Current active matter systems, such as self-propelled colloids or migrating cells, are inherently 2D, which limits the potential engineering applications. Brandeis developed the first 3D active nematic material by mixing an isotropic active fluid (Microtubules + kinesin motors) with a passive nematic colloidal liquid crystal (fd viruses). Using multiview light sheet microscopy, they explored the structure and the dynamics of topological defects in a 3D active nematic.

Both experiments and 3D hydrodynamic simulations suggest that topological defects in the turbulent regime are curvilinear. The defects form a complex network of lines and closed loops where neutral disclination loops are the generic excitations of 3D active nematics. The neutral loops can spontaneously nucleate from a uniform background through the bend instability, or split from the pre-existing network. The loops can also self-annihilate by closing on themselves or merge with the rest of the network. These events have also been identified in 3D hydrodynamic simulations.