NuInt12 : Eighth International Workshop on Neutrino-Nucleus Interactions in the Few-GeV Region

Monday 22 October 2012 - Saturday 27 October 2012

Book of Abstracts

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2p2h effects on the weak pion production cross section

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The one pion production process νA →A'lπN results to be an important background to the quasielactic νA →A'lN process used as signal in neutrino oscillation experiments, at the moment of constrain fake events. When only 1p1h final states are considered, the calculated cross section is rough 50% below the experimental data. In this contribution we analyze the effect of adding 2p2h final states.

Summary:

The νA →A'lπN cross section is calculated including in the elementary amplitude the Δ(1232 MeV) resonance and nucleon pole, cross and meson exchange nonresonant contributions. Nuclear effects are introduced in the Relativistic Hartree Approximation of QHDI, while pion final state interactions are accounted using the eikonal approach. Both, 1p1h and 2p2h configurations in the final state are considered.

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A-dependence of weak nuclear structure functions

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We shall present the results for the ratio of weak nuclear structure functions $\frac{F_2^A}{F_2^{proton}}$ and $\frac{F_3^A}{F_3^{proton}}$, where A is the different nuclear targets like ${}^2_1D$, CH, H_2O, ${}^{56}Fe$ and ${}^{208}Pb$ which are being used in the ongoing MinerνA experiment at Fermilab.
We have studied these nuclear structure functions
using relativistic nuclear spectral function which incorporate Fermi motion,
nuclear binding, and nucleon correlations. We have also included the pion and rho meson cloud contributions calculated
from a microscopic model for meson-nucleus self-energies. Shadowing and anti-shadowing effects have also been taken into account.
The deuteron structure functions have been calculated using
the same formulas as used for the weak nuclear structure functions, but performing the convolution with the deuteron wave function squared instead
of the spectral function. For the numerical calculations,
parton distribution functions for the nucleons have been taken from the parametrization of CTEQ Collaboration (CTEQ6.6) and we have performed the calculations at LO as well as at NLO.

The details of the model are given in Refs.

1. $\nu(\bar{\nu})$-208Pb deep inelastic scattering.
H. Haider, I. Ruiz Simo and M. Sajjad Athar
Phys. Rev. C 85 (2012) 055201.

2. Nuclear medium effects in $\nu(\bar{\nu})$-nucleus deep inelastic scattering.
H. Haider, I. Ruiz Simo, M. Sajjad Athar and M. J. Vicente Vacas
Phys. Rev. C 84 (2011) 054610

Summary:

We find that the nuclear medium effects like Fermi motion and binding energy corrections are the same in F_2 and F_3 nuclear structure functions which have been incorporated by using the spectral function obtained for nuclear matter and implemented in nuclei using the
local-density approximation. The differences in our results for F_2 and F_3 are due to the meson cloud contributions in the F_2
structure function whereas in the F_3 structure function they are absent. We have observed that the effect of meson clouds are large at low and intermediate x.
Furthermore, the shadowing effects in F_2 and F_3 structure functions are different.
Thus it is not appropriate to take the same correction factor for the F_2 and the F_3 nuclear structure functions.
The ratios of structure functions for different nuclei are not the same. This study may be useful in understanding the medium effects in the nuclear structure functions when the results from
$MinerνA$ would come up. Also this study is important in the incorporation of medium correction for the deep inelastic scattering presently considered in the Neutrino Monte Carlo event generators.

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Argoneut

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Beta-beam neutrinos and neutrino-nucleus interactions

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BoNuS latest results and updates

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CC and quasi-elastic introduction

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CCQE results from MINERnA

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CCQE, 2p2h excitations and nu energy reconstruction

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CHARGED CURRENT INCLUSIVE ANALYSES IN MINERvA

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MINERvA is a few-GeV neutrino scattering experiment that has been taking data in the NuMI beam line at Fermilab
since November 2009. The experiment will provide important inputs, both in support of neutrino oscillation searches and as a
pure weak probe of the nuclear medium. For this, MINERvA employs a fine-grained detector, with an eight ton active target region
composed of plastic scintillator and a suite of nuclear targets composed of helium, carbon, iron, lead and water placed upstream
of the active region.
In this poster, we present the current status of the charged current inclusive analysis in plastic scintillator as well as in the nuclear targets.

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CONNIE: Coherent Neutrino-Nucleus Interaction Experiment

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This is a new experiment intended to detect very low energy neutrinos coming from a nuclear reactor using CCDs (Charge Coupled Devices). These silicon detectors have very low energy threshold (˜7eV RMS) and very good spatial resolution (˜15um). Also, nowadays, it is possible to fabricate very thick CCDs (˜250um) increasing the detecting mass to 1g. All these characteristics make them a perfect candidate for detecting low energy neutrinos by coherent elastic neutrino-nucleus scattering. The experiment is going to be running at Angra Nuclear Power Plant in Brazil since 2013.

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CTEQ latest results and updates

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Charged Current Charged Pion and Charged Current Coherent Pion Production

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MINERvA (Main Injector Experiment for v-A) is a neutrino scattering experiment in the 1-10 GeV energy range in the NuMI high-intensity neutrino beam at FermiNational Accelerator Laboratory. MINERvA is measuring neutrino/antineutrino scattering off a variety of different nuclear materials (C, Fe, Pb, He, H2O). This poster will describe the analysis of Charged Current Charged Pion Production with emphasis on Coherent Pion Production and MINERvA's methods for differentiating signal from background.

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Charged Current Neutral Pion Production at MINERvA

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MINERvA is a neutrino experiment located at Fermilab. The main goal of the experiment is to study neutrino interactions using different targets and to measure differential neutrino cross sections. In this poster we concentrate on Charged Current Neutral Pion Production at the MINERvA experiment where the signal is defined as a muon, nucleon and neutral pion in the final state. The reconstructed neutral pion invariant mass and a comparison between data and Monte Carlo is shown.

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Charged Current Quasi-elastic Neutrino Analysis at MINERvA

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MINERvA (Main INjector Experiment for v-A) is a neutrino scattering experiment in the NuMI high-intensity neutrino beam at the Fermi National Accelerator Laboratory. MINERvA was designed to make precision measurements of low energy neutrino and antinuetrino cross sections on a variety of different materials (plastic scintillator, C, Fe, Pb, He and H2O). We present the current status of the charge current quasi-elastic scattering in plastic scintillator.

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Charged pion production results from MINERnA

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Charged pion production results from T2K

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Coherent and neutral pion production results from MINERnA

Authors: Aaron Higuera[1] ; Jose Luis Palomino Gallo[2]

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Coherent elastic neutrino scattering

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Comparison of MC and theoretical models to recent pion production data

Author: Philip Rodrigues[1]

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Comparison of MC codes (introduction)

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Comparisons of theoretical calculations with MiniBooNE pion production data

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Confronting theory and experiment Discussion

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Confronting theory and experiments / **56**

Conparison of MC codes (results)

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Consistent analysis of NC and CC neutrino scattering off carbon

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Deep and shallow inelastic scattering, quark hadron duality / **113**

DIS collider experiment results

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Happy hour with posters / **25**

Determination of $sin^2\theta_W$ using $\nu(\bar{\nu})$-Nucleus scattering

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We shall present the results of our study of non-isoscalarity corrections and nuclear medium effects in the extraction of $sin^2\theta_W$ using Paschos-Wolfenstein(PW) relation.
PW relation for an isoscalar nuclear target is defined as
\begin{eqnarray} \label{ratio_cross}
R_{PW}=\frac{\sigma(\nu_\mu~A \rightarrow \nu_\mu~X)~-~\sigma(\bar\nu_\mu~A \rightarrow \bar\nu_\mu~X)}{\sigma(\nu_\mu

\rightarrow \muˆ-˜X)˜-˜\sigma(\bar\nu_\mu˜A \rightarrow \muˆ+˜X)}=\frac{1}{2}˜-˜\sinˆ2 \theta_W
\end{eqnarray}
where $\sigma(\nu_\mu(\bar\nu_\mu)\ A \rightarrow \nu_\mu(\bar\nu_\mu)\ X)$ is the neutral current induced neutrino(antineutrino)
cross section, $\sigma(\nu_\mu(\bar\nu_\mu)\ A \rightarrow \mu^-(\mu^+)\ X)$ is the charged current induced neutrino(antineutrino) cross section
for a Z=N nuclear target A, and θ_W is the Weinberg angle. The above relation is valid for the total as well as differential cross sections.

The differential cross section is expressed in terms of nuclear structure functions. We have studied nuclear medium effects in the structure functions $F_2^A(x,Q^2)$ and $F_3^A(x,Q^2)$
by taking into account Fermi motion, nuclear binding, shadowing and antishadowing corrections and pion and rho meson cloud contribution.
Calculations have been performed in a local density approximations using relativistic nuclear spectral functions which include nucleon correlation.
These structure functions are calculated with target mass correction (TMC) and
CTEQ6.6 parton distribution functions (PDFs) at the Leading-Order (LO).

Summary:

NuTeV Collabn. has obtained $sin^2\theta_W$ using iron nuclear target and found $\sin^2\theta_W$ to be 0.2277 ± 0.0004, which is
3 standard deviations above the global fit of $sin^2\theta_W = 0.2227 \pm 0.0004$ and this is known as NuTeV anomaly. PW relation is valid for an isoscalar target while iron is a nonisoscalar target(N=30,Z=26), therefore, nonisoscalar corrections are required. Furthermore, nuclear dynamics may also play an important role in the case of neutrino nucleus scattering. Various corrections made by the NuTeV Collaboration has been discussed in literature, but still the reported deviation could not be accounted for.

We shall present the result for $sin^2\theta_W$ vs y, at some values of x for (anti)neutrino energy of 80 GeV, for an isoscalar target like carbon as well as nonisoscalar nuclear target like iron.
To see the effect of nonisoscalarity in iron target we use a modified PW relation:
\begin{eqnarray}
R_{PW}=\frac{1}{2}-\sinˆ{2}\theta_W + \delta Rˆ{NI}
\end{eqnarray}
where δR^{NI} is the correction factor due to nonisoscalarity. We find that there is a nonisoscalarity dependence on the determination of $sin^2\theta_W$ in the different regions of x and y.
We shall also present the results for $sin^2\theta_W$ vs y due to nuclear medium corrections. We shall discuss these results in detail in the workshop.

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Exclusive CCQE topologies in ArgoNeuT

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Final remarks

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Current and future experiments / **97**

Flux issues in Xsec - measurements

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Current and future experiments / **100**

Future Water experiments

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Deep and shallow inelastic scattering, quark hadron duality / **115**

GiBUU latest results and updates

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Very low neutrino interactions / **123**

Helium and lead observatory od supernovae neutrinos

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Electron scattering and meson exchange currents / **95**

Hints on nuclear effects from ArgoNeut,

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How much does MSW contributes to the reactor neutrino anomaly?

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Reactor neutrino experiments have observed a 5% deficit of electron anti-neutrino flux, when compared to the one predicted from nuclear physics as a product of the reactor's fission chains. One aspect that might have been overlooked in the literature is the contribution from extreme non-adiabatic effects coming from "decompression" when leaving the high density nuclear fuel rods. This work explores a analytic solution for this effect and presents its contribution to the reactor neutrino deficit.

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Impact of systematic uncertainties for the CP violation measurement in superbeam experiments,

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Electron scattering and meson exchange currents / **90**

Inelastic scattering in eA and the measurement of R

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MC implementation of MEC models

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Current and future experiments / **51**

MINERvA

Author: Guillermo Fiorentini[1]

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Deep and shallow inelastic scattering, quark hadron duality / **61**

MINERvA CC inclusive latest results

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MINERvA Neutrino Detector Calibration

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Current and future neutrino oscillation experiments depend on precise knowledge of neutrino-nucleus cross-sections. MINERvA is a neutrino scattering experiment at Fermilab, studying the interactions of muon neutrinos and antineutrinos with various nuclear targets. In order to make these measurements, it is vital that we carefully calibrate our detector. This poster explains the various in situ calibration techniques and cross-checks used by MINERvA to convert our electronics output to absolute energy deposition values.

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MINERvA hadron testbeam results

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We exposed a scaled-down version of the MINERvA detector to a beam of pions, kaons, and protons with momenta between 400 and 2000 MeV. These data are important for constraining the detector response to hadrons for our neutrino analyses in many respects: calorimetry, tracking, and PID response, and to constrain detector and Geant4 model uncertainties. For this, we built and operated a new tertiary beamline at the Fermilab Test Beam Facility in Summer 2010, and operated our detector with reconfigurable absorber in a tracker + ECal and ECal + HCal configurations. This poster will include the preliminary results from the analysis of calorimetric response in the
ECal + HCal configuration.

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MINOS/NOVA

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Measurement of neutrino induced NC-1\piˆ0 using the ND280 Tracker region

Author: Helen O'Keeffe[1]

Co-authors: Abraham Jacob [1] ; Alfons Weber [1] ; Antonin Vacheret [1] ; Giles Barr [1] ; Zachary Williamson [1]

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Single \piˆ0 production is one of the most important backgrounds in the \nu_\mu->\nu_e appearance measurement in T2K. Large uncertainties in this production rate make it difficult to predict. Therefore, measurement at the near detector (ND280) is required to constrain efficiently not only the background prediction at the far detector (Super-K) but also at the near detector to improve knowledge of the intrinsic \nu_e contamination within the beam. We present an analysis based on Monte Carlo simulation of neutral current (NC) single \piˆ0 production in the tracker region of ND280. NC-1\piˆ0 are selected using a specific two-gamma signature in the tracker. The first gamma from the pi0 decay is reconstructed by selecting an eˆ+/eˆ- pair starting in the Fine-Grained target Detector (FGD) and extending into the TPC, where the leptons can be identified and their momentum measured accurately. The second gamma is then selected in time in the calorimeter modules surrounding the tracker. We will present in detail selections cuts, efficiency and purity of the selection. A projection of the expected number of single pi0 candidates that are expected for 3 x 10E20 POT exposure (run I+II+III data) will be given.

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Measurement of the muon background at the Angra Neutrino laboratory

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The Angra II nuclear reactor, which has the 4 GW of thermal power, is located in the Angra dos Reis nuclear power plant in the State of Rio de Janeiro in Brazil. The large fission rate of 10^{20} per second produce about 5000 antineutrino interactions per day in a detector with only 1 m^3 at the distance of 30 m from the reactor core. As the flux of antineutrinos is proportional to the thermal power delivered by the reactor, by measuring the interaction rate of antineutrinos in the detector, we expect to be able to monitor the thermal power generated by the reactor in quasi-real time as well as the time evolution of the composition of the nuclear fuel. However, in order to observe antineutrinos coming from the reactor, we have to veto muons, one of the most important background components. Moreover, energetic muons can produce neutrons through the process of spallation that can mimic the neutrons generated by the neutrino interaction, increasing the background. In this work we have performed the measurement of the muon flux at sea level as these data are very
important to estimate the background level in the antineutrino detector.

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Measurements of pion production in eA with the CLAS detector

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Preliminary results on semi-inclusive charged pion production in eA
collisions at Ebeam=5 GeV/c2 are presented. These data are thought to be useful for tuning the hadronic production models used in extracting results from current and next-generation neutrino oscillation experiments.
The data were collected using the CLAS detector, which is a multipurpose,
large acceptance, magnetic spectrometer located in Hall B at the Thomas
Jefferson National Accelerator Facility. Distributions (integrated and differential) in W, Q2, pion momentum , and pion angle are shown for data produced using
Deuterium, carbon, and iron targets, including radiative corrections. Preliminary comparisons with data simulated using the GENIE generator
are made.

Summary:

Preliminary results on semi-inclusive charged pion production in eA on deuterium, carbon, and iron are shown and compared to the MC prediction of GENIE.

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MiniBooNE CC inclusive latest results

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CC and NC quasi-elastic scattering / **83**

MiniBooNE anti-nu quasi-elastic and neutral current elastic analysis

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MiniBoone/SciBoone

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Path forward and future prospects / **103**

NC and CC QE Scattering Discussion

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Pion production and other inelastic processes / **79**

Neutral pion results from T2K

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Very low neutrino interactions / **119**

Neutrino nucleosynthesis process in core-collapsed supernovae and neutrino oscillations

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Very low neutrino interactions / **122**

Neutrino oscillations and nucleosynthesis in supernovae amd GRB

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Neutrino-induced forward meson production reactions in nucleon resonance region

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Neutrino-nucleus reactions based on recent structure studies

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NuSTORM

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Nue cross-sections at the recently proposed nuSTORM experiment at Fermilab

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Opening

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Confronting theory and experiments / **127**

Overview talk on MC generators

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Phenomenological investigation of muon neutrino disappearance via CC interaction

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Experimental evidences showed that the time evolution of a particular neutrino flavor state can produce the transition to a different flavor state, a phenomena called neutrino oscillation. In this work we aim to study the oscillation model by doing a phenomenological analysis using the MINOS (Main Injector Neutrino Oscillation Search) published data. We first review the muon neutrino CC disappearance results from SK, K2K and MINOS, then we show some quality tests of the data extracted, including a comparison with the allowed region contour plots. We also show preliminary results of our analysis including 3-flavor oscillation model. This study could contribute to test different subdominant models, such as decay and decoherence, trying to improve the oscillation model.

Summary:

The study presented in this poster, which is a preliminary result of a Master dissertation, is not directly related to the physics discussed in NuINT, however the student is going to do his PhD on MINOS / MINOS+ experiment which justifies the importance of this workshop for his formation. Nevertheless, to obtain the necessary financial support for the present workshop the student is asked to present a poster.

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Photon emission in (anti)neutrino neutral current interactions with nucleons and nuclei

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Pion Production Discussion

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Very low neutrino interactions / **124**

Possibilities for direct nu-Argon cross section measurements in the low energy region

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Predictions for hadron polarizations and left-right asymetry in inclusive reactions involving photons

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A phenomenological model which has had some success in explaining polarization phenomena and left-right asymmetry in inclusive proton-proton scattering is considered for reactions involving photons and, hopefully, neutrinos.
In particular, the reactions (a) gamma + p -> H + X, (b) gamma + p(up) -> pi(+-) = X, and (c) p(up) + p -> gamma + X are considered where gamma = resolved photon, and hyperon H = Lambda0, Sigma+-, etc.
Predictions for hyperon polarization in (a) and the asymmetry (in (b) and (c)) provide further tests of this particular model.

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Present Status of the Neutrino Angra Project

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We will present the status of the Neutrino ANGRA project, aimed at developing an antineutrino detector for monitoring nuclear reactor activity. The Angra experiment will be deployed at the Brazilian nuclear power plant Angra II. A water Cherenkov detector of one ton target will be placed in a commercial container next to the reactor containment, about 30 m from the reactor core. The 4 GW thermal power of the Angra II reactor will provide a few thousand antineutrino inverse beta decay interactions per day. The detector will consist of three subsystems: 1) a muon veto placed in the outer most detector layer; 2) a neutron shield 30cm thick consisting of water; 3) a central detector consisting of an inner neutron shield (20cm) and a one ton central target both filled with a mixture of water and 0.2% of gadolinium.The main challenge of the experiment will be to overcome the very high cosmic ray induced background at sea level, consisting of muons, neutrons, gammas, protons, pions, positrons and electrons.We have simulated the signal and background events at the expected rates and used a Mixer program to organize them in temporal order, simulating in this way the real events in the Angra detector. We will present the analysis strategy to overcome the background and extract the number of antineutrino events.

Current and future experiments / **98**

Progress on Liquid argon technologies

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Electron scattering and meson exchange currents / **91**

QE scattering in eA and scaling from nuclei

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CC and NC quasi-elastic scattering / **88**

QE scattering in the Relativistic Green Function approach

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Happy hour with posters / **27**

RCNP E398 experiment C,O(p,p') to measure \gamma ray branching ratio (E>5MeV) from the giant resonances of carbon and oxy-

gen in relation to the \gamma ray production in C,O(\nu,\nu').

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Co-authors: Makoto Sakuda [1] ; Takaaki Mori [1] ; Takatomi Yano [1]

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We plan to measure the branching ratios of \gamma-ray emission (E_\gamma >5 MeV) from giant resonance of ˆ16O and ˆ12C, as the functions of excitation energy (E_x).

This measurement will provide the fundamental and important information not only for the \gamma-ray production from primary neutral-current neutrino-oxygen (-carbon) interactions but also for that from the secondary hadronic (neutron-oxygen and -carbon) interactions.
The understanding of the \gamma-ray production will introduce a new neutrino detection method to Supernova neutrino physics and Neutrino oscillation physics.

In the second stage, we would like to perform O,C(He,t) (T=1) experiment at 0 degrees to continue the systematic study of spin-isospin response through the measurement of the \gamma-ray production with oxygen and carbon nuclei.

Ref.
[1] T.Mori, M.Sakuda, A.Tamii, H.Toki, M.Nakahata, and K.Ueno, Study of \gamma-ray production
from neutral-current neutrino-Oxygen interaction and the detection of the neutrino
from Supernova explosion, AIP Conf. Proc.1269, 418-420, 2010.
[2] A.Ankowski,O.Benhar,T.Mori,R.Yamaguchi,and M.Sakuda,
Analysis of \gamma-ray production in neutral-current neutrino-oxygen quasi-elastic interactions above 200 MeV,
Phys.Rev.Lett.108,052505(2012).

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Recent experimental developments on coherent neutrino-nucleus interactions and related aspects

Author: Guillermo Fernandez Moroni[1]

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Very low neutrino interactions / 118

Recent experimental developments on coherent neutrino-nucleus interactions and related aspects

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Deep and shallow inelastic scattering, quark hadron duality / 116

SIS latest results and updates

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Path forward and future prospects / **106**

Shallow to DIS Discussion

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Happy hour with posters / **38**

Simulation of atmospheric temperature effects on cosmic ray muon flux

Authors: Ricardo Gomes[1] ; Stefano Tognini[1]

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The collision between a cosmic ray and an atmosphere nucleus produces a set of secondary particles, which will decay or interact with other atmosphere elements. This set of events produced by a primary particle is known as an extensive air shower (EAS) and is composed by a muonic, a hadronic and an electromagnetic component. The muonic flux, produced mainly by pion and kaon decays, has a dependency with the atmosphere's effective temperature: an increase in the temperature results in a lower density profile, which decreases the probability of pions and kaons to interact with the atmosphere and, consequentely, resulting in a major number of meson decays. Such correlation between the muon flux and the atmosphere's effective temperature was measured by a set of experiments such as AMANDA, Borexino, MACRO and MINOS. This phenomena can be investigated by simulating the final muon flux produced by two different parameterizations of the isothermal atmospheric model in CORSIKA, where each parameterization is described by a depth function which can be related to the muon flux in the same way that the muon flux is related to the temperature. This research checks the agreement among different high energy hadronic interaction models and the physical expected behavior of the atmosphere temperature effect by analysing a set of variables, such as the height of the primary interaction and the difference in the muon flux.

Summary:

The study presented in this poster, which is the result of a Master dissertation, is not directly related to the physics discussed in NuINT, however the student is going to do his PhD on MINOS / MINOS+ experiment which justifies the importance of this workshop for his formation. Nevertheless, to obtain the necessary financial support for the present workshop the student is asked to present a poster.

Pion production and other inelastic processes / **73**

Strange particle production from nucleons and nuclei

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Happy hour with posters / **32**

Study of Quasi-elastic interactions using the NOvA Near Detector Prototype

Author: Minerba Betancourt[1]

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NOvA is a 14 KTon long-baseline neutrino oscillation experiment currently being installed in the NUMI off-axis neutrino beam produced at Fermilab. A 222 Ton prototype NOvA detector (NDOS) was built and operated in the neutrino beam for over a year to understand the the response of the detector and its construction. Muon neutrino interaction data collected in this test are being analyzed to identify quasi-elastic charge-current interactions and measure the behavior of the Quasi-elastic muon neutrino cross section. The status of these quasi-elastic studies in NDOS will be shown.

Electron scattering and meson exchange currents / **92**

Superscaling in electro-nucleus scattering and its link to NC and CC QE neutrino-nucleus scattering

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Path forward and future prospects / **108**

Systematic Effects Discussion

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Systematis / **64**

Systematic in J-PARC/Hyper-K

Systematis / **65**

Systematic in LBNO (EU)

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Happy hour with posters / **42**

Systematic muon capture rates in PQRPA

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In this work we performed a systematic study of the inclusive muon capture rates for the nuclei 12C, 20Ne, 32Mg, 28Si, 40Ar, 52Cr, 54Cr, 56Fe, and 58Ni using the Projected Random Quase-particle Phase
Approximation (PQRPA) as nuclear model.
The theoretical results of the capture rates within the PQRPA have been compared with those obtained in other works using other models.
We reckon that the comparison between theory and data for
the inclusive muon capture is not a fully satisfactory test on the nuclear model that is used. The exclusive muon transitions are more robust for such a purpose.

Summary:

In this work we performed a systematic study of the inclusive muon capture rates for the nuclei 12C, 20Ne, 32Mg, 28Si, 40Ar, 52Cr, 54Cr, 56Fe, and 58Ni using the Projected Random Quase-particle Phase Approximation (PQRPA) as nuclear model.
The theoretical formalism for the muon capture rates shown in Ref. [1] is used with the delta interaction as the residual interaction in nuclear structure calculations.
The theoretical results of the capture rates within the PQRPA have been compared with those obtained in other works using the models of RPA+BCS [2] and RQRPA (relativistic QRPA) [3].
This leads to a modification of the axial coupling constant gA = 1 to gA = 1.135, resulting in one better agreement with the experimental data.
The influence of the CVC (Conserved Vector Current) in the muon capture rates for the presented nuclei was explicitly verified for the first time in the literature. This showed to be more significant in lighter nuclei, still more when the Coulomb term of muon-nucleus interaction is disrespected.
A final comparison was carried through inclusive capture and exclusive muon capture rates in 12C showing that the PQRPA did not present a good experimental agreement for the exclusive capture, only for the inclusive one. We reckon that the comparison between theory and data for the inclusive muon capture is not a fully satisfactory test on the nuclear model that is used. The exclusive muon transitions are more robust for such a purpose. Therefore, it would be necessary

more experimental data for the exclusive capture rates in other nuclei, beyond 12C, to test if a nuclear model is satisfactory [4].

References
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[3] N. Paar, T. Niksic, D. Vretenar, and P. Ring, Phys. Rev. C 69, 054303 (2004); N. Paar, D. Vretenar, T. Marketin and P. Ring, Phys. Rev. C 77, 024608 (2008).
[4] Danilo Sande Santos,Captura de mons usando PQRPA, thesis presented for the degree of Master of Physics Science, unpublished, Universidade Estadual de Santa Cruz, February 2012, Bahia, Brazil.

Systematis / **67**

Systematics at a Neutrino Factory

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Current and future experiments / **53**

T2K

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Deep and shallow inelastic scattering, quark hadron duality / **62**

T2K CC inclusive latest results

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Path forward and future prospects / **110**

The Path Forward, A Theorist's Perspective

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Path forward and future prospects / **109**

The Path Forward, An Experimentalist's Perspective

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CC and NC quasi-elastic scattering / **85**

The T2K CCQE selection and prospects for CC, QE, NC cross section measurements

Author: Daniel Ruterbories[1]

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Happy hour with posters / **30**

Toward Construction of the Unified Lepton-Nucleus Interaction Model from a Few Hundred MeV to GeV Region

Author: Satoshi Nakamura[1]

Co-authors: Hiroyuki Kamano [2] ; Koichi Saito [3] ; Makoto Sakuda [4] ; Masanori Hirai [3] ; Shunzo Kumano [5] ; Toru Sato [6] ; Yoshinari Hayato [7]

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An accurate understanding of the neutrino nucleus reactions is of great importance owing to the increasing precision of the neutrino oscillation experiments. The purpose of our study is to develop a reaction model for the lepton nucleus reaction from a few hundred MeV to a few GeV. We report on our analysis of the lepton nucleus reaction with the updated resonance model and the nuclear PDF in the DIS region.

Electron scattering and meson exchange currents / **94**

Two body electroweak currents and inclusive electron and neutrino scattering

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Happy hour with posters / **31**

Understanding the NuMI Flux for MINERvA

Author: Deborah Harris[1]

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The Neutrinos at the Main Injector (NuMI) beamline delivers intense neutrino and anti-neutrino beams in an energy range of 2-20 GeV. Understanding these fluxes is crucial for measuring absolute cross sections in MINERvA. Three techniques for constraining these fluxes are being considered in MINERvA: in situ neutrino event rate measurements, external hadron production data and in situ muon flux measurements. This poster will present these three strategies and the status of each one.

Path forward and future prospects / **107**

Very Low Energy Neutrino Discussion

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Happy hour with posters / **26**

Weak interaction induced η-production off the nucleon

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η production off the nucleon induced by (anti)neutrinos is studied at
the low and intermediate energies for the ongoing and future neutrino oscillation experiments.
The non-resonant terms are calculated using a microscopical model based on the SU(3) chiral Lagrangians.
We consider S_{11}(1535) and S_{11}(1650) resonances. The vector part of the N-S_{11} transition form factor has been obtained from the helicity amplitudes
using MAID(2007) data, dipole form is taken for the axial form factor and the PCAC relation
is used for the pseudoscalar form factor.

Summary:

Most of the neutrino experiments are using (anti)neutrino beam of a few GeV, to which neutrino oscillation parameters are sensitive.
In the few GeV energy region the contribution to the cross section comes from the quasielastic, inelastic as well as the deep inelastic processes.

Inelastic channel includes, one or multi pion production, kaon production, η production, associated production of particles and so on. It has been realised that the Monte Carlo generators which were being used for predicting the neutrino event rates should be revisited and updated by the new calculations.

We shall present the results for the differential and total cross sections for the (anti)neutrino induced η-production off the nucleon.

Pion production and other inelastic processes / **71**

Weak pion production off nuclei

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Happy hour with posters / **47**

νμ CCπ0 reaction in the Tracker of the ND280 detector in the T2K experiment

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Good knowledge of both inclusive and exclusive neutrino interaction cross sections is one of the key issues for a precise determination of the neutrino oscillation parameters in the T2K experiment.These studies are performed at the near detector (ND280). Its central tracker part equipped with a water target serves, among others, to study the νμ CCπ0 reaction. At the energies of the T2K neutrino beam its contribution to the total cross section is relatively large, so the reaction is a potential source of background for the quasi-elastic
νμ CC reaction. Two different production mechanisms contribute: single pion resonanse production and DIS. In addition, FSI has to be considered. Thus, the analysis of the νμ CCπ0 reaction aims also at a better tuning of the MC models used to describe neutrino interactions in T2K.

This poster describes the reconstruction and selection criteria leading to the determination of the exclusive cross section for the νμ CCπ0 reaction.