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Accretion-induced collapse to third family compact stars as trigger for eccentric orbits of millisecond pulsars in binaries

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A numerical rotating neutron star solver is used to study the temporal evolution of accreting neutron stars using a multi-polytrope model for the nuclear equation of state named ACB5. The solver is based on a quadrupole expansion of the metric, but confirms the results of previous works, revealing the possibility of an abrupt transition of a neutron star from a purely hadronic branch to a third-family branch of stable hybrid stars, passing through an unstable intermediate branch. The accretion is described through a sequence of stationary rotating {stellar} configurations which lose angular momentum through magnetic dipole emission while, at the same time, gaining angular momentum through mass accretion. The model has several free parameters which are inferred from observations. The mass accretion scenario is studied in dependence on the effectiveness of angular momentum transfer which determines at which spin frequency the neutron star will become unstable against gravitational collapse to the corresponding hybrid star on the stable third-family branch. It is conceivable that the neutrino burst which accompanies the deconfinement transition may trigger a pulsar kick which results in the eccentric orbit. A consequence of the present model is the prediction of a correlation between the spin frequency of the millisecond pulsar in the eccentric orbit and its mass at birth.

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