Peter Gyorgy
Popular Abstract

The Search for Light Dark Matter

Dark matter is a yet unknown form of matter, thought to make up around 83% of the mass of the Universe. There have been many experiments that tried to find the particles that dark matter is made of, but none were successful so far. The discovery of dark matter particles would be truly epic in its impact on how we all view the Universe and everything inside it. It would be a whole new form of matter to explore, and could bring a new golden age of physics. Children in the future would learn about the discovery, and many great scientists would emerge during humanity's journey to further study it.

The Light Dark Matter eXperiment (LDMX) is a brand new, yet unbuilt experiment to find dark matter particles. It will search for dark matter that is heavier than an electron but lighter than a proton. This kind of dark matter is called light dark matter, hence the name of the LDMX. The LDMX will search for light dark matter by colliding electrons with tungsten - a very heavy element - to see what kind of particles will be formed. The collisions will then be carefully reconstructed so the scientists can see exactly what happened. If light dark matter does exist, it means that we will be seeing some collisions where a mystery particle is formed and flies away undetected. The way we can recognise this happening is by seeing that there is missing momentum and energy that the dark matter carried away from the particles that we did detect.

The LDMX consists of several components: a "trigger scintillator", which identifies when and how many electrons came in to hit the detector, "trackers", which track the path that the electron takes, an "electromagnetic calorimeter", which detects any charged particles that are created while measuring their energy, and a "hadronic calorimeter", which catches everything else detectable that the other calorimeter does not. However, before the real LDMX is assembled, these components have to be built and tested so that we can make sure they work. Therefore, a prototype is built of the trigger scintillator and hadronic calorimeter, and various particles are shot at it with a versatile particle gun called the T9 at CERN. The results are then thoroughly analyzed and interpreted. They are then compared with the results of a simulation of the prototype.

The purpose of this project is to create the simulations of the LDMX prototype, help build the physical prototype, run various tests on it with a test beam, and analyze its data. This way, we can verify the functioning of the detector design, better characterize the behavior of its components, and improve the simulation by tuning it to the results. With the results of this project, scientists of the LDMX will have better tools and a better understanding of the machine they are building, which is vital for something as sensitive as dark matter detection. The LDMX could then potentially discover light dark matter, which would be the discovery that defines the decade, if not the century.