Contribution ID: **127** Type: **not specified**

Searching for Dark Matter

We argue that in the situation when LHC discovers only the Higgs boson and finds no signatures of new physics (confirming thus the Standard Model) the necessity to explain the observed beyond-the-Standard-Model (BSM) phenomena, in particular neutrino masses, Dark Matter and matter-antimatter asymmetry of the Universe, should largely shape the further development of particle physics. We concentrate on Dark Matter problem and suggest that, if the existing direct detection experiments (mostly searching for weakly interacting particles) do not show any convincing signals and if no signs of new "electro-weak" physics is detected at the LHC, a new class of Dark Matter candidates, the so-called super-weakly interacting particles should be searched for more thoroughly. If Dark Matter is made of super-WIMPs, detecting an astrophysical signal from their decay (the so called "indirect detection") may be the only way to identify these particles experimentally. However, it may be possible to check the dark matter origin of the observed signal unambiguously using its characteristic properties and/or using synergy with direct accelerator experiments. We argue that to fully explore this possibility a devoted cosmic telescope is needed. The suggested instrument will provide a major breakthrough in the field, by improving the sensitivity by two-three orders of magnitude and thus confirming or rejecting predictions of a number of particle physics models. The proposed program of search for decaying Dark Matter in combination with accelerator searches for neutral leptons with high intensity proton beams (described in details in the proposal by Gorbunov and Shaposhnikov) are capable of direct experimental resolution of three major BSM phenomena mentioned above. The proposed cosmic mission may greatly increase the value of accelerator searches for new particles, providing a number of independent cross-checks of dark matter production and baryogenesis mechanisms as well as explanation of neutrino flavour oscillations.

The suggested cosmic mission (a wide-field imaging X-ray spectrometer) will also have a number of important applications for cosmology, providing crucial insight into the nature of dark matter by studying the structure of the "cosmic web" by both searching for missing baryons in emission, and by using gamma-ray bursts as backlight to observe the warm-hot intergalactic media in absorption. However, it is first of all a mission optimized for the search for decaying Dark Matter. It will push model independent bounds on dark matter decay within its energy range as far as it is possible with current technologies. Therefore, a strong message from particle physics community supporting the necessity of such an instrument for the development of fundamental physics is very important.

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