The specter of the universe

A dark specter is haunting the universe. If you look up at the night sky, it is mostly dark other than the sparkle of a few billion stars. Even though there are a huge number of stars in the observable universe, they still only make up roughly 5% of the universe. The other 95% of the universe is nothing but darkness. This darkness is not the same as the night sky, but rather a way to represent the unknown, mysterious parts of the universe.

The dark universe consist of two almost equally unknown parts. These are dark matter, which makes up most of the matter in the universe, and dark energy, a mysterious energy permeating the entire universe. Dark energy is elusive, and at the moment there are only a few theories as to what it might be or how to discover it. But, modern particle physics might be able to discover dark matter in the world's biggest particle accelerator, the Large Hadron Collider, LHC. Here, billions of protons are accelerated to close to the speed of light, only to collide with each other and create many more particles. A collection of these particles, all travelling in roughly the same direction with high energies, is known as a jet.

The Standard Model of particle physics is a theory which explains how the particles that make up all visible matter in the universe interact with each other. It describes three different forces through which interaction can happen. These are the strong, weak and electromagnetic forces. The strong force is the strongest one, and binds protons and neutrons together. The weak force is the weakest of these, and causes the radioactive decay powering nuclear power plants. The electromagnetic force describes how light interacts, and is the force that keeps magnets attached to metallic surfaces.

What makes dark matter so dark is the fact that it does not seem to interact through any of these forces. Unlike the darkness of the night sky, where the stars light up heavens, dark matter does not reflect or produce light. Rather, the only observed way it has to interact with ordinary matter is through the familiar gravitational force from everyday life.

Even tough dark matter has never been observed, it is very likely that it exists. It was first inferred from the anomalous rotation of stars around galactic centers. The speed at which these stars rotate should decrease the further from the center of the galaxy a star is. The observations contradicted this. It was as if there was more matter in the galaxy than what was clearly visible. Following this more and more evidence has been discovered for the presence of dark matter in the universe. So far, dark matter has been the most successful explanation for these observations. The only problem is, no one knows what it is, since it seemingly only interacts through gravity and is thus very difficult to discover.

Since dark matter is so difficult to discover, why could it then be discovered at the LHC? There is possibility that dark matter does interact with ordinary matter, but only so very rarely that it has never been detected. It is likely that it would occur through some new, unknown interaction. This new interaction could look very similar to the known interactions, with new particles. These new particles could be detected, for example if they form jets after having been created or through interaction with ordinary matter.

The LHC collides millions of protons every second. This obviously creates a huge amount of data every second, so much data that it cannot be stored. Much of this data has to be thrown away due to this. Only those events which seem interesting due to the high energy are saved, kind of like picking the good candies out of a bag. Some of the data thrown out might be interesting but is not saved due to the energy of the event, so it might be that events from a dark matter particle are thrown out. To remedy this a method called Trigger-Level Analysis is used. This method analyses events before they are thrown out, and can thus analyze more of them, potentially discovering something that would otherwise not be.

Thus, even though dark matter has not yet been found, there might be a bright future ahead. If dark matter were to be found, it would bring even more fundamental understanding of how the universe works.