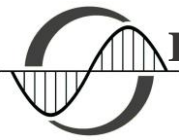




UNIVERSITÀ  
degli STUDI  
di CATANIA



DIPARTIMENTO DI FISICA E ASTRONOMIA  
“ETTORE MAJORANA”

DOTTORATO DI RICERCA IN FISICA  
ANNO ACCADEMICO 2019/2020

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## SEARCH OF NEW PHYSICS BEYOND THE STANDARD MODEL IN DOUBLE BETA DECAY

2 CFU

### Teaching staff

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**Reception hours:** Friday 15:00-17:00

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### Program of the course:

Dirac equations and neutral fermions. Majorana fermions and neutrinos. Overview of early experimental evidences of neutrinos and neutrino properties. The search for  $\beta\beta$ -decay. Early geochemical experiments (the M.G.Inghram and J.H.Reynolds experiment). The  $2\nu\beta\beta$ -decay in the laboratory (the Elliott, Hahn and Moe experiment). Overview of present search of  $2\nu\beta\beta$ - and  $0\nu\beta\beta$ -decays. The Italian experiments at LNGS underground laboratory. The case of the GERDA experiment. Nuclear structure aspects of the  $\beta\beta$ -decays. The problem of Nuclear Matrix Elements. Surrogate nuclear reactions to study relevant nuclear response to isospin operators. Single Charge Exchange reactions and connection to single  $\beta$ -decay

Fermi and Gamow-Teller nuclear transitions. The Double Charge Exchange reactions in connection with  $\beta\beta$ -decays. The NUMEN project at the INFN-LNS laboratory.

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## **Bibliography:**

E. Segrè, "Nuclei e Particelle", Edited by Zanichelli.

F. Avignone III, et al. Rev. Mod. Phys. **80**, 481 (2009)

S. Elliott, et al., Rev. Mod. Phys. **87**, 187 (2015)

F. Cappuzzello et al. Eur. Phys. J. A **54**: 72 (2018)

H. Lenske, F. Cappuzzello, M. Cavallaro and M. Colonna, Prog. in Part. and Nucl. Phys. (2019) in press, <https://doi.org/10.1016/j.pnpnp.2019.103716>

H. Ejiri, J. Suhonen, K. Zuber, Phys. Rep. **797**, 1–102 (2019)