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Retrieval of Green's function from the cross-correlation function in a scattering medium illuminated by noise sources

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The retrieval of Green's function of scalar waves for a given medium is possible from the cross-correlation function (CCF) of noises in the equi-partition state. For making such a state, there are two typical ways to illuminate receivers: one is an illumination by noise sources randomly distributed on a surrounding spherical shell with large radius compared with the receiver separation; another is an illumination by the randomly homogeneous distribution of noise sources. In both cases, the wave velocity can be well evaluated from the peak lag time of the noise CCF. Furthermore, it is interesting whether Green's function having coda in a scattering medium is retrieved from the noise CCF. We proved Green's function retrieval for the former case in a previous work. Here, using the first-order Born approximation, we mathematically shows the retrieval of Green's function having coda in a scattering medium with small dissipation from the noise CCF for the latter case. A model for the scattering medium is mathematically given by a distribution of velocity anomalies represented by delta functions. Using the prolate spheroidal coordinates for the integration over the distributed noise sources, we prove that the derivative of CCF with respect to lag time is proportional to the convolution of the noise source auto-correlation function and antisymmetrized Green's function that has a coda tail caused by single scattering and an exponential decay term caused by dissipation. We note that Green's function retrieval is possible for this type of noise distribution even though the time reversal symmetry and energy conservation are broken.

Keywords: Corrrelation analyisis, wave theory, scattering, random media, coda waves