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Large Nucleon Decay and Neutrino Detectors in Asia

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ABSTRACT

The next generation gigantic nucleon decay and neutrino detector Hyper-Kamiokande aims to explore unification of elementary particles and full picture of neutrino masses and mixings. The Kamioka site has the various benefits of the deep underground laboratory with clean natural water, 30 years experience of construction and operation of water Cherenkov detectors, and $(L\mathrm{x}\Delta m^2)/(4E\nu)$ of $\pi/2$ corresponding to neutrino oscillation maximum for the existing accelerator based neutrino facility in JPARC. The water Cherenkov detector with the dimension of 1 million tonnes has capability of exploring nucleon lifetimes about 10 times as long as the limits set by the Super-Kamiokande. For example, the sensitivity to the partial lifetime of protons for the decay mode of $p \rightarrow e^+ + \pi^0$ and $p \rightarrow \nu + K^+$ is expected to be beyond $1\mathrm{x}10^{35}$ years and $2.4\mathrm{x}10^{34}$ years, respectively. The detector also aims to study unanswered neutrino properties such as Dirac CP phase, mass order of three generation neutrinos, and octant of θ_{23} by using a high power accelerator JPARC based neutrino beam and natural atmospheric neutrinos. Measurement of CP violation (nonzero $\sin\delta_{CP}$) is within the reach if $\sin^2 2\theta_{13} > 0.01$. In the case that $\sin^2 2\theta_{13}$ is as large as the current experimental limit of 0.15, we expect to extract various information on the neutrino masses and mixings from atmospheric neutrino studies. Particle and astroparticle physics studies by using extraterrestrial neutrinos from Sun and Supernova are also within the scope of the detector.