Abstract of the PhD research

Although the Standard Model of particle physics is an extremely successful theory, multiple cosmological observations indicate that the known matter described by this framework only contributes 15% of all the matter in the universe. The remaining matter is observed through gravitational interactions, but is not visible in observations of light at any wavelength, implying it is electrically neutral. Only very little is known about this so-called dark matter, and many theoretical models exist to explain its origin. Depending on their exact nature, dark matter particles might be produced in high-energy collisions at particle colliders.

This thesis covers two searches for dark matter performed at the CMS experiment at the CERN Large Hadron Collider. In the first search, the dark matter particles are expected to leave the CMS detector undetected. They can however be observed due to an imbalance of energies measured in the detector when they are produced in association with other particles, in this case one or more collimated sprays of particles emerging from the collision, so-called jets. The work in this thesis refined the background prediction for this monojet analysis, and thus increased the sensitivity of the search. No significant excess above the predicted background was observed, setting new, stronger limits on several dark matter models, and excluding a larger part of the available parameter space. A second, more unusual search was performed as well, looking for strongly interacting candidates. The investigated signature is a pair of neutral or so-called trackless jets, which can efficiently be differentiated from the background consisting of charged jets. The result of this search is compatible with the predicted background, and again a part of parameter space was excluded.

The two searches covered in this thesis are very complementary, as the missing transverse energy signature used in the monojet search can transform into a trackless jets signature when the interaction probability becomes large enough. Although no sign of new physics was observed, these searches have led to the exclusion of more dark matter scenarios.