Gadolinium ion emission in a water Cherenkov detector

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To observe supernova relic neutrino events, gadolinium (Gd) sulfate is dissolved in the Super-Kamiokande (SK) 50 kt water Cherenkov detector aiming at improving the detection efficiency of neutrons. In addition to neutron absorption, Gd^{3+} ions can be excited by the Cherenkov light from cosmic muons and the subsequent emission at 312 nm, as shown in Fig. 1(a), is a possible background (BG) source for Cherenkov signal detection.

In this study, an experimental setup based on time-resolved laser-induced luminescence spectroscopy was constructed to measure spectroscopic data of Gd^{3+} ions in water such as molar attenuation coefficient and observed emission lifetime τ_{obs}. A simulation study was performed assuming the geometry of the SK detector to estimate the influence of the Gd^{3+} ion emission BG on the detector. Figure 1(b) shows the calculated time dependence of the expected BG count rate under τ_{obs} = 3 ms with a Gd concentration of 0.03% [1]. Development of a portable monitoring system using our spectroscopic technique will also be mentioned, which enables real-time measurements of Gd^{3+} ion concentration and emission lifetime without contamination during water sampling.

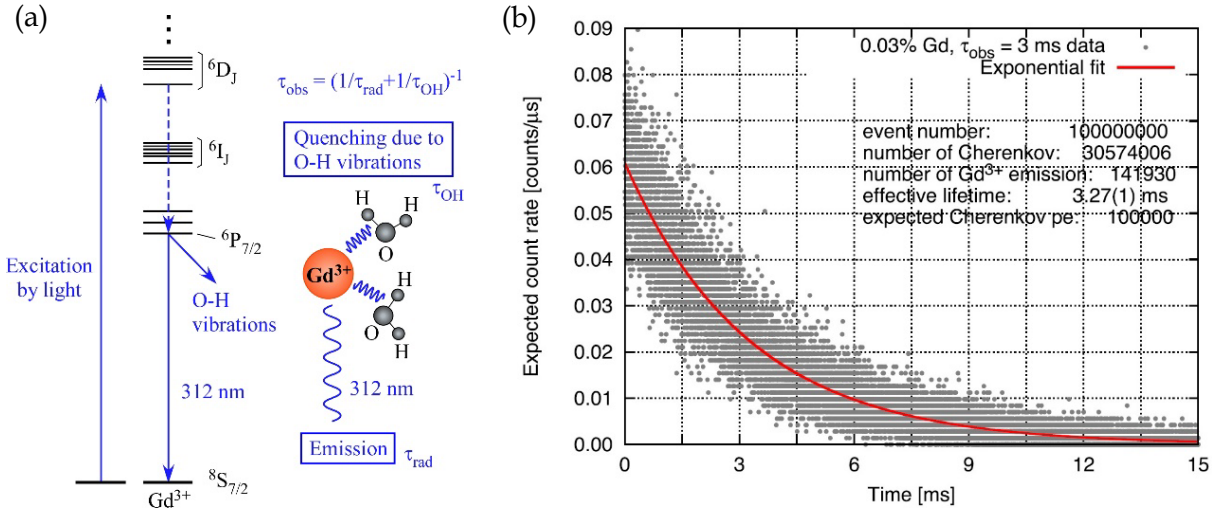

Figure 1: (a) Excitation and emission schemes of the Gd^{3+} ion, (b) Expected BG count rate under τ_{obs} = 3 ms with a Gd concentration of 0.03% [1].

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References: [1] Y. Iwata et al., Prog. Theor. Exp. Phys. **2022** (2022) 123H01.