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January 14, 2013

Centro de Fisica Teorica de Particulas
Instituto Superior Tecnico
Av. Rovisco Pais, P-1049-001 Lisboa,
Portugal

Dear Professor Branco,

I am writing to apply for the post-doctoral position which was recently advertised in your web page. I am currently a 4th year PhD student in the Astroparticle curriculum at SISSA, Trieste (Italy).

I am working under the supervision of Prof. Serguey Petcov and my research is mainly focusing on neutrino physics from different points of view. During my PhD research I have tried to deal with different topics and expand my scientific knowledge not only from a model-building point of view but also investigating several phenomenological aspects in connection with astroparticle physics and GUT symmetries.

The research fellowship program you are offering seems to be very attractive and a great opportunity to expand my scientific horizon due to the interdisciplinary nature of your research group. I am convinced that this experience would be very helpful for me to further develop myself and to improve my scientific knowledge in order to apply it at a higher standard.

Please find attached my CV, the list of publications, a brief statement of research accomplishments and the future research plans. You will receive letters of recommendation from Prof. Serguey Petcov (Full professor, SISSA), Prof. Belen Gavela (Full Professor, Universidad Autonoma de Madrid), Prof. Mu-Chun Chen (Associate Professor, University of California, Irvine).

In case of questions, please do not hesitate to contact me via my email address. I shall be very grateful for any answer.

With my best regards,

Aurora Meroni

Aurora Meroni

Curriculum Vitæ

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Trieste, 14.01.2013

Personal Information

Name **Aurora Meroni**.

Date of Birth **13/06/1984**.

Place of Birth **Como (Italy)**.

Nationality **Italian**.

Current Position

PhD Student, *Astroparticle Curriculum*, SISSA
International School for Advanced Studies - Trieste, Italy
Supervisor: Serguey T. Petcov
Expected date of PhD Defence: July/September 2013.

Education

10/06-07/09 **Master of Science**,
Università degli Studi di Padova, Dipartimento di Fisica G. Galilei,
Laurea Specialistica in Scienze Fisiche, Grade: 110/110,
Thesis: *Neutrino oscillations in dense gases, the case of Supernovae*
Supervisors M.B. Gavela (UAM- Madrid) and S. Rigolin (Università di Padova).

10/03-09/06 **Physics Bachelor**,
Università degli Studi di Padova, Dipartimento di Fisica G. Galilei,
Thesis: *Tracks reconstruction and data analysis with PRISMA*
Supervisors: F. Scarlassara and P. Mason (Università di Padova and LNL Legnaro).

06/2003 **Undergraduated studies**, *Scientific High School - Liceo Scientifico G. Galilei*, Belluno (Italy).

Fellowships

2009/13 **SISSA, Italy**, *PhD Fellowship in Astroparticle curriulum.*

2008/09 **UAM, Universidad Autonoma de Madrid, Spain**, *Erasmus Scholarship*, 9 months.

2006/07 **Université de Genéve, Switzerland**, *Bilateral agreement*, 10 months.

2003 **Award**, *MariaLaura Bocchetti Protti Foundation.*

Publications and Works in Progress

[1] **A. Faessler, A. Meroni, S.T. Petcov, F. Simkovic and J. Vergados**, *Uncovering Multiple CP-Nonconserving Mechanisms of* $(\beta\beta)_{0\nu}$*-Decay*, **Phys. Rev. D 83, 113003, 2011**, [**arXiv 1103.2434**].

[2] **M. C. Chen, K. T. Mahanthappa, A. Meroni and S. T. Petcov**, *Predictions for Neutrino Masses,* $\beta\beta_{0\nu}$*-Decay and Lepton Flavor Violation in a SUSY* $SU(5)\times T'$ *Model of Flavour*, [**arXiv:1109.0731**].

[3] **A. Meroni, E. Molinaro and S. T. Petcov**, *Revisiting Leptogenesis in a SUSY $SU(5) \times T'$ Model of Flavour*, **Phys. Lett. B, 710, Issue 3, 2012, 435-445**, [**arXiv:1203.4435**].

[4] **A. Meroni, S. T. Petcov and M. Spinrath**, *A SUSY $SU(5) \times T'$ Unified Model of Flavour with large θ_{13}*, **Phys. Rev. D 86, 113003, 2012**, [**arXiv:1205.5241**].

[5] **A. Meroni, S. T. Petcov and F. Simkovic**, *Multiple CP Non-conserving Mechanisms of $\beta\beta_{0\nu}$-Decay and Nuclei with Largely Different Nuclear Matrix Elements*, [**arXiv:1212.1331**], Submitted to JHEP.

[6] **A. Meroni, E. Molinaro and S. T. Petcov**, *TeV Scale Type I See-saw Model and $\beta\beta_{0\nu}$-Decay*, In preparation.

[7] **F. Feruglio, C. Hagedorn, A. Meroni and L. Vitale**, *Lepton mixing from groups $\Delta(3n^2)$ and $\Delta(6n^2)$*, In preparation.

[8] **A. Meroni and S.T. Petcov**, *On Multiple CP Nonconserving Mechanisms of $\beta\beta_{0\nu}$-Decay*, Published in “Venice 2011, Neutrino Telescopes” 401-403 , NeuTel 2011, XIV International Workshop on Neutrino Telescopes - Venice, Italy.

[9] **A. Meroni and S.T. Petcov**, *Multiple CP nonconserving mechanisms in $\beta\beta_{0\nu}$ decay*, in Proceedings of the International School of Physics "Enrico Fermi", Course CLXXXII, "Neutrino Physics and Astrophysics" , (IOS Press, Amsterdam and SIF, Bologna), 2012, pp. 315-319.

[10] **A. Meroni**, *Multiple mechanisms in $\beta\beta_{0\nu}$ decay*, Proceeding for “Rencontres de Moriond 2012”, ElectroWeak Interactions and Unified Theories, La Thuile (Italy), 3-10/03/12.

[11] **A. Meroni**, *A SUSY $SU(5) \times T'$ Unified Model of Flavour with large θ_{13}*, Proceedings of the 2nd Workshop on Flavor Symmetries and Consequences in Accelerators and Cosmology (FLASY12), Dortmund (Germany), 30/06-4/07/12.

Schools, Conferences and Selection of Seminars

Summer School in Cosmology, ICTP, Trieste (Italy), 19-30/07/10.

NeuTel 2011, *XIV International Workshop on Neutrino Telescopes*, Venice (Italy), 15-18/03/11.
Poster: Multiple mechanisms in $2\beta0\nu$ decay

Summer School on Particle Physics, ICTP, Trieste (Italy), 6-17/06/11.

Workshop on Cosmic Rays and Cosmic Neutrinos: Looking at the Neutrino Sky, ICTP, Trieste (Italy), 20-24/06/11.

ISAPP 2011, *Varenna School Course CLXXXII - Neutrino Physics and Astrophysics*, Varenna (Italy), 26/07-05/08/11.
Student Talk + Poster: Multiple mechanisms in $2\beta0\nu$ decay

IDEALS, *Workshop on “Investigating Dark Energy At Large Scales”*, SISSA (Trieste, Italy), 10-11/11/11.

Rencontres de Moriond 2012, *EW Interactions and Unified Theories*, La Thuile (Italy), 3-10/03/12 .
Young Scientists Forum Talk: Multiple mechanisms in $2\beta0\nu$ decay

PLANCK 2012, Varsaw (Poland), 28/05-01/06/12.
Talk: Predictions for Neutrino Masses and $2\beta0\nu$-Decay in a SUSY $SU(5) \times T'$ Unified Model of Flavour with large θ_{13}

What's nu?, *From new experimental neutrino results to a deeper understanding of theoretical physics and cosmology*, GGI, Florence (Italy), 11-29/06/12.
Talk: A SUSY $SU(5) \times T'$ Unified Model of Flavour with large θ_{13}

FLASY 2012, *Workshop on Flavor Symmetries and Consequences in Accelerators and Cosmology*, Dortmund (Germany), 30/06-4/07/12.
Talk: A SUSY $SU(5) \times T'$ Unified Model of Flavour with large θ_{13}

BENE, *Behind Neutrino Masses*, ICTP, Trieste (Italy), 17-21/09/12.
Talk: A SUSY $SU(5) \times T'$ Unified Model of Flavour with large θ_{13}

University of Padua , *FLAP Seminars*, Padua (Italy), 12/10/12.
Talk: Unveiling Neutrinoless Double Beta Decay

Max-Planck-Institut fuer Physik and TUM, Muenchen (Germany), 08/11/12.
Talk: Unveiling Multiple LNV Mechanisms in Neutrinoless Double Beta Decay

Scientific Activities

GTC2011, *LOC and website/poster design for Workshop on "Gravity as Thermodynamics: towards the microscopic origin of geometry"*, 5th-8th September 2011, SISSA (Trieste, Italy).
http://www.sissa.it/app/gtc2011/

IDEALS, *LOC and poster design in Workshop on "Investigating Dark Energy At Large Scales"*, 10th-11th November 2011, SISSA (Trieste, Italy).
http://www.sissa.it/ap/ideals/

Web Activities, *Designer and Webmaster of the website of the Thoretical Particle Physics group of Sissa* , Academic Year 2011-2012 and 2012-2013.
http://www.sissa.it/tpp

Other

Outreach — **Collaboration in "Scienza in Rete"**, *"Nuova oscillazione dei neutrini, tra materia e antimateria"* , 16/03/12.

Computer skills — **Typography**, LaTeX, SciPoster; **Web design and graphyics** HTML, CSS, PHP, Gimp, WordPress package (for blog, web pages) .

Languages — **Italian (native), English (Fluent), Spanish (Fluent), French (Good)**.

References

Serguey T. Petcov.
Position: *Full Professor*
SISSA, International School for Advanced Studies
Via Bonomea 265, 34136 Trieste (Italy)
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Belen Gavela.
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List of Publications and Works in Progress

[1] **A. Faessler, A. Meroni, S.T. Petcov, F. Simkovic and J. Vergados**, *Uncovering Multiple CP-Nonconserving Mechanisms of $(\beta\beta)_{0\nu}$-Decay*, **Phys. Rev. D 83, 113003, 2011**, [**arXiv 1103.2434**].

[2] **M. C. Chen, K. T. Mahanthappa, A. Meroni and S. T. Petcov**, *Predictions for Neutrino Masses, $\beta\beta_{0\nu}$-Decay and Lepton Flavor Violation in a SUSY $SU(5) \times T'$ Model of Flavour*, [**arXiv:1109.0731**].

[3] **A. Meroni, E. Molinaro and S. T. Petcov**, *Revisiting Leptogenesis in a SUSY $SU(5) \times T'$ Model of Flavour*, **Phys. Lett. B, 710, Issue 3, 2012, 435-445**, [**arXiv:1203.4435**].

[4] **A. Meroni, S. T. Petcov and M. Spinrath**, *A SUSY $SU(5) \times T'$ Unified Model of Flavour with large θ_{13}*, **Phys. Rev. D 86, 113003, 2012**, [**arXiv:1205.5241**].

[5] **A. Meroni, S. T. Petcov and F. Simkovic**, *Multiple CP Non-conserving Mechanisms of $\beta\beta_{0\nu}$-Decay and Nuclei with Largely Different Nuclear Matrix Elements*, [**arXiv:1212.1331**], Submitted to JHEP.

[6] **A. Meroni, E. Molinaro and S. T. Petcov**, *TeV Scale Type I See-saw Model and $\beta\beta_{0\nu}$-Decay*, In preparation.

[7] **F. Feruglio, C. Hagedorn, A. Meroni and L. Vitale**, *Lepton mixing from groups $\Delta(3n^2)$ and $\Delta(6n^2)$*, In preparation.

[8] **A. Meroni and S.T. Petcov**, *On Multiple CP Nonconserving Mechanisms of $\beta\beta_{0\nu}$-Decay*, Published in "Venice 2011, Neutrino Telescopes" 401-403 , NeuTel 2011, XIV International Workshop on Neutrino Telescopes - Venice, Italy.

[9] **A. Meroni and S.T. Petcov**, *Multiple CP nonconserving mechanisms in $\beta\beta_{0\nu}$ decay*, in Proceedings of the International School of Physics "Enrico Fermi", Course CLXXXII, "Neutrino Physics and Astrophysics" , (IOS Press, Amsterdam and SIF, Bologna), 2012, pp. 315-319.

[10] **A. Meroni**, *Multiple mechanisms in $\beta\beta_{0\nu}$ decay*, Proceeding for "Rencontres de Moriond 2012", ElectroWeak Interactions and Unified Theories, La Thuile (Italy), 3-10/03/12.

[11] **A. Meroni**, *A SUSY $SU(5) \times T'$ Unified Model of Flavour with large θ_{13}*, Proceedings of the 2nd Workshop on Flavor Symmetries and Consequences in Accelerators and Cosmology (FLASY12), Dortmund (Germany), 30/06-4/07/12.

Aurora Meroni

Research Statement

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My research, carried under the supervision of **Prof. Serguey Petcov**, is focused on several aspects of neutrino phenomenology and is an attempt to incorporate and explain the recent experimental results clearly indicating the beginning of the precise measurement era for neutrino physics. Oscillation measurements and neutrinoless double beta decay experiments are going to give important results to the scientific community in the next years. Due to its deep interdisciplinary character, it seems natural to consider neutrino physics from different points of view. During my PhD research I have tried to deal with different topics and expand my scientific knowledge not only from a model-building point of view but also investigating several phenomenological aspects in connection with astroparticle physics.

Multiple mechanisms in $2\beta0\nu$. The observation of neutrinoless double beta decay, $2\beta0\nu$, and the measurement of the Majorana effective mass, $\langle m \rangle$, would prove not only that the total lepton charge L is not conserved and that the massive neutrinos are Majorana particles but it could give information on the type of neutrino mass spectrum, on the absolute neutrino mass scale, and with additional information from other sources (^3H decay experiments or cosmological and astrophysical data considerations) one might extract unique information on the Majorana CP violation phases. If $2\beta0\nu$ decay will be observed, it will be of fundamental importance to determine the mechanism which induces the decay.
At present we do not have evidence for the existence of $\Delta L \neq 0$ terms in the Lagrangian describing the particle interactions. Nevertheless, such terms can exist and they can be operative in the $2\beta0\nu$ decay. Moreover, it is impossible to exclude the hypothesis that, if observed, the $2\beta0\nu$ decay is triggered by more than one competing mechanisms. Given the experimental observation of the $2\beta0\nu$ decay of sufficient number of nuclei, one can determine and/or sufficiently constrain the fundamental parameters associated with the lepton charge non-conserving couplings generating the $2\beta0\nu$ decay.
In **[1]** we considered the possibility of several different Lepton Number Violating (LNV) mechanisms contributing to the $2\beta0\nu$ decay amplitude in the general case of CP non-conservation. We consider the light Majorana neutrino exchange as the "standard" mechanism that induces the decay and as well other CP non-conserving mechanisms such as heavy Majorana neutrinos coupled to (V-A) currents, heavy right-handed (RH) Majorana neutrinos coupled to (V+A) currents, lepton charge non-conserving couplings in SUSY theories with R-parity breaking. Associating to each mechanism a LNV parameter, we have investigated in detail the cases of two "non-interfering" and two "interfering" mechanisms, generating the $2\beta0\nu$ decay. For instance in the first case one can set a system of two equations where the LNV parameters are the two unknowns.
In the analysis we have performed, we have used as input some hypothetical $2\beta0\nu$ decay half-lives of the following three isotopes: ^{76}Ge, ^{100}Mo and ^{130}Te. Four sets of nuclear matrix elements (NMEs) of the decays of these three nuclei were utilized: they were obtained with two different nucleon-nucleon potentials (CD-Bonn and Argonne) and two different values of the axial coupling constant $g_A = 1.25;\ 1.0$. Within the set of $2\beta0\nu$ decay mechanisms studied by us, the different half-life intervals obtained in the case of two "non-interfering" and two "interfering" mechanisms

can allow to constrain or even discriminate the active multiple mechanisms. We have shown also that further significant constraints on the physical solutions for the fundamental parameter can be obtained by using the current and the prospective upper bounds on the absolute scale of neutrino masses from the past Maintz and the upcoming KATRIN ^3H β-decay experiments of 2.3 eV and 0.2 eV, respectively.
The novelty of the method considered by us relies on the possibility to treat the cases of CP conserving and CP non-conserving couplings generating the $2\beta0\nu$ decay in a unique way. Further this method is extremely powerful once stronger experimental bounds on $2\beta0\nu$ decay half lives are found. For example, recently the EXO collaboration reported a new lower bound on the half-life of ^{136}Xe i.e. $T^{0\nu}_{1/2}(^{136}Xe) > 1.6 \times 10^{25}$ y, (90% CL). This lower bound is can be used to further constrain the solutions obtained in the case of two "non-interfering" and two " interfering" mechanisms. This new analysis **[5]** can give tantalizing results especially using nuclear isotopes with very different NMEs.

Recent Results on θ_{13}, Models of Flavour and Leptogenesis. Recently the short-baseline reactor experiments on θ_{13}, Daya Bay and RENO reported an evidence of a non zero value of θ_{13} (precisely Daya Bay and RENO measured $\sin^2 2\theta_{13} = 0.092 \pm 0.016 \pm 0.005$ and $\sin^2 2\theta_{13} = 0.113 \pm 0.013 \pm 0.019$, respectively). These new results are extremely intriguing if one wants to find a consistent and economic explanation of the origin of the mass pattern and mixing of neutrinos, and in general also of leptons and quarks. The peculiar mixing of the lepton sector in particular, i.e. the non zero value of θ_{13} and the large values of the other two mixing angles, indicate that most of the flavour models proposed in the literature connected with discrete symmetries with the assumption of $\theta_{13} = 0$ are now excluded (for instance the so called Tri-Bimaximal mixing or TBM). Interestingly, a certain attention to discrete symmetry has been revived in connection with Grand Unified Theories, especially models based on SU(5) as a gauge group. For instance the model proposed by M.-C. Chen and K. Mahanthappa in 2007 based on $SU(5) \times T'$ is a unified model of flavour with θ_{13} different from zero, precisely $\theta_{13} = \theta_c/(3\sqrt{2})$ where θ_c is the Cabibbo angle. In my paper **[2]** we analyze the phenomenology related to this kind of model that is we obtain predictions for the neutrino masses, the effective Majorana mass in neutrinoless double beta decay. We present as well the rates of the LFV charged lepton radiative decays $\mu \to e + \gamma$, $\tau \to e + \gamma$ and $\tau \to \mu + \gamma$, calculated assuming the mSUGRA scenario of soft SUSY breaking. The Chen- Mahanthappa $SU(5) \times T'$ unified model of flavour has also been the natural playground to investigate the generation of the baryon asymmetry of the Universe **[3]**. In this paper we performed a detailed calculations of both the CP violating lepton asymmetries, originating from the decays of the heavy Majorana neutrinos operative in the see-saw mechanism, and of the efficiency factors which account for the lepton asymmetry wash-out processes in the Early Universe. The latter are calculated by solving numerically the system of Boltzmann equations describing the generation and the evolution of the lepton asymmetries. The baryon asymmetry in the model considered is proportional to the J_{CP} factor, which determines the magnitude of CP violation effects in the oscillations of flavour neutrinos. The leptogenesis scale can be sufficiently low, allowing to avoid the potential gravitino problem. Of course, the Chen-Mahanthappa model is now ruled out since the value of θ_{13} predicted is not compatible with the recent experimental data. During the last year of research we pointed out that choosing the appropriate Higgs sector, the experimental value of θ_{13} obtained by Daya Bay and RENO, can be accommodated.

A Viable and Testable Unified Model of Flavour. Motivated by the fact that at present we know all three angles in the PMNS mixing matrix with a good precision, I contribute to construct a supersymmetric unified model of flavour in **[4]**, which attempts to describe correctly the quark and charged lepton masses, the mixing and CP violation in the quark sector, the mixing in the lepton sector, including a relatively large value of the angle θ_{13} as the experiments suggest.

This model is based on two main ingredients: i) a GUT embedding using $SU(5)$ as gauge group; using in the Higgs sector the adjoint representation a sizable θ_{13} has been found ii) the discrete family symmetry T', double-valued group of the tetrahedral symmetry T which is isomorphic to A_4. The complex Clebsch-Gordan coefficients of the T' group, in particular the use of the spinorial representation, are the source of CP violation once T' is broken. This is the so-called "geometrical" CP violation used in the Chen-Mahanthappa model. The novelty of the model proposed by us is first of all the Higgs sector: in particular using the adjoint representation we get realistic mass ratios between down-type quarks and charged leptons and more importantly a value of θ_{13} compatible with the recent experimental results. Indeed the latter is obtained because the PMNS mixing matrix receive sizeable contributions from the charge lepton sector in such a way that the Tri-Bimaximal mixing obtained in the neutrino sector at leading order is perturbed by the matrix diagonalizing the charged lepton mass matrix. Moreover through the GUT symmetry we are able to relate the value of θ_{13} to the value of the Cabibbo angle and hence explain why θ_{13} is different from zero i.e. $\theta_{13} \sim 0.9\,\theta_c/\sqrt{2}$. Our approach, in particular the phase pattern in the Yukawa matrices due to CGs coefficients of the T' group, permits to fit with a good approximation the parameters describing the masses and the mixing of the quark and lepton sector, leading to a consistent unified model of flavour. We investigate as well the UV completion of our effective theory finding the superpotential responsible of the Yukawa couplings. This aspect was missing in the Chen-Mahanthappa model. Another interesting aspect of the model proposed by us is the phenomenological implication in the neutrino sector. Through the type I seesaw mechanism one is able to generate light neutrino masses. In this specific model it is possible to predict exactly the values of the neutrino masses in the cases of normal and inverted hierarchy, the Majorana effective mass for $2\beta0\nu$ decay and the magnitude of CP violation effects in neutrino oscillations. This model is falsifiable since its predictions on the neutrino mass spectrum, the leptonic mixing angles and the leptonic CP violating phases can be tested in future experiments measuring the solar and atmospheric neutrino mixing angles with a high precision, in experiments searching for CP violation in neutrino oscillations and in neutrinoless double beta decay experiments.

Future Research Plan

My major scientific interests are in the fields of neutrino and astroparticle physics, as well as in theories of flavour. I am interested in all aspects of the physics of massive neutrinos and neutrino mixing, models of neutrino mass generation with related phenomenology and possible experimental tests connected with particle physics or astrophysics. I am interested also in studying the origin of the patterns of neutrino masses and mixing related to approximate symmetries and/or in connection with grand unified theories, and more generally, in building realistic unified models of flavour. The investigation of the connection between neutrino physics and the physics of the Early Universe, and, in particular, the possible relation between the generation of the neutrino masses and the generation of the baryon asymmetry of the Universe, are integral part of my future research program. The problem of determination of the nature - Dirac or Majorana, of massive neutrinos will continue to be in the focus of my reserach interests. I plan to expand my research activity in the domain of the dark matter problem, the physics of the supernovae neutrino oscillations and related topics. The tools I have been developing in the last few years as a Ph.D. student can be used to treat most of the problems listed above as well as to analise future data on the important process of neutrinoless double beta ($(\beta\beta)_{0\nu}$) decay. More specifically, my plans for future research include, but are not limited by, tackling of the following problems.

Mechanism(s) of $(\beta\beta)_{0\nu}$ Decay In [1] we have proposed a method of analyzing prospective $(\beta\beta)_{0\nu}$ decay data in the case when the decay is induced not by one, but by multiple, CP non-conserving in general, mechanisms. The method allows to determine, in principle, whether more than one mechanism are generating the decay. However, identifying the mechanisms involved in $(\beta\beta)_{0\nu}$ decay in the case of data on the half-lives of the nuclei ^{76}Ge, ^{130}Te and ^{100}Mo, considered in [1], is faced with difficulties due to degeneracies related to the properties of the corresponding $(\beta\beta)_{0\nu}$ decay nuclear matrix elements (NMEs): different sets of mechanisms active in the decay can produce essentially the same sets of $(\beta\beta)_{0\nu}$ decay half-lives of the nuclei ^{76}Ge, ^{130}Te and ^{100}Mo. I plan to investigate the possible ways of lifting the indicated degeneracies, which otherwise could plague the interpretation of the $(\beta\beta)_{0\nu}$ decay data if the process will be observed. I plan to apply the methods thus developed to derive constraints on the various possible $(\beta\beta)_{0\nu}$ decay inducing couplings if new significantly larger lower bounds on the $(\beta\beta)_{0\nu}$ decay half-lifes of ^{76}Ge, ^{130}Te, ^{100}Mo, ^{136}Xe and other nuclei will be experimentally obtained. If the $(\beta\beta)_{0\nu}$ decay will be discovered, I plan to develop a more accurate analysis of the corresponding data based on the methods developed in [1] by taking into account all the relevant uncertainties that can play a role in the determination of the mechanism(s) inducing the decay. In particular, I plan also to use the $(\beta\beta)_{0\nu}$ decay data synergetically with the most recent cosmological data (for example, those that will be released by PLANCK) on the sum of the neutrino masses. Such a combined analysis will be essential to constrain or determine the value of the $(\beta\beta)_{0\nu}$ decay effective Majorana mass and eventually to get information on the type of the neutrino mass spectrum and possibly a hint on the value of the Majorana CP phases present in the lepton mixing matrix.

Understanding the Status of CP in the Lepton Sector As is well known, the relatively large value of θ_{13} opens up the possibility for searching for CP violation effects in neutrino oscillation experiments with high intensity accelerator neutrino beams. These experimental searches will provide indications on, or will determine, the value of the Dirac CP violating phase in the neutrino mixing matrix. One of the principal goals of my future research would be to try to understand theoretically, on the basis of, e.g., realistic theories of flavor, the origin of the CPV phases in the neutrino mixing matrix and the status of the CP symmetry in the lepton sector. This is particularly important for making progress in understanding the mechanism of generation of the matter-antimatter (or baryon) asymmetry of the Universe. In certain theories of flavor (see, e.g., [3]), and more generally, under certain phenomenological conditions, the generation of the baryon asymmetry can be related to the CP violation provided by the Dirac CPV phase in the neutrino mixing matrix.

Origin of the Observed Patterns of Neutrino Masses and Mixing Another tantalizing problem is understanding the origin of the patterns of neutrino masses and mixing, and more generally, the origin of the flavor structure in the lepton sector. The most recent analysis of the global neutrino oscillation data show that θ_{23} deviates significantly from the value $\pi/4$. If this would be experimentally confirmed, most of the simplest explanations connected with discrete symmetries would be ruled out and one would be led to consider other specific symmetries or mechanisms leading to the observed lepton masses and mixing. My plans include investigating the possible symmetries and frameworks with which one can have a relatively large value of the angle θ_{13} and at the same time significant deviations of the angle θ_{23} from the value $\pi/4$. This problem is related to the problem of understanding the fundamental mechanism giving rise to neutrino masses and mixing and possibly to L_ℓ non-conservation. TeV scale models considered currently are attractive scenarios to generate the neutrino masses and at the same time this energy scale has a variety of potential effects in currently running particle physics experiments, such as LHC, lepton flavor violation, FCNC, etc. I plan to investigate various aspects of the phenomenology of these models.

Unified Theories of Flavor Given the large number of data accumulated over the years on the quark masses, mixing, CP violation in the quark sector, charged lepton masses, neutrino (lepton) mixing and neutrino masses, it is not anymore sufficient, in my opinion, to try to solve the quark flavor problem and the lepton flavor problem separately, we need a unified solution of the flavor puzzle. Models based on SU(5) as a gauge group together with discrete symmetries are able to accommodate the measured relatively large value of θ_{13}. Further, in a class of these models, based on the SU(5) GUT symmetry, due to the SU(5) structure one is able to relate θ_{13} to the Cabibbo angle. One of my interests is to continue the studies of the unified models of flavor and their predictions within the framework of the SO(10) GUTs, employing discrete symmetries based on the group $\Delta(3n^2)$.

Models with Light Sterile Neutrinos and their Phenomenology Another interesting topic that I would like to treat in my future research is sterile neutrinos. At present there are numerous hints for the possible existence of one or two sterile neutrinos with mass ~ 1 eV, none of them conclusive. They come from the results of LSND and MiniBooNE experiments, which reported a slight excess of $\overline{\nu_e}$ events in the $\overline{\nu_\mu} \to \overline{\nu_e}$ channel, from the calibration experiments of the Ga-Ge solar neutrino detectors GALLEX and SAGE, as well as from the reanalises of the short baseline reactor antineutrino oscillation data, performed using updated results on the flux of reactor $\bar{\nu}_e$. In general, the number n of massive neutrinos ν_j, can be bigger than 3 - the number of active flavour neutrinos, if there exist sterile neutrinos and they mix with the flavour neutrinos. The explanation of the data mentioned above is marginally consistent with the existence of two or more light sterile neutrinos with masses in the 1 eV range, which mix with the ν_e and ν_μ. There are a large number of experimental projects aiming to test the sterile neutrino hypothesis. My research plans include building models of neutrino mixing where the sterile neutrinos are included, and investigating their phenomenology.