

Research Report

ICRR Inter-University Research Program 2021

Research Subject:

Constraining systematics at T2K and SuperKamiokande oscillation analyses using neutrino-nucleus interaction models

Principal Investigator:

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Participating Researchers:

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- Maria Benedetta Barbaro (University of Turin and INFN)
- T. William Donnelly (Massachusetts Institute of Technology (MIT))
- Kimihiro Okumura (University of Tokyo, ICRR)
- Yoshinari Hayato (University of Tokyo, ICRR)
- Guillermo D. Megias (University of Tokyo, ICRR & University of Seville)

Summary of Research Result:

- Due to the Covid-19 pandemic, the research could not be conducted as initially planned.

- We will also continue this project on FY2022 under the ICRR Inter-University Research Program 2022.

In spite of the current situation and travel limitations, the outcomes of these projects have been presented at several workshops and conferences as well as in some proceedings:

- *T2K Neutrino Interaction Working Group Workshop 2021. Oral contribution (online). "MODELLING SEMI-INCLUSIVE NEUTRINO-NUCLEUS SCATTERING". J. M. Franco-Patiño*
- *TNPI2021-XVIII Conference on Theoretical Nuclear Physics in Italy. Oral contribution (online). "Semi-inclusive charged-current neutrino-nucleus reactions: Analysis of Data in the relativistic Plane-Wave Impulse Approximation". J.M. Franco Patiño*
- *T2K Cross Section General Workshop 2021. Oral contribution (online). "Neutrino-nucleus cross sections: Theoretical nuclear models and implementation in MC event generators" G. D. Megias*

- *Proceeding: Semi-inclusive charged-current neutrino-nucleus reactions: analysis of data in the relativistic plane-wave impulse approximation, J.M. Franco-Patino et al., PoS(NuFact2021) 402, 227 (2022). DOI: 10.22323/1.402.0227*
- *Proceeding: Inelastic neutrino-nucleus scattering in the superscaling model. J.Gonzalez-Rosa, G. D. Megias, J.A. Caballero and G.D. Megias, PoS(NuFact2021) 402, 228 (2022). DOI: 10.22323/1.402.0228*

The list of publications related to this project in FY2021 is shown in a separate document and includes important outcomes published in high impact factor journals (Nature, Physical Review D, Physical Review C, etc.)

Work is in progress and has been carried out with Prof. Hayato-san (ICRR) on a joint analysis of low-energy nuclear effects at T2K, Ninja and SK kinematics in comparison with SuSAv2-MEC and RMF models. Also, in collaboration with Hayato-san, S. Dolan (CERN) and other T2K and SK researchers, a first implementation of the inclusive and semi-inclusive RMF-1p1h models in NEUT is expected in the next months. Some successful comparisons of the RMF models (using different choices for the nuclear potentials) with T2K semi-inclusive and TKI measurements has been recently performed and a manuscript is now in preparation. All this will allow the reweight of several parameters for the oscillation analysis, the study of nuclear-medium effects, and a comparison between nuclear optical potentials and cascade models in generators, among other issues. Moreover, we have also started a collaboration with Prof. Sato-san (Osaka University) and Prof. Hayato-san to implement the DCC model from the Osaka group, which describes nucleonic resonances, in the SuSAv2 framework and to compare this implementation with the one being developed in NEUT. The outcomes of these research lines will be published in coming months.

With regard to the ICRR Research Program, the University of Seville group (J. A. Caballero, G. D. Megias and others) has obtained a 3-year R&D project of the Spanish Ministry of Science in which Prof. Hayato-san (ICRR) has been included as collaborator. The University of Seville consider this collaboration a research line of strategic interest and has recently approved two special allocations, in 2021 and 2022, to support the participation of their researchers in the T2K Collaboration, which have allowed the University of Seville to officially join T2K as a member institution.

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