

12. Februar 2013

Letter of recommendation for Lucia Hošeková

To whom it may concern!

I am pleased to write on behalf of Dr. Lucia Hošeková to support her application for a post-doctoral position at your institute.

Lucia Hošeková has got her Masters degree in physics from the Comenius University, Bratislava, Slovakia under the supervision of Dr. Karol Kovarik. The corresponding work was actually carried out at HEPHY in Vienna. In her master thesis she calculated the decay of a neutral Higgs boson into two photons in the MSSM. Thereby she learned the basic techniques for one-loop calculations and got acquainted with the MSSM.

In the framework of the HEPTOOLS Marie Curie Research Training Network Lucia held a doctoral position at PSI from October 2007 until October 2011 under my supervision. Lucia spent part of her working time at PSI and part at Zurich University. In November 2011 she moved to Valencia to take up an appointment as ESR fellow in LHCPheNet. The PhD degree was awarded in September 2012.

The topic of Lucia's PhD thesis was the calculation of the NLO QCD corrections to gauge-boson-scattering processes at the LHC within the Standard Model. The aim was to provide predictions for all massive gauge-boson pairs, $W^\pm W^\pm$, $W^+ W^-$, WZ , and ZZ with leptonic decays and irreducible background diagrams included, i.e. for all final states with two jets and four leptons. Calculating NLO corrections to a six-particle final state is highly non-trivial and requires to organize the large number of contributing Feynman diagrams in an efficient way. Lucia used a strategy similar to the one devised by the group of Dieter Zeppenfeld. All diagrams are constructed from a relatively small set of generic building blocks. The building blocks are calculated with the help of FormCalc and own routines that encode the Weyl van der Waerden formalism. Unlike in the approach of the Zeppenfeld group, they are sewed together via polarization sums to form complete matrix elements. Amplitudes for more complicated final states are obtained with the help of crossing symmetry. The building blocks are organized in such a way that for the calculation of QCD corrections only a few of them have to be reevaluated at NLO.

Lucia's start at PSI was pretty hard, since the doctoral project was much more demanding than her master thesis work. It required quite some support from the group and a big effort by herself to get the project going. While Lucia was definitely behind in the beginning, she has caught up considerably and finally reached the level of other good doctoral students. During her thesis' work Lucia became acquainted with many techniques relevant for the calculation of NLO QCD corrections. She gathered experience with FormCalc, Mathematica and Fortran and learned about renormalization, spinor techniques, subtraction methods and Monte Carlo integration. This can serve as a good basis to work on new projects.

Despite huge efforts, the progress of Lucia's doctoral work was slowed down by several troubles out of her control. Lucia's task was to calculate the LO and NLO matrix elements for the vector-boson scattering processes. In parallel a second doctoral student was constructing a Monte Carlo program for the phase-space integration. In order to get predictions for cross sections, the matrix elements were interfaced to the Monte Carlo program. After thorough checks it turned out, that the obtained results for W^+W^+ scattering disagreed with published results by Zeppenfeld et al. Only after several attempts and with the help of Barbara Jäger it finally turned out that the setup described in the publication of Zeppenfeld and the results given there were not compatible (a cut had not been applied in the calculation). Moreover, the fellow student of Lucia finished his PhD in 2011 and left physics. Unfortunately, his Monte Carlo program was buggy and Lucia spent quite some time to debug this code. While she learned a lot about Monte Carlo integration, her doctoral degree was delayed by almost one year.

So far, only results for W^+W^+ scattering have been published. This provided the first independent confirmation of NLO results for vector-boson scattering in the literature and various new numerical results. Thus, it was explicitly shown by direct calculation that the contribution of s -channel diagrams and interferences is negligible if vector-boson-fusion cuts are applied. However, Lucia has calculated the QCD one-loop matrix elements for all gauge-boson scattering processes $pp \rightarrow W^+W^+/WZ/ZZ/W^+W^- + 2\text{jets}$. For the WZ final states the corrections were implemented into a Monte Carlo generator, and presently Lucia is working on phenomenological results.

Lucia is highly motivated and very enthusiastic about her work and particle physics in general. She works hard and has learned to struggle through complicated and long-lasting projects. She used many opportunities to take part in schools and meetings in order to enlarge her knowledge. Last but not least, Lucia has a pleasant personality, takes responsibilities and contributes nicely to the social life of the group.

Based on the above considerations **I recommend Dr. Lucia Hošeková** for a post-doctoral position at your institute.

Yours sincerely,

A handwritten signature in black ink, reading "A. Denner". The signature is written in a cursive, flowing style.

Prof. Dr. A. Denner