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Physics Potential of Super-K Gd

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The next stage of the highly successful Super-Kamiokande experiment is to load gadolinium (Gd) sulphate at 0.2% by mass. Gadolinium has a very large cross section for thermal neutron capture, which produces a cascade of gamma rays totalling 8 MeV. This is much easier to detect than the 2.2 MeV gamma ray from neutron capture on hydrogen that is currently used for neutron tagging. By tagging events which produce neutrons, background rates are radically reduced for some analyses.
Super-K has published the best limits on the diffuse supernova neutrino background (DSNB, also called supernova relic neutrinos); neutron tagging with Gd will enable detection of the DSNB in 10 years from Gd loading.
In the event of a core collapse supernova in our galaxy, neutron tagging with Gd will give new insight in to the dynamics of the neutrino burst, and a more accurate measurement of the direction to the supernova. Prior to a very close supernova (<1kpc), the late stages of stellar burning would be detected, giving even earlier supernova warning, and probing a never before observed stellar process.
Super-K sets the best limits on proton decay - this will be improved by the addition of gadolinium as the majority of atmospheric neutrino induced backgrounds have one or more neutrons in the final state. Additionally hundreds or thousands of reactor neutrinos will be detected, and spallation induced backgrounds, which create dead-time for many analyses, will be reduced.
The expected benefits of the addition of Gd are explored for these various physics analyses.

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