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Ref.: Reference letter for Michael Grefe

Dear Colleague,

I am writing in support of Michael Grefe, who is applying for a post-doc position at Your Institute. Michael took my Particle Physics and Cosmology course at Hamburg University in the SS2007 and immediately struck me as the best student of the course, so that I readily accepted him as a Diploma student that fall. At the time, we had just proposed a model with gravitino DM with R-parity breaking in JHEP 0703(2007)037, which is consistent with high reheating temperature and Big Bang Nucleosynthesis, and since the gravitino in this scenario decays mostly into neutrino and gauge or Higgs boson, I proposed to Michael as Diploma project to compute the neutrino flux from gravitino decay. The project was quite challenging for a mere Diploma student, since it involved supergravity Feynman rules and working with spin 3/2 fermions, so I was ready to help Michael through the computation and did not expect quick results. But Michael surprised me very positively, since he was able to perform the computation practically without assistance and even computed some well-known expressions like the gravitino polarisation sum “ab initio” without relying on previous work. He also first spotted a discrepancy in the interference part compared to a parallel computation from Moroi *et al* in Phys. Rev. D78(2008)063505, which turned out to be connected to the choice of relative sign of the gravitino mass to the neutralino masses.

But Michael not only performed the analytical computation of the gravitino decay rates on his own, while I was trying to catch up with him instead of having to help him. He also showed from the start a very deep phenomenological intuition in considering how best to see the neutrino signal from gravitino decay and he became also our expert in the discussion of the experimental questions like the atmospheric neutrino backgrounds and detector issues. We wrote our results together with Alejandro Ibarra and David Tran, who performed part of the computation independently, in particular the computation of the neutrino flux from fragmentation, in the paper JCAP 0901(2009)029. The paper was written mostly by Michael and is based on Michael’s Diploma thesis, which appeared practically

at the same time. It is not so common that a Diploma project directly produces a publication and it goes mostly to Michael's credit. His thesis is the best one I have had the fortune to read (or supervise) so far and has been awarded the "Otto Stern Preis" for the best Physics Diploma thesis at the University of Hamburg in the Summer Semester 2008.

I then offered Michael to continue with me for his Ph.D. and proposed to him to study the different supersymmetry breaking mediation mechanisms, in particular those which have the gravitino as the LSP. My idea was to lead him more towards model-building, but due to his strong interest in phenomenology and the new developments connected to the PAMELA excess, we went back to the question of indirect detection of decaying Dark Matter. Immediately after the first paper, again with Alejandro Ibarra and David Tran, we thought to quickly extend our study of the neutrino signal in a more model independent approach. Even in this case, Michael turned out to be the driving force of the project, which would have been completed much earlier if I and Alejandro had not slowed it down due to our other commitments. While we were at the end of the writing phase and Michael had already long obtained the main results and especially noted the importance of shower events for the detection of the signal, a similar analysis by Mandal *et al.*, Phys. Rev. D81(2010)043508, appeared. Our more complete analysis was instead finished one month later and published in JCAP 1004(2010)017. It is mostly my responsibility if our papers did not appear first and has for this reason perhaps gained not as much attention.

In the following year Michael returned to the study of the gravitino as decaying DM, considering not only the neutrino final state, but a multichannel approach. He extended the gravitino decay rates to the 3-body final states, discussed also by K.Y. Choi and C. Yaguna in Phys. Rev. D82(2010)015008, and got interested as well in the Deuteron channel, together with Gilles Vertongen. Together we started to look at the possibility of direct detection for gravitino in R-parity violating scenarios, obtaining unfortunately rates way too small for detection. Michael included all this work in his thesis, one of the most clear, detailed and challenging thesis that I have had the chance to read. He was able there to draw a complete bow from his very reliable theoretical computations to a detailed phenomenological study of decaying gravitino DM models. In fact, his Ph.D. thesis was awarded a "Summa cum Laude".

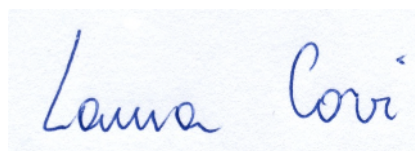
Last year Michael moved to the Autonoma University of Madrid and has adjusted very well to the new environment. At the moment, he is working on various papers on gravitino DM indirect and direct detection: on one side together we are writing up the results for the direct detection rates, on the other side, with Timur Delahaye he is continuing the phenomenology of indirect detection. After moving to Madrid, he also joined the group of Carlos Muñoz in the question of indirect detection of the gravitino DM in the $\mu\nu$ SSM. Hopefully one or two of this publication will appear before the end of the year.

As I already said, Michael is my best Diploma and Ph. D student so far: he has shown from the start a very quick grasp of the theoretical models and strong technical abilities, he is very fast and reliable in the analytical and numerical computations and shows a precision and maturity in his work that goes beyond his years. Moreover he really has an uncommonly strong physical and phenomenological intuition and interest in the discussion of the experimental issues. In my experience very often theoreticians (like myself) do not care much about the experimental details, or how an analysis is done, they just want to see the final result. Michael instead has a real gift in going deep also into experimental questions and suggesting alternative ways to measure a signal and therefore I would readily imagine him working also in contact with an experimental group. He is less interested in building new models “per se” without being driven by data, even if I do not doubt that he could also contribute to the model-building side of theoretical physics.

I would also like to stress that he has gained at DESY a quite extensive education also beyond the subjects of his Diploma and Ph.D. thesis and he has participated intensively to the group activities, like workshop seminars and lectures. He has lead the exercise class for the “Beyond the Standard Model” course last year displaying very good teaching skills. He is a very carefully prepared and solid speaker, even if a bit reserved. He has a quiet character, but can communicate well and not only work very well in a group, but even play the leading role in a project.

I think he would be a great addition to any astroparticle, cosmology or particle physics theory group, and that he would really thrive on close contact with experimental groups. In this era where new results are expected both from colliders and from astrophysical measurement, he could be the right person to contribute to the understanding of new phenomena. In conclusion, Michael is a very promising young physicist with a strong motivation, the intellectual abilities and the talent needed for a productive and successful career and therefore I would like to recommend him very strongly as a post-doc in Your Institute.

Best regards,

A handwritten signature in blue ink that reads "Laura Covi". The signature is written in a cursive, flowing style. The first name "Laura" is written in a larger, more prominent script, and the last name "Covi" is written in a slightly smaller, more compact script to its right.

Laura Covi