond** (C. Biggio)
Flavour physics in the Standard Model: charged fermions masses and mixing in the quark sector. Flavour mixing in the leptonic sector and neutrino masses. Dirac mass vs Majorana mass. The seesaw mechanism. Different seesaw models and connections with Effective Field Theories.
- **Selected topics in neutrino physics** (C. Biggio)
Neutrino oscillations in matter, neutrino non-standard interactions, neutrinoless double beta decay, neutrino mass bounds from cosmology, sterile neutrinos, ...
- **Experimental studies of neutrino properties:** (S. Zavatarelli)
 - The first observations, direct mass measurements.
 - Solar and atmospheric neutrinos and evidence for flavor oscillations.
 - Man-made neutrinos: short and long baseline experiments.
 - Parameters of the oscillation matrix, direct or inverse mass hierarchy problem. Sterile neutrinos
- What will we learn in the coming years? Tests on the possible existence of sterile neutrinos, on the mass hierarchy and the CP phase. Neutrinos as messengers from the most distant Universe or from the Earth
- **Nuclear Astrophysics:** (S. Zavatarelli)
 - Nuclear reactions in stars: energy production;
 - Nuclear reactions in stars: from primordial nucleosynthesis to the synthesis of the heavier elements (Big Bang Nucleosynthesis, H, He, C, Ne, O, Si burning, explosive burning)
 - What nuclear reactions can we study in the laboratory? Direct and indirect experimental methodsThe LUNA experiment at the Gran Sasso Laboratory and the Luna-MV and LUNANOVA projects.