Spectral Properties of Disordered Systems: Blue Sky, Long-Time Tails and Boson Peaks

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The spectral properties of quenched disordered systems are described using a fieldtheoretic formulation. Very different systems like electromagnetic waves in a disordered medium (our sky) sound waves in disordered solids and diffusing particles in disordered environments can be treated on the same footing. Rayleigh scattering (leading to the blue color of our sky) turns out to be mathematically equivalent to the long-time tail of the velocity autocorrelation function of diffusing particles, observed frequently in computer simulations. The enhancement of the vibrational density of states (boson peak), observed in glasses is equivalent to the onset of a strong frequency dependence of the AC conductivity of the diffusing (charged) particles. The field-theoretic treatment allows also for the inclusion of anharmonic interactions in the case of phonons in glasses. This leads to a low-frequency sound attenuation proportional to the temperature and the frequency squared - in agreement with experiment. Explicit expressions for the spectra measured in Raman spectroscopy, inelastic neutron and X-Ray scattering are given and compared with experimental data.