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## Dark Matter: theoretical models, particle candidates and prospects for their experimental discovery

The mystery of dark matter is undoubtedly one of the most fundamental challenges of particle physics and cosmology today. Its existence as one of the largest building blocks of the Universe (about 26% of the total mass-energy balance) has been confirmed by a large body of observational data. Many arguments also clearly suggest that the most natural solution to the dark matter puzzle is some yet unknown elementary particle which is weakly interacting and massive (WIMP). As a result, the WIMP hypothesis practically dominates the field. On the other hand, nobody really knows what exactly the dark matter in the Universe is, even adopting the generally accepted paradigm that it is a so-called thermal WIMP - dark matter produced in the early Universe through freeze-out from the thermal plasma. This is because the WIMP concept is rather general and as such does not explain the exact nature of the particle constituting dark matter is. One can only clarify this through a fruitful interaction between experimental searches and theoretical investigations. The latter are conducted in the framework of specific models of particle physics, mainly models of ``new physics" beyond the Standard Model. The list of possible solutions is long but for many years the most promising approach has been that based on supersymmetric models with the lightest neutralino as dark matter. In this framework there are some extremely interesting and well motivated solutions, although other ones are also possible.

One of the main goals of the Project will be to reassess these and other candidates for dark matter in light of new data expected within the next few years from dark matter searches and from the Large Hadron Collider. It is very likely that the data will lead to an experimental confirmation of one of these solutions, or on the other hand, to substantially restricting, or even excluding, them. As a result, the second option is likely to lead to even abandoning the currently dominant paradigm of the thermal WIMP. Whatever the outcome, positive or negative, one should expect that this will have enormous impact on the future of the program of dark matter searches.

Most promising appears to be the possibility of detecting, during the next few years, a theoretically predicted signal of dark matter in currently built detectors. One also cannot exclude that dark matter will be discovered in a way or measurement where signal is currently not really expected. Such claims will need to be thoroughly examined and an attempt should be made to theoretically explain them in terms of models or mechanisms. There exist also other possible and interesting solutions both within the thermal WIMP paradigm and beyond it. Investigating them probably lead to new predictions which are likely to be verified by experiment. There are many possibilities but new experimental data that over the next few years will arrive from much more sensitive detectors, will most likely lead to a breakthrough in the field. Only time will tell if this be a discovery of a dark matter WIMP-type particle that has been predicted by theorists, or else something completely unexpected.