Abstract Submitted
for the APR16 Meeting of
The American Physical Society

Can magnetic-field windup kill the r-mode instability of neutron stars? JOHN FRIEDMAN, University of Wisconsin-Milwaukee, LEE LINDBLOM, University of California San Diego, LUCIANO REZZOLLA, Goethe University of Frankfurt — At second order in perturbation theory, the unstable r-mode of a rotating star includes growing differential rotation whose form and growth rate are determined by gravitational radiation reaction. With no magnetic field, the angular velocity of a fluid element grows exponentially until the mode reaches its nonlinear saturation amplitude and remains nonzero after saturation. With a background magnetic field, the differential rotation winds up and amplifies the field, and previous work suggests that the amplification may damp out the instability. A background magnetic field, however, turns the time-independent perturbations corresponding to adding differential rotation into perturbations with characteristic frequencies of order the Alfven frequency. We argue that magnetic field growth stops soon after the mode reaches its saturation amplitude. We show that this is the case for a toy model, where magnetic amplification for small saturation amplitude is too small to damp the r-mode. For a more realistic model of a cold, rotating neutron star, an analogous upper limit depends on the assumption that there are no marginally unstable perturbations.

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Date submitted: 11 Jan 2016 Electronic form version 1.4