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Dear Colleagues,

This is a letter of recommendation for Aurora Meroni, who is a forth year Ph. D. student at the Elementary Particle Physics Sector, SISSA (Scuola Internazionale Superiore di Studi Avanzati), Trieste, Italy, and is applying for for a post-doctoral position at your Institution. A. Meroni will obtain her Ph. D. degree in the autumn of 2013.

I know A. Meroni since October, 2009, when she became a Ph. D. student in our Sector of SISSA. She is working since the summer of 2010 on her Ph. D. thesis under my supervision. My impressions about her professional qualities are based on the contacts I had with her during the period she followed the course of lectures entitled "Theory of Electroweak Interactions" I give for the first year Ph. D. students, from our discussions related to her Ph. D. studies and from the joint research we did and are doing in the field of physics of massive neutrinos and neutrino mixing, unified theories of flavour, leptogenesis and TeV scale type I see-saw mechanism of neutrino mass generation.

A. Meroni is among the best students who attended my lectures during the sixteen years I give them at SISSA. The thesis work A. Meroni did so far under my supervision is in the domain of the physics of massive neutrinos and neutrino mixing, unified theories of flavour and radiative resonant leptogenesis.

1. One of the most challenging and pressing problems in the field of neutrino physics today is determining the nature - Dirac or Majorana, of massive neutrinos. The only feasible experiments which can provide information on the Majorana nature of massive neutrinos at present are the experiments searching for the process of neutrinoless double beta (bb0nu) decay of certain even-even nuclei: $(A, Z) \rightarrow (A, Z-2) + e^- + e^-$. A large number of a new generation of bb0nu decay experiments aim at achieving a sensitivity by a factor of 5 to 10 better than that achieved so far. Some of these experiments are already taking data (GERDA, EXO, KamLAND-Zen), while a certain number is under preparation (CUORE, SuperNEMO, MAJORAN, SNO+, COBRA, CANDLES, etc.). The "standard" mechanism of bb0nu decay is the exchange of light massive Majorana neutrinos. However, the bb0nu decay can also be induced by other mechanisms: heavy left-handed (LH) and heavy right-handed (RH) Majorana neutrino exchanges, lepton charge non-conserving couplings in SUSY theories with R-parity breaking; examples of the latter are the so-called "gluino exchange" mechanism" and the "squark-neutrino mechanism". Each of these mechanisms is characterised by a fundamental lepton number violating (LNV) parameter. In an article published in the journal Physical Review D, Aurora investigated the possibility of several different mechanisms contributing to the bb0nu-decay amplitude in the general case of CP nonconservation. She obtained a number of very important results in this study. She showed, in particular, that if the bb0nu-decay is induced by, e.g., two "non-interfering" mechanisms (e.g., light Majorana neutrino and heavy RH Majorana neutrino exchanges), one can determine $|\eta_i|^2$ and $|\eta_j|^2$, η_i and η_j being the two fundamental parameters characterising these mechanisms, from data on the half-lives of two nuclear isotopes. In the case when two "interfering" mechanisms are responsible for the bb0nu-decay, $|\eta_i|^2$ and $|\eta_j|^2$ and the interference term can be uniquely determined, in principle, from data on the half-lives of three nuclei. Aurora showed also that given the half-life of one isotope, the "positivity conditions" $|\eta_i|^2 \geq 0$ and $|\eta_j|^2 \geq 0$ lead to stringent constraints on the half-lives of the other bb0nu-decaying isotopes. Aurora derived these conditions, as well as the conditions for constructive (destructive) interference and analysed their implications. She showed also that the experimental limits on neutrino masses obtained in the ^3H β-decay experiments can constrain further the multiple mechanisms of bb0nu-decay if one of the mechanisms involved is the light Majorana neutrino exchange. The results obtained in this study are already widely known. Although the article, where these results are published, has additional four authors, by far most of the work on the study was done by A. Meroni.

In a follow up study, Aurora investigated the possibility to discriminate between different pairs of CP non-conserving mechanisms inducing the nbb0nu-decay by using data on bb0nu-decay half-lives of nuclei with largely different nuclear matrix elements (NMEs). The nuclei considered are ^{76}Ge, ^{82}Se, ^{100}Mo, ^{130}Te and ^{136}Xe. While for each of the five single mechanisms discussed, the NMEs for ^{76}Ge, ^{82}Se, ^{100}Mo and ^{130}Te differ relatively little, the relative difference between the NMEs of any two nuclei not exceeding 10%, the NMEs for ^{136}Xe differ significantly from those of ^{76}Ge, ^{82}Se, ^{100}Mo and ^{130}Te, being by a factor $\sim (1.3 - 2.5)$ smaller. This allowed, in principle, to draw conclusions about the pair of non-interfering (interfering) mechanisms possibly inducing the bb0nu-decay from data on the half-lives of ^{136}Xe and of at least one (two) more isotope(s) which can be, e.g., any of the four, ^{76}Ge, ^{82}Se, ^{100}Mo and ^{130}Te. Aurora showed, in particular, that depending on the sets of mechanisms considered, the conclusion can be independent of, or can depend on, the NMEs used in the analysis. In the same work she also exploited the implications of the EXO lower bound on the half-life of ^{136}Xe for the problem studied.

2. In two publications A. Meroni investigated various aspects of a SUSY $SU(5)\times T'$ model of flavour proposed by M.-C. Chen and K. Mahanthappa (see Phys. Lett. B652, 34 (2007) and B681, 444 (2009)), which gave rise to realistic masses and mixing patterns for quarks and leptons. In the first paper, Aurora obtained the predictions of the model for the neutrino masses, the effective Majorana mass in neutrinoless double beta decay and for the rates of the lepton flavor violating processes $\mu \rightarrow e + \gamma$, $\tau \rightarrow e + \gamma$ and $\tau \rightarrow \mu + \gamma$. In the second publication Aurora investigated the generation of the baryon asymmetry of the Universe via leptogenesis in the SUSY $SU(5) \times T'$ flavour model of M.-C. Chen and K. Mahanthappa. She showed that i) the baryon asymmetry predicted by the model is proportional to the J_{CP} factor, which determines the magnitude of CP violation effects in the oscillations of flavour neutrinos, ii) that the leptogenesis scale can be sufficiently low, allowing to avoid the potential gravitino problem, and iii) the results of a similar study performed in arXiv:1107.3856 were incorrect.

3. In March of 2012 the reactor neutrino mixing angle θ_{13} was measured with a high precision in the Daya Bay experiment. This measurement showed that $\sin\theta_{13} \cong (0.10 - 0.20)$ at 3σ, while the model of M.-C. Chen and K. Mahanthappa predicted $\sin\theta_{13} \cong 0.058$ and thus was ruled out. In a subsequent publication Aurora together with Martin Spinrath constructed a realistic $SU(5)\times T'$ model of flavour which predicted $\theta_{13} \cong 0.9\theta_c/\sqrt{2} \cong 0.14$, $\theta_c \cong 0.22$ being the Cabibbo angle. The model predicts also i) values of the solar and atmospheric neutrino mixing angles, which are compatible with the existing data; ii) light massive neutrinos to be Majorana particles; iii) the value of the Dirac CP violating (CPV) phase in the neutrino mixing matrix $\delta = \pi/2 - 0.45\theta_c \cong 84.3°$; iv) the values of the two Majorana CPV phases in the neutrino mixing matrix; v) the values of the three light neutrino masses with relatively small uncertainties, which allowed to get also unambiguous predictions for the bb0nu-decay effective Majorana mass. The model correctly describes the quark masses, the quark mixing and the CP violation in the quark sector as well. The non-trivial problems of constructing the superpotential of the model which leads to the correct flavon vacuum alignment as well as of finding the UV completion of the model, were also solved in the study.

4. Currently Aurora is working on two projects which are expected to be completed within the next two months. The first is a study of the applications of discrete symmetries for understanding the pattern of neutrino mixing. The second project concerns aspects of the low-energy phenomenology of the TeV scale type I see-saw model.

A. Meroni is an excellent Ph. D. student. She possesses the curiosity, the enthusiasm and drive, and the technical skills necessary for doing first class research. I was impressed by the speed with which she was able to learn new subjects. In our discussions and joint work Aurora always tried to reach a deep understanding of the physics of the problem being studied and of the related formalism. A. Meroni is also very hard working and has a pleasant character.

A. Meroni is already a highly qualified expert in the physics of massive neutrinos and neutrino oscillations, leptogenesis, discrete symmetry groups used to explain the pattern of neutrino mixing and in unified theories of flavour (quark and lepton). More generally, A. Meroni has a very solid scientific background, in particular, in elementary particle physics and cosmology. In view of the above I very strongly support the application of A. Meroni for a Post-Doctoral position in your Institution.

With best regards,

Yours sincerely,

Prof. S. T. Petcov