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Search for sub-millicharged particles at J-PARC

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Electric charge quantization is a long-standing question in particle physics. While fractionally charged particles (millicharged particles hereafter) have typically been thought to preclude the possibility of Grand Unified Theories (GUTs), well-motivated dark-sector models have been proposed to predict the existence of millicharged particles while preserving the possibility for unification. Such models can contain a rich internal structure, providing candidate particles for dark matter. A number of experiments have searched for millicharged particles (χs), but in the parameter space of the charge () and mass (m_χ), the region of $_\chi > 0.1$ GeV/c^2 and $< 10^{-3}$ is largely unexplored.

SUB-Millicharge ExperimenT (SUBMET) has been proposed to search for sub-millicharged particles using 30 GeV proton fixed-target collisions at J-PARC. The detector is composed of two layers of stacked scintillator bars and PMTs, and is proposed to be installed 280 m from the target. The main background is expected to be a random coincidence between the two layers due to dark counts in PMTs and the radiation from the surrounding materials, which can be reduced significantly using the timing of the proton beam. With $\mathrm{N_{POT}} = 5 \times 10^{21}$, the experiment provides sensitivity to χs with the charge down to 8×10^{-5} in $_\chi < 0.2$ GeV/c^2 and 10^{-3} in $_\chi > 1.6$ GeV/c^2. This is the regime largely uncovered by the previous experiments.

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