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Nonlinear development of the r-mode instability of accreting neutron stars: Three Modes RUXANDRA BONDARESCU, SAUL TEUKOLSKY, IRA WASSERMAN, Cornell University, Ithaca, NY — Rotating neutron stars have modes that are driven unstable by gravitational radiation reaction, principally the "R-mode", a L=m=2 Rossby wave. It has been suggested that the R-mode instability is what sets the largest spin frequency of accreting neutron stars. This maximum frequency depends on the neutron star composition via viscous dissipation and neutrino cooling, and so is a probe of the high density nuclear physics of neutron stars. The nonlinear development of the instability plays a very important role in determining how this process works, and also illustrates how instabilities can saturate at low amplitudes as a consequence of nearly resonant excitation of other modes. We model the nonlinear effects using a minimal model, which includes three modes: the r-mode and the first two near-resonant modes it couples to that become unstable. We solve the coupled equations for the three-mode amplitudes in conjuction with the spin and temperature evolution numerically. The mode amplitudes settle quickly into quasi-stationary states that depend weakly on angular velocity and temperature. Eventually, the system may reach an equilibrium or undergo a cyclic evolution, with an r-mode amplitude $\sim 10^{-5}$. Alternatively, it may runaway, in which case the r-mode amplitude grows large enough to excite more modes and the three-mode model becomes insufficent.

Ruxandra Bondarescu
Cornell University, Ithaca, NY

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