Position Profile for Chinese Applicants running for 2019 Helmholtz – OCPC – Program

PART A (Info about the Position)
Helmholtz Centre and institute: DESY

Title of the project: Search for Dark Matter with the CMS experiment via machine learning

Project leader: Prof. Dr. Christian Schwanenberger

Web-address: http://cms.desy.de/e53612/e90916/e293567/e293569/

Description of the project:
One of the main unresolved questions in particle physics today is the presence of Dark Matter (DM), which constitutes 85% of the matter content of the Universe. The rest is what we know as atoms and molecules and can be successfully described in the world of elementary particles by the so-called Standard Model (SM). Assuming DM is a weakly interacting massive particle, it could be produced in proton-proton collisions at the Large Hadron Collider (LHC) at CERN and be detected by the CMS experiment. In this case DM particles would couple via so-called mediator particles to SM particles. If those mediators have similar properties as the Higgs boson discovered at the LHC in 2012, one of the hottest channels for discovery would be the production of DM particles in association with the heaviest elementary particle, the top quark.

The DESY CMS group is working on DM searches with top quark pairs. The current state of the analysis is, that in one of the channels with a potential heavy Higgs-like DM mediator decaying to top-quark pairs, an excess in data over the SM prediction with a significance of about 3 standard deviations has been observed, utilizing the LHC Run-2 data of 2016. In this project the search will be continued with 2017 and 2018 data. If the excess is indeed due to new physics such as through the existence of DM particles, the significance should increase analyzing more data.

The data analysis is very challenging, since DM cannot be found as a simple bump in, for example, the invariant mass distribution of the top quark pairs, because DM contributions are interfering with SM contributions. Several kinematic variables and angular distributions analyzing spin and polarization effects can be exploited to distinguish events with DM candidates from the majority of SM. If DM particles couple to SM particles, for example, via scalar (Higgs-like) or pseudoscalar mediators, this would change the correlation between the spin of the top quark and the spin of the anti-top quark. Therefore the usage of artificial intelligence such as multivariate analysis methods is foreseen in this project for the first time to increase the sensitivity to find DM, but also to explain its nature if discovered. Therefore this analysis is very exciting and of highest priority.

Required qualification of the post-doc:

- PhD in particle physics
- Experience with large scale data analysis
- Strong skills in computing (C++, if possible python and root)

PART B (Materials and Procedures)

The applicants shall submit the following documents to a Chinese postdoc station affiliated to a research institution or a university, after passing through the internal selection, the qualified application shall be forwarded to OCPC, and then to Helmholtz for evaluation:

- Detailed description of the interest in joining the project (motivation letter)
- Curriculum vitae, copies of degrees
- List of publications
- 2 letters of recommendation
- Proof of command of English language

PART C (General Conditions)

Additional requirements on the postdoctoral fellows:

- Chinese citizenship from Mainland China (allows application while staying abroad)
- Max. age of 35 years, PhD degree not more than 5 years by submission of application
- Very good command of English language
- Strong ability to work independently and in a team