NuFact15 : XVII International Workshop on Neutrino Factories and Future Neutrino Facilities

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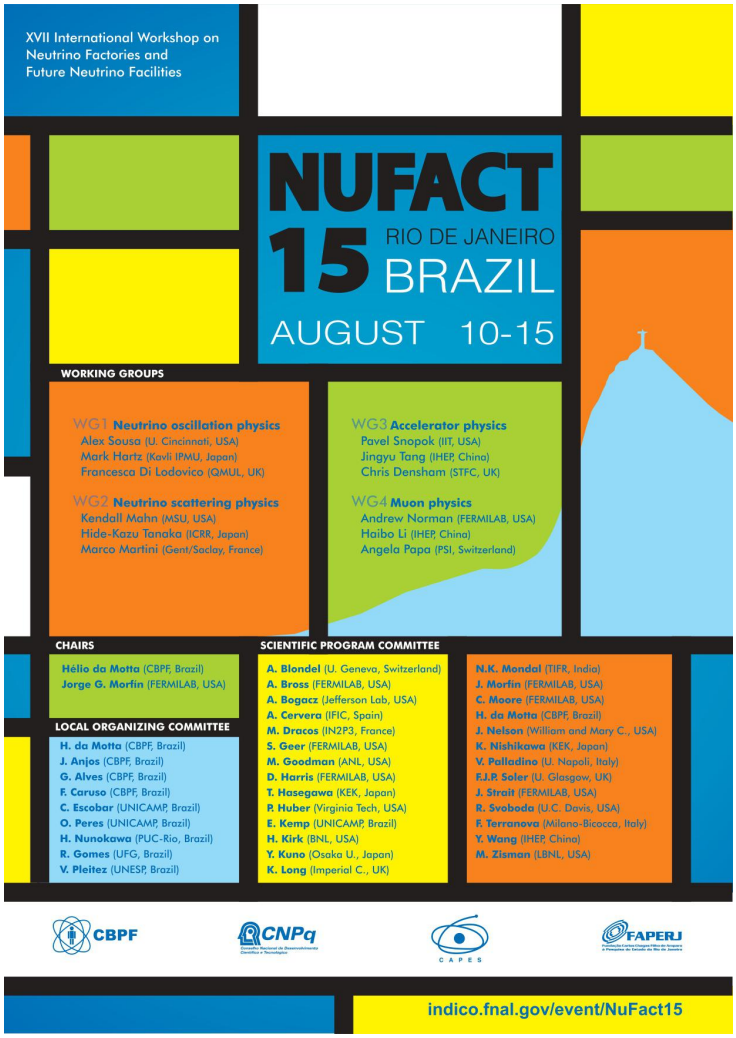
Centro Brasileiro de Pesquisas Físicas



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Study of the impact of using directionality to investigate geophysical models via the $\bar{\nu}_e + e^-$ elastic scattering interaction

Autores Jonathan Miller[1]; Roger Rodrigo Galindo Orjuela[1]

Co-autor Claudio Dib [1]

[1] *Universidad Tecnica Federico Santa Maria*

Autor Correspondente: roger.galindo.12@sansano.usm.cl

The ν_e from radioactive decays (238U, 232Th, 40K) inside the Earth, called geoneutrinos provide the best way to investigate the composition of the Earth. First experimental results and evidence of these neutrinos were observed by KamLAND and Borexino utilising the inverse beta decay process. Using this process the directionality of the neutrino can not be measured making the measurements sensitive only to the bulk composition. In our study utilising the Likelihood ratio test, we investigate $\bar{\nu} + e$ elastic scattering as a technique to measure the neutrino directionality and the geochemical structure of the Earth. Such a measurement could take place at the proposed ANDES laboratory to be completed in 2022 in Chile.

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The ANDES project

Autor Correspondente: claudio.dib@usm.cl

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Autor Correspondente: pietro.chimenti@ufabc.edu.br

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Autor Correspondente: colin.whyte@strath.ac.uk

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Autor Correspondente: popovic@fnal.gov

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Autor Correspondente: j.lagrange@imperial.ac.uk

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Autor Correspondente: tongjf@ihep.ac.cn

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Autor Correspondente: mengc@ihep.ac.cn

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Autor Correspondente: bross@fnal.gov

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Autor Correspondente: j.lagrange@imperial.ac.uk

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Autor Correspondente: bogacz@jlab.org

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Autor Correspondente: strait@fnal.gov

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Autor Correspondente: snopok@gmail.com

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Autor Correspondente: mapalmer@fnal.gov

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Autor Correspondente: dharris@fnal.gov

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Autor Correspondente: alessandro.bravar@unige.ch

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Autor Correspondente: cmoore@fnal.gov

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J-PARC high intensity neutrino beam

Autores Correspondentes: tetsuro.sekiguchi@kek.jp, takashi.kobayashi@kek.jp

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PRISM

Autor Correspondente: j.pasternak@imperial.ac.uk

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Mu2e

Autor Correspondente: vnagasl@fnal.gov

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Muon beam line for COMET

Autor Correspondente: kanouyou@kune2a.nucl.kyushu-u.ac.jp

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ESS-SB

Autor Correspondente: marcos.dracos@in2p3.fr

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Autor Correspondente: m.a.uchida@imperial.ac.uk

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Autor Correspondente: francesco.terranova@cern.ch

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Autor Correspondente: o.caretta@rl.ac.uk

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Autor Correspondente: kirkmcd@princeton.edu

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CAPTAIN+LAriat

Autor Correspondente: stjohn@fnal.gov

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Autor Correspondente: mayly@iastate.edu

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Impact of systematic uncertainties on Hyper-K

Autor Correspondente: mark.hartz@ipmu.jp

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Revisiting T2KK and T2KO physics potential and nu_mu - anti-nu_mu beam ratio

Autor Yoshitaro Takaesu[1]

Co-autores Kaoru Hagiwara [2]; Naotoshi Okamura [3]; Pyungwon Ko [4]

[1] *University of Tokyo*

[2] *KEK*
[3] *International University of Health and Welfare*
[4] *KIAS*

In this presentation, we revisit the sensitivity studies of a Tokai-to-Kamioka-and-Korea (T2KK) and Tokai-to-Kamioka-and-Oki (T2KO) proposals where a 100 kton detector is placed in Korea (L = 1000 km) and Oki island (L = 653 km) in Japan, respectively, in addition to the Super-Kamiokande (SK) for determination of the neutrino mass hierarchy and leptonic CP phase (δCP).

We systematically study the nu_mu and anti-nu_mu focusing beam ratio with dedicated estimation of backgrounds for the nu_e appearance and nu_mu disappearance signals, especially improving treatment of the neutral current (NC) pi0 backgrounds.

Using a nu_m : anti-nu_mu beam ratio between 3 : 2 and 2.5 : 2.5, the mass hierarchy determination with Delta_chi^2 = 10–30 by the T2KK and 3–20 by the T2KO experiment are expected for 5×10^21POT when sin(θ23)^2 = 0.5.

The CP phase is measured with the uncertainty of 20 deg. – 50 deg. by the T2KK and T2KO using the nu_mu : anti-nu_mu focusing beam ratio between 3.5 : 1.5 and 1.5 : 3.5.

These findings indicate that the T2KK and T2KO experiments can improve their sensitivity to both the mass hierarchy determination and leptonic CP phase measurement simultaneously, using nu_mu and anti-nu_mu focusing beams with 3 : 2 - 2.5 : 2.5 beam ratio.

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Autor Correspondente: andy.furmanski@gmail.com

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Autor Correspondente: anushree@cbpf.br

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Autor Correspondente: mateusc@fnal.gov

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Autor Correspondente: jpaley@fnal.gov

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Autor Correspondente: megias@us.es

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Autor Correspondente: carlotta.giusti@pv.infn.it

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Autor Correspondente: tom.vancuyck@ugent.be

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Autor Correspondente: arturo.samana@gmail.com

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CONNIE

Autor Correspondente: bonifazi@if.ufrj.br

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COHERENT

Autor Correspondente: scholz@uchicago.edu

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Deep inelastic scatering at MINERvA

Autor Correspondente: alessandro.bravar@unige.ch

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Autor Correspondente: gdodge@odu.edu

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T2K Near Detector Experience

Autor Correspondente: mahn@pa.msu.edu

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Compact formulas for neutrino oscillation probabilities in matter

Autor Hisakazu Minakata[1]

[1] *University of São Paulo*

Autor Correspondente: hisakazu.minakata@gmail.com

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Super-K

Autor Correspondente: kameda@suketto.icrr.u-tokyo.ac.jp

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INO

Autor Correspondente: sanjeev3kumar@gmail.com

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CHIPS

Autor Correspondente: joao.coelho@tufts.edu

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MINOS/MINOS+

Autor Correspondente: joao.coelho@tufts.edu

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OPERA

Autor Correspondente: chiara.sirignano@pd.infn.it

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SBL Reactor Experiments

Autor Correspondente: damartin83@gmail.com

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Autor Correspondente: ghiano@lngs.infn.it

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Autor Correspondente: eito@post.kek.jp

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Double CHOOZ

Autor Correspondente: guillaume.pronost@subatech.in2p3.fr

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Autor Correspondente: kyungkwangjoo@gmail.com

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Autor Correspondente: yumalyshkin@uc.cl

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Autor Correspondente: gorebigann@lbl.gov

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Autor Correspondente: alessandro.bravar@unige.ch

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Autor Correspondente: nicola.serra@cern.ch

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Autor Mu-Chun Chen[1]

[1] *University of California, Irvine*

Autor Correspondente: muchunc@uci.edu

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Autor Sushant Raut[1]

[1] *KTH Royal Institute of Technology, Stockholm*

Autor Correspondente: sushantkr@gmail.com

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DUNE Physics

Autor James Strait[1]

[1] *FNAL*

Autor Correspondente: strait@fnal.gov

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HK Physics

Autor Tom Feusels[1]

[1] *University of British Columbia*

Autor Correspondente: tfeusels@phas.ubc.ca

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MEG

Autor Correspondente: grigoriev@inp.nsk.su

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MEG Upgrades

Autor Correspondente: angela.papa@psi.ch

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COMET

Autor Correspondente: benjamin.krikler07@imperial.ac.uk

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DeeMee

Autor Correspondente: aokim@phys.sci.osaka-u.ac.jp

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Mu3e

Autor Correspondente: rgredig@physik.uzh.ch

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PIBETA/PEN

Autor Correspondente: pocanic@virginia.edu

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alcap

Autor Correspondente: benjamin.krikler07@imperial.ac.uk

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Mulan

Autor Correspondente: klynch@york.cuny.edu

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mucap

Autor Correspondente: kiburg@fnal.gov

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LHC LFV Atlas

Autor Correspondente: blocker@brandeis.edu

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LHC LFV CMS

Autor Correspondente: alexander.nehrkorn@cern.ch

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Belle LFV

Autor Correspondente: claudia.cecchi@pg.infn.it

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EDMs at PSI

Autor Correspondente: elisabeth.wursten@fys.kuleuven.be

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g-2 FNAL

Autor Correspondente: klynch@york.cuny.edu

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Theoretical Status of Neutrino Physics

Autor Mu-Chun Chen[1]

[1] *University of California, Irvine*

Autor Correspondente: muchunc@uci.edu

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Atmospheric Neutrino Status and Prospects

Autor João Pedro Athayde Marcondes de André[1]

[1] *Penn State University*

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Autor Correspondente: zukanov@if.usp.br

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Autor Correspondente: mayly@iastate.edu

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Autor Correspondente: ygkolomensky@lbl.gov

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Autor Correspondente: weiswang@gmail.com

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Future Accelerator-based Neutrino Physics in Asia

Autor Correspondente: takashi.kobayashi@kek.jp

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Autor Correspondente: k.long@imperial.ac.uk

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Experimental status of neutrino scattering

Autor Sara Bolognesi[1]

[1] *IRFU, CEA Saclay*

Autor Correspondente: sara.bolognesi@cern.ch

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Generator status

Autor Correspondente: hugh.gallagher@tufts.edu

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MAP/MICE

Autor Correspondente: mapalmer@fnal.gov

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MOMENT synergies with other projects

Autor Correspondente: tangjy@ihep.ac.cn

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Autor Correspondente: kiburg@fnal.gov

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CLFV and Future Facilities (Experimental Overview)

Autor Correspondente: yoshi.uchida@imperial.ac.uk

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Connections between g-2, EDMs, CLFV and LHC (Theory Overview)

Autor Correspondente: paride.paradisi@pd.infn.it

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MeV gauge boson and secret interaction of sterile neutrinos

Autor Zahra Tabrizi[1]

Co-autor Orlando Luis Goulart Peres [2]

[1] *IPM and UNICAMP*

[2] *UNICAMP*

Autor Correspondente: peres.orlando@gmail.com

Recent results from the neutrino experiments show evidence for light sterile neutrinos which do not have any SM interactions. These light sterile states are disfavored by cosmology due to the constraints from onthe Big Bang nucleosynthesis and the Large Scale Structure Formation. This tension could be solved if the sterile neutrino states could have interaction with a light gauge boson X with mass M_X (the secret interaction model) with a field strength at least 100-1000 times beggar than the Fermi constant. We show in this paper that such large interaction strength is disfavored from MINOS experiment and we can constrain the mass of the light gauge boson. A tiny region was found compatible with anomalous g-2 results, constrains from cosmology and MINOS data with M_X\sim 10-100 MeV and $g_x \sim 10^{-3} - 10^{-4}$.

Summary:

We work the implications of secret interactions of sterile neutrinos with light gauge boson in neutrino phenomenology and we have found a curious common region for constrains from cosmology, MINOS data and g-2 anomalous results.

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Phenomenology of single spin asymmetries in inclusive reactions involving photons and leptons

Autor Carlos Javier Solano Salinas[1]

[1] *UNI, Peru*

Autor Correspondente: jsolano@uni.edu.pe

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. In particular,the reactions (a) $\gamma + p \longrightarrow H + X$; (b) $\gamma + p(\uparrow) \longrightarrow \pi^{\pm} + X$ and (c) $p(\uparrow) + p \longrightarrow \gamma + X$ are considered
where γ = resolved photon and hyperon H = Λ, Σ, Ξ etc. Predictions for hyperon polarization in (a) and the asymmetry (in (b) and (c)) provide further tests of this particular model. Feasibility of observing (b) at the acce;erators the effect of the polarization of the sea in the proton in $p(\uparrow) + p \longrightarrow \pi^{\pm} + X$ is briefly discussed.
We also see the possibility of these effects in leptons (including neutrinos)

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Development of muon LINAC for the muon g-2/EDM experiment at J-PARC

Autor Masashi Otani[1]

Co-autores Naohito Saito [1]; Ryo Kitamura [2]; Tsutomu Mibe [1]; Yasuhiro Kondo [3]; Yoshihisa Iwashita [4]

[1] *KEK*

[2] *U. Tokyo*

[3] *JAEA*

[4] *Kyoto University*

Autor Correspondente: masashio@post.kek.jp

The muon anomalous magnetic moment (g-2) and electric dipole moment (EDM) are one of the effective paths to beyond Standard Model of elementary particle physics. The E34 experiment aims to measure g-2 with a precision of 0.1 ppm and search EDM with a sensitivity to 10-21 e*cm with high intensity proton driver at J-PARC and a newly developed novel technique of the ultra-cold muon beam. The ultra-cold muons, which are generated from surface muons by the thermal muonium production and laser ionization, are accelerated to 300 MeV/c by muon linear accelerator. The muon LINAC consists of RFQ and following three types of the RF cavities. The muon acceleration with RF cavity to this energy will be the first case in the world. This poster reports about status of the initial acceleration test with RFQ and the development of the RF cavities.

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Searching for QCD effects in the neutrino absorption by the Earth's interior at ultra high neutrino energies

Autor Diego Gratieri[1]

Co-autor Victor P.B. Gonçalves [2]

[1] *Universidade Federal Fluminense, UFF*

[2] *Universidade Federal de Pelotas*

Autor Correspondente: drgratieri@id.uff.br

We investigate how the uncertainties in neutrino-nucleon charged-current cross-section due the different QCD dynamic models would modify the neutrino absorption while they travel across the Earth. We compare the predictions from FJKPPP model, based in linear QCD evolution equation for the parton densities with BBMT model, which impose a Froissart unitarity of CC neutrino-nucleon cross-section at such UHE. We find that while the absorption function integrated with respect the angular direction is not sensitive to such effects, the probability of neutrino absorption by the Earth, for different neutrino incident directions, should be sensitive to the QCD dynamics at few percent at IceCube energies and reaches a factor greater than two at UHE limit.

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HTS Pion Capture Solenoid for Next Generation Muon Beam Line

Autor Ye Yang[1]

Co-autores Makoto Yoshida [2]; Toru Ogitsu [2]

[1] *Kyushu University*

[2] *KEK*

Autor Correspondente: kanouyou@kune2a.nucl.kyushu-u.ac.jp

High intensity muon beam is required for the muon electron transition experiment due to its low branching ratio. Thus, the pion capture superconducting solenoid has to be operated under the high radiation environment. Currently, LTS coil has small temperature margin and limit of magnetic field, whereas HTS coil has not only the large temperature margin but also good radiation resistance. We finished the conceptual design for compact pion capture solenoid with HTS.

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Baksan Experiment on Sterile Transitions

Autor Yury Malyshkin[1]

Co-autores Alexander Shikhin [2]; Anatoly Kalikhov [2]; Anatoly Matveev [2]; Bruce Cleveland [3]; David Sinclair [3]; Evgeny Veretenkin [2]; Hamish Robertson [4]; Ilya Mirmov [2]; Jeff Nico [5]; John Wilkerson [6]; Sergei Danshin [2]; Steven Elliott [7]; Tatiana Ibragimova [2]; Tatiana Knodel [2]; Valery Gorbachev [2]; Vladimir Gavrin [2]; Yulia Kozlova [2]

[1] *Institute for Nuclear Research RAS, Russia; Pontifical Catholic University of Chile*

[2] *Institute for Nuclear Research RAS, Russia*

[3] *SNO Lab, Canada*

[4] *U. of Washington*

[5] *National Institute of Standards and Technology, USA*

[6] *University of North Carolina*

[7] *Los Alamos National Laboratory*

Autor Correspondente: yumalyshkin@uc.cl

A neutrino deficit is observed in radio-chemical solar neutrino experiments GALLEX and SAGE in measurements with radioactive sources. This result can be explained by neutrino transitions to a hypothetical sterile state on a short baseline, corresponding to the squared mass difference of the order of 1 eV^2. A new underground experiment to search for this type of neutrino transition is planed to be carried out at the Baksan Neutrino Observatory on the Gallium-Germanium Neutrino Telescope, which has been used in the solar neutrino experiment SAGE. The idea is to observe the neutrino capture rate at two distances from the source. A Ga target is divided in two concentric zones in a way that the neutrino path lengths in each zone are equal. A statistically significant difference of the neutrino capture rate in these zones, as well as a considerable deficiency of the average rate in both zones in comparison with the expected rate, will indicate to the existence of the neutrino oscillation on a short baseline. The key features of this experiment are the intense compact neutrino source, which provides a high flux of monochromatic neutrinos, low backgrounds (including solar neutrinos), and a well established during decades technique of neutrino detection. The experiment allows to put constraints on squared mass difference and mixing angle corresponding to the oscillations to the hypothetical sterile neutrinos.

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Cosmological bounds of sterile neutrinos in a $SU(3)_C \otimes SU(3)_L \otimes SU(3)_R \otimes U(1)_N$ model as dark matter candidates

Autor Cesar Peixoto Ferreira[1]

Co-autores Marcelo Moraes Guzzo [2]; Pedro Cunha de Holanda [2]

[1] *Unicamp*

[2] *UNICAMP*

Autor Correspondente: cesarpferreira@gmail.com

We study sterile neutrinos in an extension of the standard model, based on the gauge group $SU(3)_C \otimes SU(3)_L \otimes SU(3)_R \otimes U(1)_N$, and use this model to illustrate how to apply cosmological limits to thermalized particles that decouple while relativistic. These neutrinos, N_{aL}, can be dark matter candidates, with a keV mass range arising rather naturally in this model. We analyse the cosmological limits imposed by N_{eff} and dark matter abundance on these neutrinos. Assuming that these neutrinos have roughly equal masses and are not CDM, we conclude that the N_{eff} experimental value can be satisfied in some cases and the abundance constraint implies that these neutrinos are hot dark matter. With this information, we give upper bounds on the Yukawa coupling between the sterile neutrinos and a scalar field, the possible values of the VEV of this scalar field and lower bounds to the mass of one gauge boson of the model, U_L. Also, these Hot Dark Matter sterile neutrinos should have an impact on the neutrino mass sum measured in cosmology, $\sum m_\nu < 0.23$ eV, and we verify that this bound is satisfied in the model.

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T2K CC1pi+CC coherent results (on and off axis)

Autor Correspondente: martti.nirkko@cern.ch

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NEUT model improvements, external data fit comparisons

Autor Correspondente: tfeusels@phas.ubc.ca

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CAPTAIN (BNB and the CAPTAIN/MINERvA physics programs)

Autor Correspondente: ahiguera@central.uh.edu

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Calibration and energy reconstruction at Daya Bay

Autor Yury Malyshkin[1]

[1] *Pontifical Catholic University of Chile*

Autor Correspondente: yumalyshkin@uc.cl

Daya Bay is an international experiment based in China. Its primary goal is the measurement of the neutrino mixing angle \theta_{13} with unprecedented precision. In addition, it can address other topics in neutrino physics including sterile-neutrino searches, and high-statistics measurements of reactor anti-neutrinos. In Daya Bay, electron anti-neutrinos from 6 reactor cores are detected via the inverse beta-decay reaction in 4 near and 4 far liquid scintillator detectors with identical performance. A key feature of most of the physics done in Daya Bay is the relative measurements of physical quantities among detectors as a function of energy which is reconstructed based on the amount of detected light in the photo-multiplier tubes. To ensure energy is measured correctly, periodic calibration of the detectors with a number of radioactive sources and natural radioactivity in the liquid scintillator are performed. All aspects of energy calibration in Daya Bay will be briefly presented in this poster.

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Neutrino Nucleon Cross Sections at High Energies

Autores Carlos Argüelles[1]; Mike Kroll[2]

[1] *University of Wisconsin-Madison, WIPAC*

[2] *Ruhr-Uni Bochum*

Autor Correspondente: mkroll@icecube.wisc.edu

We present a new calculation of the neutrino nucleon cross sections for charged and neutral currents using recent PDF fits that incorporate LHC data. We have performed a simple LO calculation as well as full NLO calculation, and further include corrections important at O(1GeV) energies such as lepton mass suppression for ν_τ and target mass corrections (TMC).

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CCQE-like events in MicroBooNE

Autor Andrew Furmanski[1]

[1] *University of Manchester*

Autor Correspondente: andy.furmanski@gmail.com

MicroBooNE is a 170 ton liquid argon TPC placed in the Booster Neutrino Beam at Fermilab. The detector is currently being commissioned and first neutrino beam data is expected towards the end of this year. Located in a beam with energies between 0.1 and 3GeV, MicroBooNE is able to make high statistics measurements of CCQE-like events. Recently, there have been indications experiments of correlated nucleon ejection from both QE-like neutrino scattering on argon, as well as electron scattering measurements. With bubble chamber-like image quality and calorimetric information, MicroBooNE will be able to make detailed measurements of the hadronic side of the interactions and investigate these nuclear effects. This poster will compare different generator predictions for MicroBooNE and investigate its potential to discriminate between models.

WG2: neutrino scattering physics / **275**

NuSTEC Update

Autor Correspondente: morfin@fnal.gov

WG2: neutrino scattering physics / **276**

WG2 Summary Preparation

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Parameter Limits for Neutrino Oscillation with Decoherence in KamLAND

Autor Guilherme Gomes[1]

Co-autores Marcelo Guzzo [2]; Pedro Holanda [2]; Roberto Oliveira [2]

[1] *Campinas State University - Unicamp*

[2] *Unicamp*

Autor Correspondente: gbalieirogomes@gmail.com

In the framework of quantum open systems we analyze data from KamLAND by using a model which considers neutrino oscillation in a three-family approximation with the inclusion of the decoherence effect. Using a χ^2 test we find new limits for the decoherence parameter which we call γ, considering the most recent data by KamLAND.

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The Neutrinos Angra experiment

Autor Stefan Wagner[1]

Co-autores Herman Lima [1]; Hélio da Motta [1]; Joao Anjos [2]; Otto Rocha [1]

[1] *CBPF*

[2] *CBPF - Centro Brasileiro de Pesquisas Físicas*

Autor Correspondente: swagner@cbpf.br

The *Neutrinos Angra* experiment aims to measure the antineutrino flux from the reactor cores of the Angra dos Reis nuclear power plant. The main objective is to determine the reactor power and the nuclear fuel composition from the detected antineutrinos. Since this method could find application as a tool for nuclear safeguards and non-proliferation, the detector is designed to be safe, compact and cost-effective, according to reccomendations of the IAEA.

Neutrinos Angra employs a water Cherenkov detector. Its central component is the 1 m³ Target volume for the detection of antineutrinos via the inverse beta decay. This volume is doped with Gadolinium to observe the resulting neutron and thus create a characteristic coincidence signal. In addition the Target is surrounded by three veto volumes to reject cosmic muon events and other backgrounds. This is all the more important since the detector was planned as an above-ground experiment and will have no overburden. Currently the detector is set up and taking data at the CBPF in Rio de Janeiro, where it is placed for extensive testing. The acquired data has already been used to validate and characterize the PMTs and readout electronics as well as to assess the Target volume. It also allows a study of the cosmic muon flux and the rate of further background, which helps to improve the Monte Carlo simulations of the experiment. After the tests are concluded the detector will be shipped to Angra later this year.

Summary:

The *Neutrinos Angra* experiment aims to measure the antineutrino flux from the reactor cores of the Angra dos Reis nuclear power plant. The main objective is to determine the reactor power and the nuclear fuel composition from the detected antineutrinos. Since this method could find application as a tool for nuclear safeguards and non-proliferation, the detector is designed to be safe, compact and cost-effective, according to reccomendations of the IAEA.

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The Multiple Muon Charge Ratio in the MINOS Far Detector

Autor C. M. Castromonte[1]

Co-autores M. C. Goodman [2]; P. Schreiner [2]; R. A. Gomes [1]

[1] *Universidade Federal de Goiás*

[2] *Argonne National Laboratory*

Atmospheric muons are produced when primary cosmic ray nuclei interact near the top of the atmosphere to produce hadronic showers which contain pions and kaons. These secondary mesons can either interact in further collisions in the atmosphere or decay to produce atmospheric muons. Since the majority of primary cosmic rays are protons, there is an excess of positively charged mesons in the showers, and consequently, the atmospheric muon charge ratio Rμ = Nμ+ / Nμ− , defined as the number of positive over negative muons, is larger than unity. Its expected that heavier elements become a more important component of cosmic ray primaries as the energy increases. This increasingly heavy composition would decrease the ratio of primary protons to neutrons, which in turn,

would decrease the muon charge ratio. With careful measurements of the muon charge ratio in the cosmic rays, models of the interactions of cosmic rays in the atmosphere can be improved.

The MINOS Far Detector is a magnetized planar steel-scintillator detector situated underground at depth of 2070 mwe. A small fraction of the cosmic ray muons observed in the MINOS FD contain multiple muons. Using the complete MINOS atmospheric data set we will present the first measurement of the multiple muon events charge ratio Rμ = Nμ+ / Nμ− . Systematic uncertainties on the charge ratio were minimized by utilizing data collected with both forward and reversed magnetic field running.

WG3:accelerator physics / **281**

Discussion

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Discussion

WG3:accelerator physics / **283**

Discussion

Plenary session 1 / **284**

WG1: plans and questions

Autor Correspondente: mark.hartz@ipmu.jp

Plenary session 1 / **285**

WG2:plans and questions

Autor Correspondente: mahn@pa.msu.edu

Plenary session 1 / **286**

WG3:plans and questions

Autor Correspondente: snopok@gmail.com

Plenary session 1 / **287**

WG4:plans and questions

Autor Correspondente: angela.papa@psi.ch

Plenary session 9 / **288**

WG1 summary

Autor Correspondente: alex.sousa@uc.edu

Plenary session 9 / **289**

WG2 summary

Autores Correspondentes: martini.marco@gmail.com, mahn@pa.msu.edu

Plenary session 9 / **290**

WG3 summary

Autor Correspondente: snopok@gmail.com

Plenary session 9 / **291**

WG4 summary

Autor Correspondente: anorman@fnal.gov

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Discussion

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Decoherence and Relaxation in Long Baseline Neutrino Experiments

Autor Roberto Oliveira[1]

Co-autor Marcelo M. Guzzo [1]

[1] *UNICAMP*

Autor Correspondente: roleneves@gmail.com

Focusing in the next generation of Long Baseline Neutrino Experiments, we study phenomenologically the neutrino oscillations behavior when decoherence and relaxation effects are taken into account in the propagation. In three neutrino oscillation approach, we can see that one particular oscillation channel may be enhanced due to decoherence and matter effect in the resonant region decoherence. We can explain this effect even in two neutrino approximation. We also show as it is possible to implement these effects in the analytical solution that use $\Delta m^2_{12} << \Delta m^2_{31}$ approximation. In the behavior study, we use numerical solution to investigate the three possible decoherence effects and two relaxation effects. We discuss the situation where all effects are combined and how these future experiments may limit all these effects.

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Discussion

Round table / **295**

Physics potential of non-conventional neutrino beams: Neutrino Factory +

Autor Correspondente: bross@fnal.gov

Round table / **296**

Round table: Developing an International Strategy toward a Neutrino Factory

Autores Correspondentes: tangjy@ihep.ac.cn, mapalmer@fnal.gov, k.long@imperial.ac.uk, takashi.kobayashi@kek.jp

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Constraint on Neutrino Decay with Medium-Baseline Reactor Neutrino Oscillation Experiments

Autor Alexander Quiroga[1]

Co-autores Hiroshi Nunokawa [2]; Hisakazu Minakata [3]; Thamys Abrahão [1]

[1] *PUC-Rio*

[2] *Department of Physics, Pontificia Universidade Catolica do Rio de Janeiro*

[3] *University of São Paulo*

Autor Correspondente: alarquis1823@gmail.com

In this work we use the fact that JUNO has the best opportunity to put the most stringent constraint in nu_3 lifetime over others experiments which utilize artificial neutrinos source. If there is a neutrino decay into invisible states, we find, by studying the \chi^2, that the \nu_3 timelife can

be constrained to \tau_3/m_3 > 7.5 (5.5) x 10^(-11) s/eV at 95%(99%) C.L. by JUNO by 100kt.years of exposure. We also discuss the effect of \nu_3 decay on the determination of neutrino mass ordering as well as the precision of oscillation parameters measured by JUNO.

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Constraining Majorana CP Phase in Precision Era of Cosmology and Double Beta Decay Experiment

Autor Alexander Quiroga[1]

Co-autores Hiroshi Nunokawa [2]; Hisakazu Minakata [3]

[1] *PUC-Rio*

[2] *Department of Physics, Pontificia Universidade Catolica do Rio de Janeiro*

[3] *University of São Paulo*

Autor Correspondente: alarquis1823@gmail.com

We show that precision measurement of sum of neutrino masses by cosmological observation and efective neutrino mass by neutrinoless double beta decay, together with beta decay experiments, have a synergy which allows us to get information on the Majorana phase of neutrinos. In order to quantify this information, we use, in addition to the allowed region plots, the CP exclusion fraction function as a complementary tool. This function shows how much fraction of the CP phase parameter space can be excluded for a given set of assumed inputs parameters. We find that one of the two CP neutrino phases can be constrained by excluding 10-50% of the phase space at 3σ CL for the lowest neutrino mass of 0.1eV. We also consider if the nuclear matrix element can be constrained by consistency of such measurements.

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Neutrinos generating events for intranuclear cascade in CRISP code

Autor Danaisis Vargas[1]

Co-autores Arturo Rodolfo Samana [1]; César Barber [2]; Fermin García Velasco [1]

[1] *Universidade Estadual de Santa Cruz*

[2] *Instituto de Física La Plata, CONICET*

Autor Correspondente: d.vargas882014@gmail.com

Some years ago, the CRISP (Collaboration Rio-Ilhéus-São Paulo) code was developed to describe spallation and fission reactions [1] using the Monte Carlo method approach. In order to improve the physics and the capacity of prediction of the code, the neutrino channel is being implemented. This improvement could be applied in several experiments where the neutrino-nucleon/nucleus cross section is used to measure neutrino oscillations [2]. A study of the neutrino-nucleon interaction was made and critically analyzed taking into account the advantages and shortcomings of CRISP when the neutrino event generator is implemented. It is known that the neutrino-nucleus interaction is fundamental for event detection in neutrino oscillation experiments. The treatment of the interaction in the nuclear medium is more complicated due to the processes involve effects of nuclear structure and interactions between the various nucleons. The effect of the nuclear medium and the interactions of the final state will be included to make more accuracy comparisons with the different experiments fluctuations. An accurate event generation program leads to the elimination of “false events”. The primary amplitudes of neutrino-nucleon interaction developed by C. Barbero and A. Mariano [3] will be used. This formalism is essentially different from other ones in the way to treat the resonances

and their interference with the non-resonant background. A comparison will be performed with others formalisms employed in neutrino generator events, such as in NUANCE [4] or GENIE [5] codes.

WG4: muon physics / **300**

WG4 Summary Preparation

WG4: muon physics / **301**

g-2 JPARK

Autor Correspondente: masashio@post.kek.jp

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Probing Neutrino-Scalar Couplings

Autores Orlando Luis Goulart Peres[1]; Pedro Simoni Pasquini[2]

[1] *UNICAMP*

[2] *Unicamp*

Autor Correspondente: pedrosimpas@gmail.com

Motivated by discovery of scalar particles at the LHC, we revisit the bounds from Yukawa couplings of scalar particles with neutrinos. Using data from meson decays and including for the first time the spectrum from meson decays we manage to put the following constraints for massless scalars: $|g_e|^2 < 1.9 \times 10^{-6}$, $|g_\mu|^2 < 7.4 \times 10^{-8}$ and $|g_\tau|^2 < 2.1 \times 10^{-2}$ at 90%C.L. and we get bounds on massive light scalars.

305

Progress on Cherenkov Reconstruction for MICE

Autor Daniel Kaplan[1]

Co-autores David Sanders Sanders [2]; Lucien Cremaldi [2]; Michael Drews [1]; Miles Winter [1]

[1] *Illinois Institute of Technology*

[2] *University of Mississippi*

Autor Correspondente: kaplan@iit.edu

Two beamline Cherenkov detectors (Ckov-a,-b) support particle ID in the MICE beam line. Electrons and high-momentum muons and pions can be identified with good efficiency. We report on the Ckov-a,-b performance in detecting pions and muons with Step I data.

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Computation of atmospheric neutrinos production

Autor Gabriela Vitti Stenico[1]

Co-autor Orlando Luis Goulart Peres [2]

[1] *Universidade Estadual de Campinas*

[2] *UNICAMP*

Autor Correspondente: gstenico@ifi.unicamp.br

Atmospheric neutrinos are produced by the interactions of cosmic rays with Earth's atmosphere which create unstable secondary particles that decay producing neutrinos. Due to have a wide energy spectrum of some hundreds of MeV until order of TeV, these neutrinos are good objects to test new theories and to study neutrino oscillation where there is a change of neutrino flavor state to another. In addition, atmospheric neutrinos constitute both the background and calibration of high energy neutrino telescopes and the search for rare processes, which motivates us to study how is its production and evolution in the atmosphere. In this way, we want to determinate the basic reactions of atmospheric neutrino creation by weak interactions and the processes of absorption and scattering of charged particles, such as pions and muons, produced by the interactions of protons (main constituents of cosmic rays) with the atmosphere. For this, we will proceed to solve cascade equations that relate source and sink terms of the particle flux to obtain its evolution up to the earth surface, including the dependence of atmospheric density and the different arrival directions for incident protons. We started with analytical calculation to understand the physics of the cascade development and the dependence on the free mean path, the decay length and particle energy loss observing how this parameters are modified for each particle that compose the cascade.

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Can Neutrinos Decay?

Autor Renan Picoreti[1]

Co-autores Marcelo Moraes Guzzo [2]; Orlando Luis Goulart Peres [3]; Pedro Cunha de Holanda [2]

[1] *Universidade Estadual de Campinas*

[2] *Unicamp*

[3] *UNICAMP*

Autor Correspondente: picoreti@ifi.unicamp.br

Before the establishment of the LMA-MSW solution, Neutrino Decay was studied - both by itself and together with standard flavor oscillations - to explain the difference between the expected Solar Neutrino flux from nuclear fusion processes in the Sun and the detected flux on Earth - the so-called Solar Neutrino Problem (SNP).

In this work, we studied Neutrino Decay as a sub-leading effect in the propagation of Solar Neutrinos and, combining the data from Solar Neutrino experiments with the data from Kamland and Daya Bay experiments, we set a new lower bound to the ν_2 neutrino eigenstate lifetime at $\tau_2 / m_2 \geq 7.7 \times 10^{-4}$ s . eV^{-1}, at 99% C.L..

Also, we calculate how seasonal variations in the Solar Neutrino data, which can be enhanced through decay, can give additional information about Neutrino's lifetime. Including in our analysis current data for the seasonal variation of Solar Neutrino flux, it results in a slightly lower value at 99% C.L. for $\tau_2 / m_2 \geq 7.2 \times 10^{-4}$ s . eV^{-1} due to the fact that the current eccentricity measurements and errors will favor lower, already excluded, lifetimes, for which the enhancement in the seasonal variation (and hence measured eccentricity) is higher.

Plenary session 2 / **308**

Recent developments in neutrino-nucleus scattering theory

Autor Marco Martini[1]

[1] *Ghent University*

Autor Correspondente: martini.marco@gmail.com

Opening / **309**

Welcome

Autor Correspondente: helio@fnal.gov

WG4: muon physics / **310**

Mu2e FNAL

Autor Correspondente: klynch@york.cuny.edu

Closing / **311**

Final remarks

Autor Correspondente: helio@fnal.gov

Plenary session 7 / **312**

Fermilab proton driver

Autor Correspondente: popovic@fnal.gov

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FORBUSH EVENT DETECTED BY CARPET ON 2012 MARCH

Autor Edith Tueros[1]

Co-autores Emilia Correia [2]; Jean-Pierre Raulin [3]

[1] *CRAAM*

[2] *CRAAM/INPE*

[3] *CRAAM/Mackenzie*

Autor Correspondente: edithtueros@gmail.com

We present preliminary results of cosmic rays flux behavior during a disturbed geomagnetic period detected by CARPET installed in CASLEO at the Argentinian Andes.CARPET was conceived to study cosmic rays modulation during transients and, sporadic events associated with coronal mass ejections (CME) and solar proton events, as well as long duration phenomena associated with 11-year solar cycle. CARPET data was corrected by pressure and temperature effects, which influence in the cosmic rays counts. We chose a period, 2012 March 6 - 12, with 2 geomagnetic storms associated with a CME/X1 flare on March 5. CARPET detected a gradual decrease on the muons count rate, namely a Forbush decrease. Comparison was made with neutron monitor
data, Dst and kp indexes for this period. Forbush decrease event detected by CARPET exhibits a good time correlation with neutron monitor and geomagnetic indexes.

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Coherent elastic scattering between neutrinos and nuclei

Autores Bruno Miguez[1]; Orlando Luis Goulart Peres[2]

[1] *Unicamp - LNGS*

[2] *UNICAMP*

Autor Correspondente: brunomiguez@gmail.com

In the limit of low momentum transfer for neutrino nuclei elastic scattering is expected to observe a coherent superposition in the cross section for the nucleons that compose the nucleus, increasing the interaction cross section. This effect was already observed for scattering for electrons, but due to experimental difficulties it have never been verified in neutrino scattering. Some groups dedicated to its verification were created. Beside it, the next generations of dark matter detectors probably will be sensitive to this interactions.
A study of the expected signal produced by coherent elastic scattering for neutrinos from different sources (solar, atmosphere, diffuse flux from supernovae, reactors and accelerators) was made. Considering a conservative threshold o 1 keV, as a detectable nuclear recoil, the most promising source to be observed is the 8B neutrinos produced in the Sun, with an expected rate of ~100 events/(ton*year). Another promising source is the reactor, but the use of this source is quite dependent of the possible distance between reactor and detector. For a detector far 1 km from the reactor it is expected ~10 events/(ton*year), but if be possible decrease this distance for 100 m the rate would be increased to 1000 events/(ton*year).

SPC meeting / 315

SPC/WG meeting

Autor Correspondente: dharris@fnal.gov

Closing / 316

Welcome to Vietnam

Autor Correspondente: jtrantv@gmail.com