Investigation of Crackling Noise in Seismic Attenuation System of KAGRA

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The sensitivity of ground-based interferometric gravitational wave detectors are limited by seismic vibration. The main optics of KAGRA, the 3 km Japanese second generation interferometric gravitational wave detector, are isolated from seismic vibration by seismic attenuation system, of which the vertical vibration isolation is mainly provided by GAS(Geometric Anti-Spring) filter. The seismic attenuation system of KAGRA for the main 3-km cavities named type-A system has five-stage GAS filters, and the system for other core optics named type-B has three-stage GAS filters systems.

We have conducted an experiment to investigate crackling noise in GAS filter. Crackling noise includes a broad class of noise when a system responds to a changing external condition in a nonlinear way. It has been studied that the strain-stress curves exhibit crackling noise near yielding point. As GAS filter works in the condition that is highly stressed, it is possible that crackling noise will be generated when GAS filter is vibrating. Consequently, it is possible that crackling noise in the GAS filter will couple into KAGRA's readout. This experiment is designed to investigate the crackling noise in Seismic Attenuation System of KAGRA, further more to help KAGRA to achieve the designed sensitivity and to increase the sensitivity, which will contribute on the establishment of gravitational wave astronomy in Japan.

The experiment is constructed as a null instrument. Two identical GAS filters will be equipped and identical changing external forces which excite crackling noise will be applied to the GAS filter. A Michelson interferometer is used to detect the variation of the difference of the beam length of two beams. It is supposed that only nonlinear response to the changing force, such as crackling noise, will be detected in the readout of Michelson. The use of interferometric method and GAS filter is an original and sensitive method to detect crackling noise.