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Recommendation Letter for Avelino Vicente Montesinos

To whom it may concern:

I write this letter in support of **Avelino Vicente** who has sent you an application for a PostDoctoral fellowship. I am happy to recommend Avelino very strongly for this appointment.

I know Avelino for more than six years now. Avelino did his PhD under my supervision in our institute, the Instituto de Fisica Corpuscular (IFIC) at the University of Valencia and defended his thesis in March 2011. Before that, Avelino wrote his Master thesis in Physics in the summer of 2007 at the University of Valencia, also under my supervision. In his thesis Avelino has studied different supersymmetric models for the generation of neutrino masses, mainly but not exclusively concentrating on those based on R-parity breaking. During his thesis Avelino has published four original research papers, all written together with me.

In the first of these, published as Phys. Rev. **D77** 075005 (2008), we have studied the decays of the lightest neutralino in a model in which R-parity is spontaneously broken and thus a (singlet) Majoron exists. The paper discusses how to correctly explain neutrino masses and mixings and shows how various properties of the LSP decays are predicted in the model once neutrino data is taken into account.

The Majoron in spontaneous R-parity breaking models can lead to the exotic decay $\mu \rightarrow eJ$, which we have studied in Phys. Rev. **D79** 055023 (2009). The main result of this work is the complementarity of this decay mode to the invisible neutralino decay $\chi_1^0 \rightarrow \nu J$. Searches for $\mu \rightarrow eJ$ can thus provide interesting constraints on the scale of R-parity breaking.

In JHEP 05 (2009) 120 we have studied the phenomenology of the so-called $\mu\nu$ SSM. This model has been proposed to solve the μ -problem of the MSSM and explain neutrino masses at the same time. In our publication we have studied the LHC phenomenology of this proposal and compared its signals to those expected in other R-parity breaking models.

In his final year towards his PhD Avelino studied certain variants of supersymmetric left-right symmetric models, both from a more model building point of view and from the phenomenological perspective. This work has been published as JHEP12 (2010) 077. Maybe the most interesting result of this study is that lepton flavour violating signals differ from minimal “pure” seesaw models, thus the model can, in principle, be distinguished from the pure SUSY seesaw.

Already during his PhD Avelino has contributed to all publications significantly. In our first paper he had to calculate all relevant couplings of the neutralino and in the process also learned a lot about supersymmetric models in general. He had to handle the numerical code SPheno, originally written by Werner Porod, but had to extend it and check for the new couplings specific for the spontaneous R-parity violating model and with this numerical work is responsible for most of the plots shown in the paper. In our second paper, Avelino calculated the decay $\mu \rightarrow e + J + \gamma$ completely independently. This decay shows an infrared divergence and Avelino impressed me with his rapid grasp of the situation and his efficient handling of the calculation. Also in this paper Avelino was responsible for the bulk of the numerical work done. For the $\mu\nu SSM$ paper we decided to divide the tasks into different pieces since different variants of the model - with one or more generation of singlets - can be formulated. Avelino was responsible for studying the LHC phenomenology of the $\mu\nu SSM$ in case two (or more) light singlet fields exist. To his last publication towards his PhD, JHEP12 (2010) 077, Avelino really contributed the bulk of the work and I consider my role in this paper as rather minor.

After defending his Phd, Avelino went to work for 8 months at the University of Würzburg in the group of Prof. Werner Porod. He then started a PostDoc position at the University of Paris-Sud XI/CNRS in October 2011 with Prof. Asmaa Abada.

Since defending his PhD in March 2011, Avelino has published no less than eight more refereed papers, two of them are still in the referee process. I personally contributed to only three of these eight publications: JHEP01 (2012) 095; Phys. Rev. **D85** (2012) 113013 and arXiv:1207.6635. JHEP01 (2012) 095 calculates the neutralino relic density in the supersymmetric left-right symmetric models, which we first studied in JHEP12 (2010) 077. It is really a “left-over” from his PhD thesis, which due to time constraints could not be included in the thesis. Phys. Rev. **D85** (2012) 113013 considers the Z-penguin contribution to $l_i \rightarrow 3l_j$ lepton flavour violating decays. It points out that in models with new interactions terms or right-handed neutrino fields near the electro-weak scale the Z-penguin can easily dominate over the photonic penguin diagram, in contrast to the situation in the MSSM. In this paper the principal observation was made by Avelino, while all numerical details were worked out by him and Florian Staub. In the last of those three papers, arXiv:1207.6635, accepted for publication in JHEP, motivated by the recent ATLAS and CMS discovery of a Higgs-like boson with a mass around 125 GeV, and by the need of explaining neutrino masses, we have analysed the three canonical SUSY versions of the seesaw mechanism (type I, II and III) with CMSSM boundary conditions. In type II and III cases, SUSY particles are lighter than in the CMSSM (or the constrained type I seesaw), for the same set of input parameters at the universality scale. Thus, to explain $m_{h^0} \simeq 125$ GeV at low energies, one is forced into regions of parameter space with very large values of m_0 , $M_{1/2}$ or A_0 . We have compared the squark and gluino masses allowed by the ATLAS and CMS ranges for m_{h^0} (extracted from the 2011-2012 data), and discussed the possibility of distinguishing seesaw models in view of future results on SUSY searches. Again I have to say that it was Avelino who did practically all of the calculations necessary for this work.

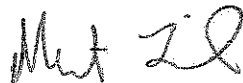
I believe that with his publication record Avelino now has also clearly demonstrated that he

can do scientific research independent from me. There are, as mentioned above, already 5 papers in his CV which he has written without me and with different collaborators from as many as four different universities (not counting our instiute) by now.

In summary, I can recommend Avelino very strongly. He is without any doubt the brightest PhD student I have supervised so far and certainly in the top 5 % of all PhD students I have seen in the course of my career. I admire his insistence in "getting things right", not being satisfied until proven the solution found for a given problem is correct and the speed with which he grasps new concepts. I need to especially emphasize that despite being only at the beginning of his career, Avelino is already working highly independently. It is always a pleasure to discuss physics with him and he shows a surprisingly broad knowledge also on aspects of the field he has not (yet) worked on himself. On a more personal level I would like to add that Avelino is a very pleasant person to work with and his enthusiasm for physics makes me enjoy our collaboration very much.

Sincerely yours,

Martin Hirsch

A handwritten signature in black ink, appearing to read 'M. Hirsch'.