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CJPL 中宇宙线缪子通量和缪致中子产额测量

Keywords

CJPL, Cosmic-ray muon, Muon-induced neutron, Liquid scintillator detector

摘要

中国锦屏地下实验室（CJPL）是开展 MeV 尺度中微子实验和寻找无中微子双 β 衰变的理想场所。为了理解宇宙线本底，我们分析了一吨原型探测器 820.28 天的数据，测得宇宙线 μ 子通量为 (3.61±0.19stat.±0.10sys.)×10−10cm−2s−1。从探测到的宇宙线 μ 子事件中，我们还测量了液体闪烁体中 μ 子诱发的中子产额，在 μ 子平均能量为 340 GeV 时，其值为 (3.44±1.86stat.±0.76sys.)×10−4⊠−1g−1cm2。此外，我们对全球不同实验室位置的 μ 子通量进行了研究，包括位于山下的实验室和矿井中的实验室。在相同的垂直覆盖层深度下，由于从山体侧面的泄漏，前者的 μ 子通量通常是后者的 (4±2) 倍。基于锦屏山的地形和 CJPL-I 的测量结果，我们预测了 CJPL-II 四个厅的宇宙线 μ 子能量、角度分布和通量。我们发现 C 厅和 D 厅的通量分别约为 2.3×10−10cm−2s−1 和 2.5×10−10cm−2s−1。

关键词

中国锦屏地下实验室，宇宙线缪子，缪致中子，液体闪烁体探测器

Abstract

China Jinping Underground Laboratory (CJPL) is ideal for carrying out MeV-scale neutrino experiments and searching for neutrinoless double-beta-decay. To understand the cosmogenic background, we analyzed 820.28 days of the dataset from a one-ton prototype detector and measured the cosmic-ray muon flux to be (3.61±0.19stat.±0.10sys.)×10−10cm−2s−1. From the detected cosmic-ray muon events, we also measured the muon-induced neutron yield in liquid scintillation, which is (3.44±1.86stat.±0.76sys.)×10−4⊠−1g−1cm2 at 340 GeV average energy of muons. In addition, we performed a survey of muon fluxes at different laboratory locations globally, considering both those situated under mountains and those down mine shafts. Under the same vertical overburden, the former is generally (4±2) times the latter due to the leakage through the mountain. Based on Jinping Mountain's terrain and the measurement in CJPL-I, we predicted cosmic-ray muons' energy and angle distributions and fluxes for the four halls at CJPL-II. We found the fluxes of Hall C and Hall D were about 2.3×10−10cm−2s−1 and 2.5×10−10cm−2s−1 respectively.

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