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General relativistic simulations of slowly rotating, magnetized stars: A perturbative metric approach ZACHARIAH ETIENNE, Y.T. LIU, S. SHAPIRO, UIUC — Understanding the role general relativistic magnetohydrodynamic (GRMHD) effects play in the evolution of nascent neutron stars is a problem at the forefront of theoretical astrophysics. To this end, we performed long-term ($\sim 10^4 M$) axisymmetric simulations of differentially rotating magnetized neutron stars in the slow-rotation, weak magnetic field limit using a dynamically updated perturbative metric evolution technique. Although the perturbative metric approach yields results comparable to those obtained via a nonperturbative (BSSN) metric evolution technique, simulations performed with the perturbative metric solver require about 1/4 the computational resources at a given resolution. This computational efficiency enabled us to observe and analyze the effects of magnetic braking and the magnetorotational instability (MRI) at very high resolution. Our GRMHD simulations demonstrate that (1) MRI is not observed unless the estimated fastest-growing mode wavelength is resolved by $\gtrsim 10$ gridpoints; (2) as resolution is improved, the MRI growth *rate* converges, but due to the small-scale nature of MRI-induced turbulence, the maximum growth *amplitude* increases, but does not exhibit convergence, even at the highest resolution; and (3) independent of resolution, magnetic braking drives the star toward uniform rotation as energy is sapped from differential rotation by winding magnetic fields.

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