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Status and Perspectives of Dark Matter Searches in China

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Abstract In this paper, we give a review of direct detection searches reported by the DAMA (China as a Co-I), and indirect detection searches reported by the ATIC (China as a Co-I). We also outline the future plans of dark matter search in China.

Keywords Dark matter search, Direct detection

1 Introduction

Today most research of dark matter is focused on the nature of dark matter. There are two different techniques for detecting dark matter. One technique, known as indirect detection, is to look for products of dark matter annihilations or decay. The other technique is called direct detection. Experimenters using this technique look for evidence of dark matter particle interacting with nuclei in their detector's target medium.

2 Present Status

2.1 Direct Detection

The current experiments employ one of two methods for detecting dark matter. The first method is to look for an annual modulation of WIMPs due to the earth's rotation around the sun as the sun travels through the solar system. The difficulty with this method is that one looks for a small, time-varying signal on top of a huge background. It requires a large detector volume and a stable background. The advantage is one does not need to know the characteristics of the background as long as it is not time-varying. The other method is to reduce the background to near zero and detect dark matter-nucleon interactions. The difficulty with this approach is characterizing the backgrounds and achieving an extremely low-background experimental environment.

DAMA/LIBRA is running at the Gran Sasso National Laboratory of the INFN. Chinese team is an important Co-I. Up to now, total exposure of DAMA is about 1170 kg · year, corresponding to 13 annual cycles. The data shows the model independent evidence of the presence of Dark Matter (DM) particles in the galactic halo on the basis of the DM annual modulation signature (8.9 sigma C.L. for the cumulative exposure)[1]. This signal has not been corroborated by other experiments. Because other experiments use different target nuclei, various results can only be compared in the context of specific theories of dark matter. The mass of the simplest, supersymmetric WIMPs and their couplings to normal matter, proposed to explain the DAMA result, have been excluded by other experiments.

2.2 Indirect Detection

By observing cosmic ray electrons and γ-rays, people can find some signals from dark matter. ATIC instrument was developed to investigate high energy cosmic rays such as proton and He nucleus. After detailed Monte Carlo simulation and beam test, ATIC has successfully observed high energy cosmic ray electrons and γ-rays. The first high energy resolution cosmic electron spectrum from 20 GeV to 3 TeV has been measured. The results point to the evidence that

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the surplus between 300 and 800 GeV in the electron spectrum could come from the annihilation from dark matter particle[2]. The research results were selected by the American Physical Society as one of the top 10 physics achievement in 2008 and regarded as the best physics development of 2008 in November by the European Physical Society.

3 Future Plan

3.1 Direct Detection

China plans to develop a large underground lab near Jinping dams. The Jinping lab would be the deepest underground science facility in the world, approximately 2500 meters of marble and sandstone above it. This year, Chinese scientists will have a 5-meter-high, 5-meter-wide, 30-meter-long chamber for dark matter particle experiments. First dark matter experiments will start at the end of this year. One ton Xenon experiment will be started in the near future.

3.2 Indirect Detection

China plans to launch a space detector within several years: Dark Matter Searcher (DMS), DMS is a high energy electron and γ-ray telescope covering energy range from 5 GeV to 10 TeV. By high resolution observation of γ-rays and electrons, it will find the products of the annihilation or decay from dark matter particles. The energy resolution is 10 times higher than FERMI γ-ray telescope, and geometry factor is 5 times bigger than CALET. DMS is expected to be launched in 2013–2014.

In 2009, "Space Science & Technology in China: A Roadmap to 2050" was published. This report was mostly based on "The Strategic Report of Long-term Plan of Chinese Space Science (2011–2025)". Dark matter searches are important parts of these two reports. Large experiments for dark matter detection are under study for the future.

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