Characterizing disorder in space and time

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In many crystalline materials disorder, such as lattice defects, often critically controls properties. In glasses the structure is disordered without the lattice. In liquids, such as electrolyte, not only special disorder but temporal disorder is relevant, because the dynamics of disorder determines their properties. However, it is not easy to characterize disorder, both conceptually and by experiment. I discuss how recent advances in scattering techniques made it possible to determine atomic correlations in space and time much more accurately than before, through the atomic pair-density function (PDF), dynamic PDF, and the van Hove function, determined by elastic and inelastic x-ray and neutron scattering measurements. Examples include the structure of nano-crystals, local dynamics of relaxor ferroelectrics, liquid metals, superfluid helium and water.