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# Quasi-universal properties of neutron star mergers

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In principle yes, but the **late inspiral** (and possibly **merger**) signal is needed.

([Damour&al, 2012], [Del Pozzo&al, 2013], [Read&al, 2013])

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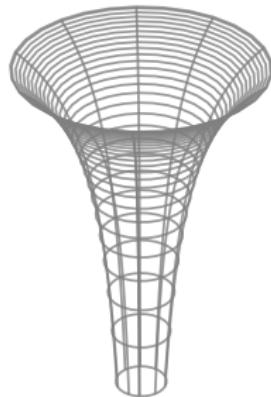
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Which method can be used to describe neutron star dynamics close to merger?

- ▶ Numerical Relativity
- ▶ Effective One Body (EOB) approach!

# Basic EOB concept: a $\nu$ -deformed Schwarzschild metric

Schwarzschild



$M$

$$A(u) = 1 - 2u$$

EOB

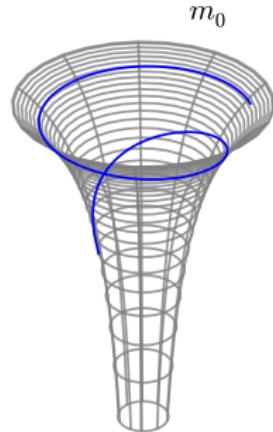


$M_{tot}$

$$\begin{aligned} A(u) = P_4^1 & \left[ 1 - 2u + 2\nu u^3 \right. \\ & \left. + \left( \frac{94}{3} - \frac{41}{32}\pi^2 \right) \nu u^4 + a_5 \nu u^5 \right] \end{aligned}$$

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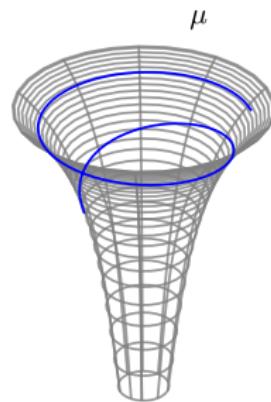
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## A little bit more details...

Non-spinning EOB Hamiltonian:

$$H_{EOB} = M \sqrt{1 + 2\nu(H_{eff}/\mu - 1)}$$
$$H_{eff}/\mu = \sqrt{A(u; \nu) (1 + p_\varphi^2 u^2 + 2\nu(4 - 3\nu)u^2 p_{r*}^4) + p_{r*}^2}$$

(See [Buonanno&Damour, 1999],[Damour&al, 2000]).

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(See [Buonanno&Damour, 1999],[Damour&al, 2000]).

**In the present work:** uncalibrated model with  $A(u)$  up to 4PN, with Padé  $P_4^1$ ; spin-orbit effects up to NNLO ( $\sim 3.5$ PN), spin-spin effects at LO ( $\sim 2$ PN), according to the lineage of [Damour, 2001] (other versions exist!).

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From [Damour&Nagar, 2010]:

$$A(u) = A^0(u) + A^T(u)$$
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- ▶ Point-particle EOB radial potential

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- ▶ **Tidal coupling constant**
- ▶ Fractional 1PN and 2PN tidal corrections  
(functions of  $\kappa_\ell^T$  and of the mass-ratio).

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$$\kappa_\ell^T = 2 \frac{m_B}{m_A} \left( \frac{m_A}{M C_A} \right)^{2\ell+1} k_\ell^A + 2 \frac{m_A}{m_B} \left( \frac{m_A}{M C_B} \right)^{2\ell+1} k_\ell^B.$$

- ▶ Compactness  $C = \frac{M}{R}$
- ▶ Dimensionless Love number
  - ▶ EOS-dependent
  - ▶ measures the  $\ell$ -th order mass multipole moment induced by an external,  $\ell$ -th order multipolar tidal field

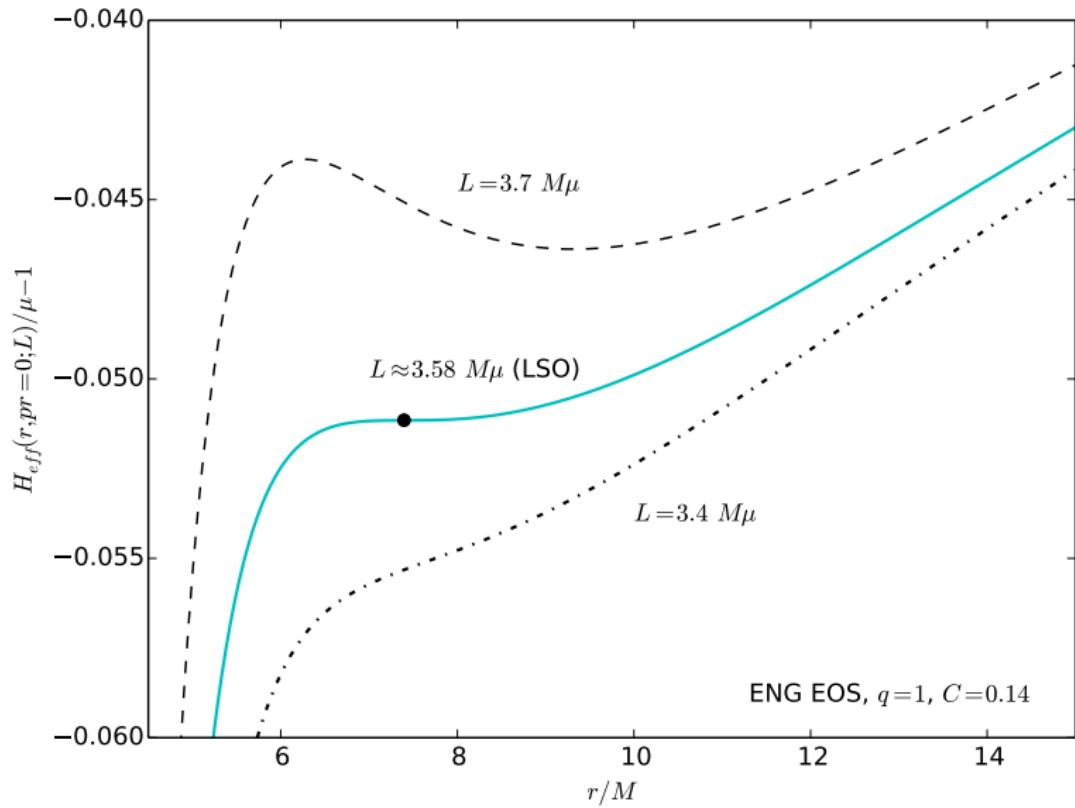
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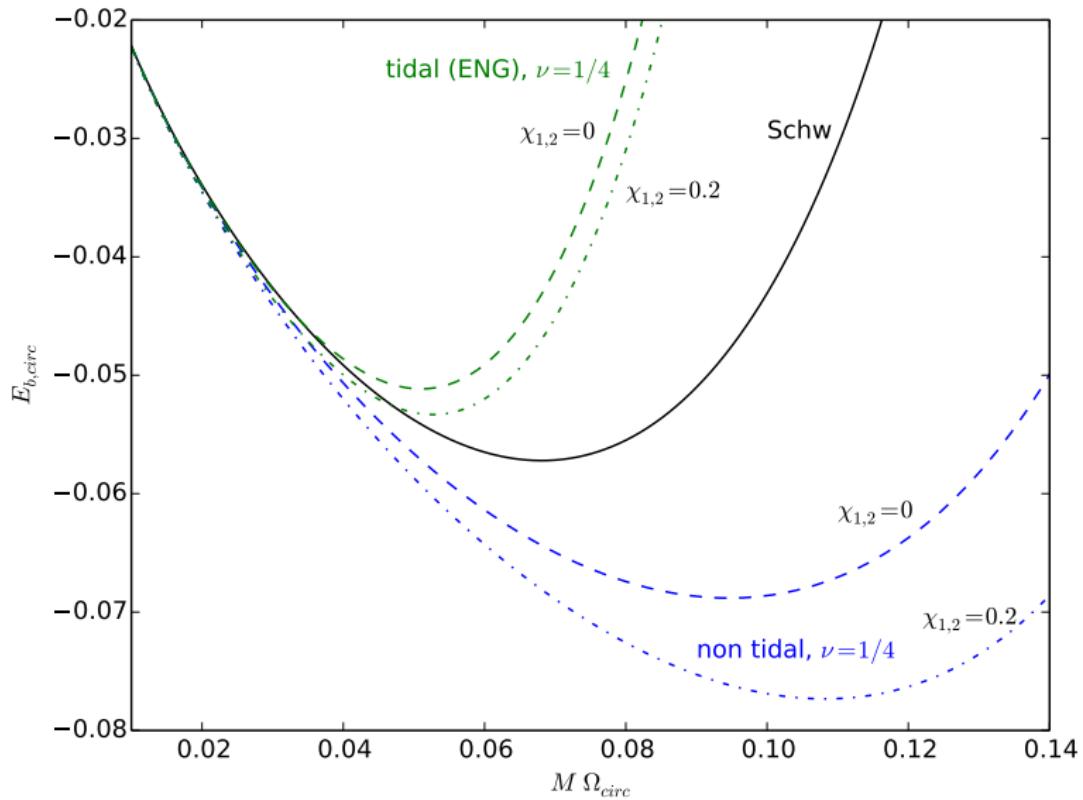
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EOS effects are essentially parametrized by the dominant coefficient  $\kappa_2^T$ !

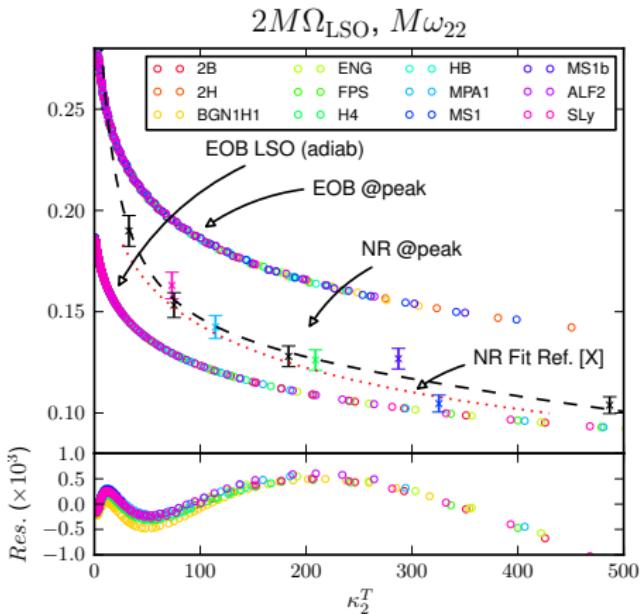
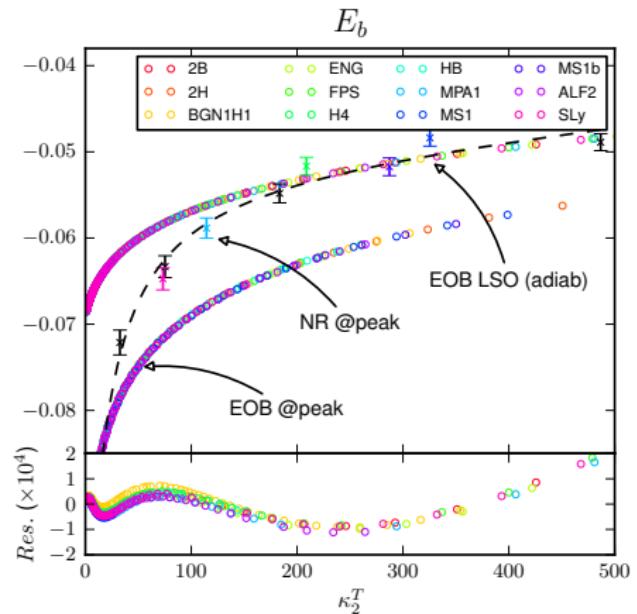
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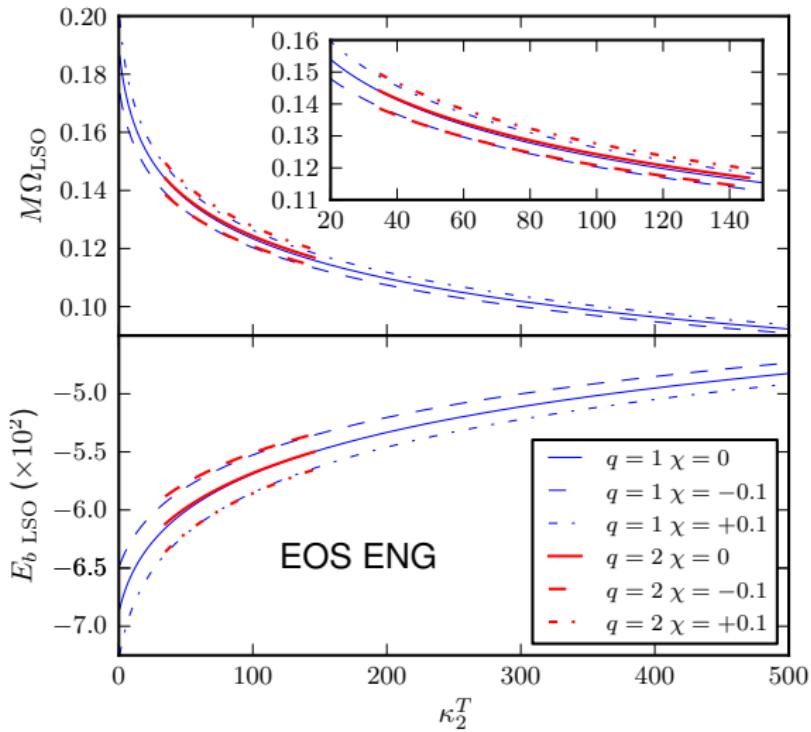
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- ▶ A **single measurement** of the frequency at merger might allow to **constrain the EOS**.