Constraining f-Modes in Binary Neutron Star Inspirals with Gravitational Waves

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Gravitational waves (GWs) from colliding neutron star binaries provide a unique means to probe matter at supranuclear densities. Whilst adiabatic tidal effects leave the strongest imprint on the GW phase, dynamical tidal effects due to the fundamental (f-) mode modify the GW phase above $\sim$ 800Hz. We present an approximate closed-form model for the GW phase from dynamical tides for circular, nonspinning binaries. This additional tidal phase depends explicitly on the frequency of the f-mode of each neutron star, making f-mode asteroseismology an accessible observable with gravitational wave detections. Without invoking universal relations, we can place a robust lower limit on the f-mode frequency. In a re-analysis of GW170817, we estimate a lower limit on the f-mode frequency consistent with the predictions from universal relations. Finally, we present prospects for measuring the f-mode frequency from inspiraling neutron star binaries with future GW observatories.