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Pressure-dependent structures of amorphous red phosphorus and the origin of first sharp diffraction peaks.[1] JOSEPH ZAUG, LLNL, ALAN SOPER, RAL, SIMON CLARK, LBNL — Characterizing the nature of medium range order (MRO) in liquids and disordered solids is important for understanding their structure and transport properties. However, accurately portraying MRO, as manifested by the first sharp diffraction peak (FSDP) in neutron and X-ray scattering measurements, has remained elusive for more than 80 years. Here, using X-ray diffraction of amorphous red phosphorus (a-rP) compressed to 6.30 GPa, supplemented with micro-Raman scattering studies, we build three-dimensional structural models consistent with the diffraction data. We discover that the pressure dependence of the FSDP intensity and line position can be quantitatively accounted for by a characteristic void distribution function, defined in terms of average void-size, void-spacing, and void-density. This work provides a template to unambiguously interpret atomic and void-space MRO across a broad range of technologically promising network-forming materials.

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