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Ambient Seismic Vibrations in Seismology and Earthquake Engineering

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The last decade witnessed the specular emergence of **ambient seismic noise** as a powerful tool for imaging Earth structure at many different scales. Applications are emerging for sundry data sets with better understanding for a wide range of applications in **Seismology** including time-dependent imaging, underwater acoustics, helioseismology, and structural health monitoring, to cite only a few. These advances powered also significant applications in **Earthquake Engineering** as well. Besides noise-based imaging, innovative applications arise to establish dominant periods of sites and inverting the soil structure in order to compute seismic response.

This communication aims to review this wide subject. The author chooses as a conducting thread the energy, specifically the Principle of Equipartition of Energy and its implications in dynamic elasticity. The point of view is rather personal and links the multiple scattering with the idea of diffuse fields in which the energy equilibrate to fulfill the conditions predicted by the theory. The experimental verification of these predictions is discussed. It is then proposed that a random set of plane waves that fulfill the equipartition principle allows to retrieve from correlations the Green's function and allows defining a diffuse field. A correlation type representation theorem is used as a tool to derive useful equations. The use of emerging applications are discussed: The computation of Green's functions using equipartitioned cocktails of plane waves and the tomography of an alluvial valley using earthquake data collected along the years. The auto-correlations are related to directional energy densities and this leads to the deterministic partitions of energy and the interpretation of the noise H/V spectral ratio in terms of the Green's functions. This allows to deal with layered media and consider inversion from surface data and at depth. The effects of lateral heterogeneity can be studied from the same point of view.