Abstract Submitted
for the SES21 Meeting of
The American Physical Society

**A Force Explosion Condition for Spherically Symmetric Core-collapse Supernovae** MARIAM GOGILASHVILI, JEREMIAH MURPHY, Department of Physics, Florida State University — Understanding which stars explode leaving behind neutron stars and which stars collapse forming black holes remains a fundamental astrophysical problem. We derive an analytic explosion condition for spherically symmetric core-collapse supernovae. The derivation starts with the exact governing equations, considers the balance of integral forces, includes the important dimensionless parameters, and includes an explicit set of self-consistent approximations. The force explosion condition is $\tilde{L}_\nu \tau_g - 0.06\tilde{\kappa} > 0.38$, and only depends upon two dimensionless parameters. The first compares the neutrino power deposited in the gain region with the accretion power, $\tilde{L}_\nu \tau_g = L_\nu \tau_g R_{\rm NS}/(G\dot{M}M_{\rm NS})$. The second, $\tilde{\kappa} = \kappa \dot{M}/\sqrt{GM_{\rm NS}R_{\rm NS}}$, parameterizes the neutrino optical depth in the accreted matter near the neutron-star surface.Using numerical, steady-state and fully hydrodynamic solutions, we test the explosion condition. The success of these tests is promising in two ways. One, the force explosion condition helps to illuminate the underlying physics of explosions.Two, this condition may be a useful explosion diagnostic for 3D radiation hydrodynamic core-collapse simulations.

Mariam Gogilashvili
Department of Physics, Florida State University

Date submitted: 30 Sep 2021 Electronic form version 1.4