3D Printed Scintillator Metamaterials

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Abstract: Scintillators, materials which emit light when hit by radiation, are a backbone technology of radiation detection. Scintillation detectors are often the lowest-cost way to identify the presence of radiation, but they often lack the capability to differentiate between types of radiation, identify the location of the radiation source, or precisely measure the emission energy spectrum of that source. Scintillator metamaterials are structured, heterogeneous mixtures of different scintillators with emergent properties. We are designing, simulating, and prototyping scintillator metamaterials produced using additive manufacturing (3D printing) that can sense details of the radiation down to the microscopic scale of tracking the recoils induced by the radiation. Our results show that scintillator metamaterials can detect the location of neutron sources as fast as cutting-edge neutron scatter cameras, using a significantly simpler instrumentation scheme that should enable low costs. Other metamaterial applications include neutron/gamma discrimination, neutron spectroscopy, and fine position resolution. We have prototyped these metamaterials using direct ink write of a polysiloxane-based scintillating feedstock, and are advancing to an integrated detector prototype.