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SN Ia DDT Explosions Powered by the Zel'dovich Reactivity Gradient Mechanism[1] EZRA BROOKER, TOMASZ PLEWA, Florida State University, DANIEL FENN, Lawrence Livermore National Laboratory — The deflagration-to-detonation transition (DDT) mechanism remains one of the major unsolved problems of combustion physics. Astrophysicists have suspected for almost 40 years that it is also directly responsible for a subclass of white dwarf (WD) explosions powering Type Ia supernovae (SN Ia). Much of the research on DDT in SN Ia has focused on the interactions of deflagration fronts with turbulence generated by the flame itself. Other work has focused on turbulence in the WD existing prior to ignition and the influence that turbulent properties, such as the compressibility and turbulent intensity, have on the detonability of the plasma. In our work, we construct and analyze weakly compressible turbulence combustion models for carbon/oxygen plasma at a density expected for DDT to occur. We observe formation of carbon deflagrations and transient carbon detonations at early times. As turbulence becomes increasingly inhomogeneous, sustained carbon detonations are initiated by the Zel'dovich reactivity gradient mechanism. The fuel is suitably preconditioned by the action of compressive turbulent modes with wavelength comparable to the size of resolved turbulent eddies. Oxygen detonations are initiated either by aid of reactivity gradients or by collisions of carbon detonations.

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