2026.06.29-07.03 Thematic School GWsNS-2026 @Roscoff, France

Universal Relations among various Spin-induced Multipole Moments and Tidal Deformabilities of Neutron Stars

paper on the ArXiv soon!

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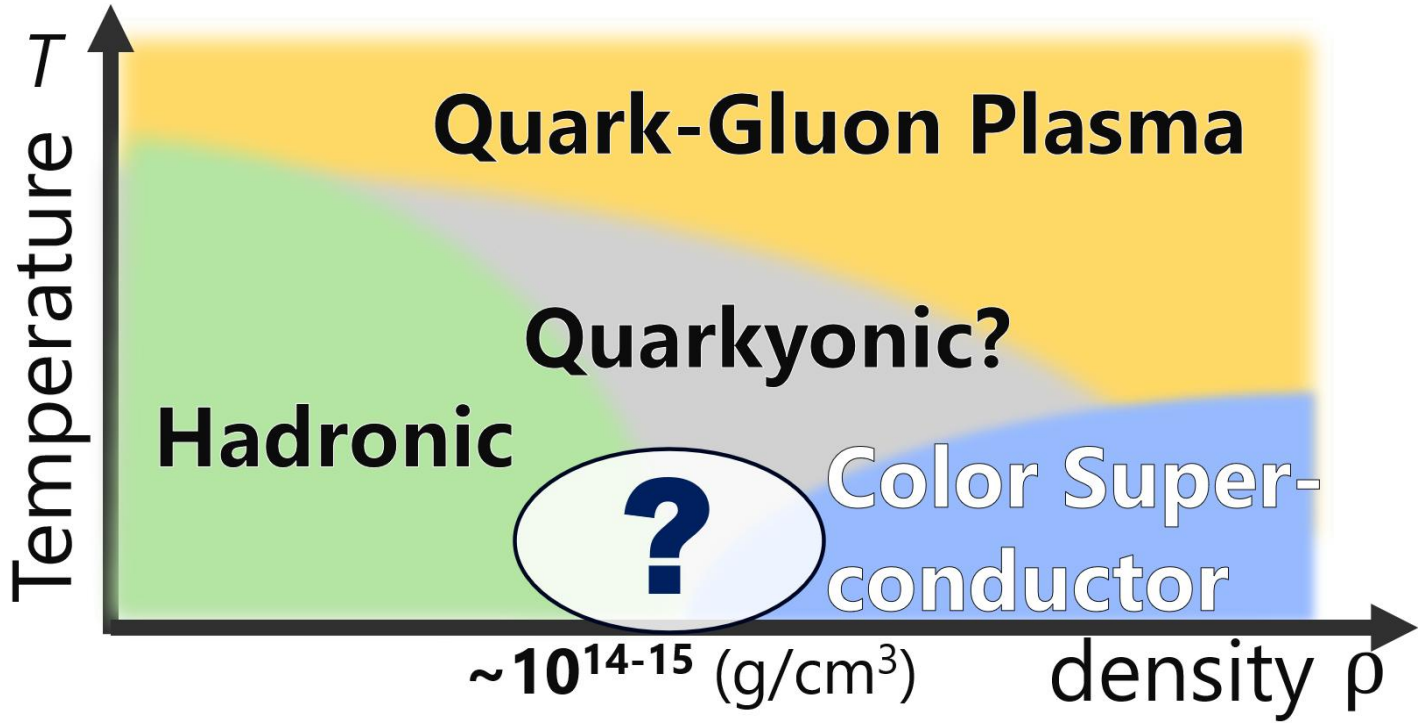
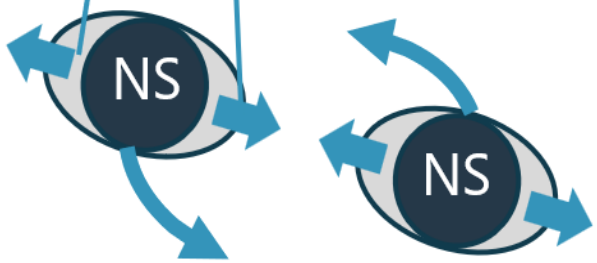
High Density Nuclear Matter Physics

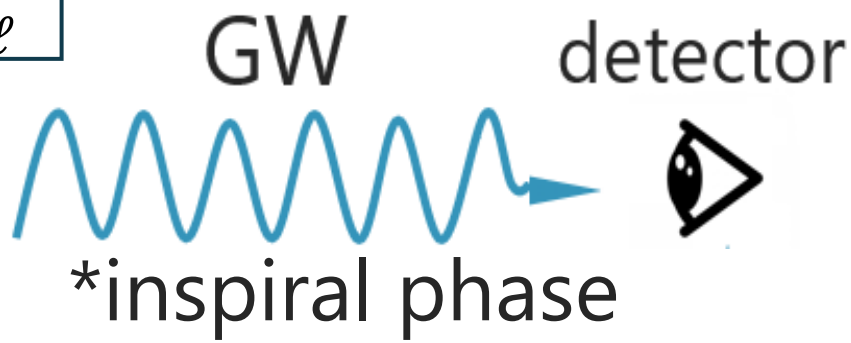


☹ ground experiment
☹ lattice QCD

☺ **Neutron star (NS)**

tidal deformability λ_ℓ

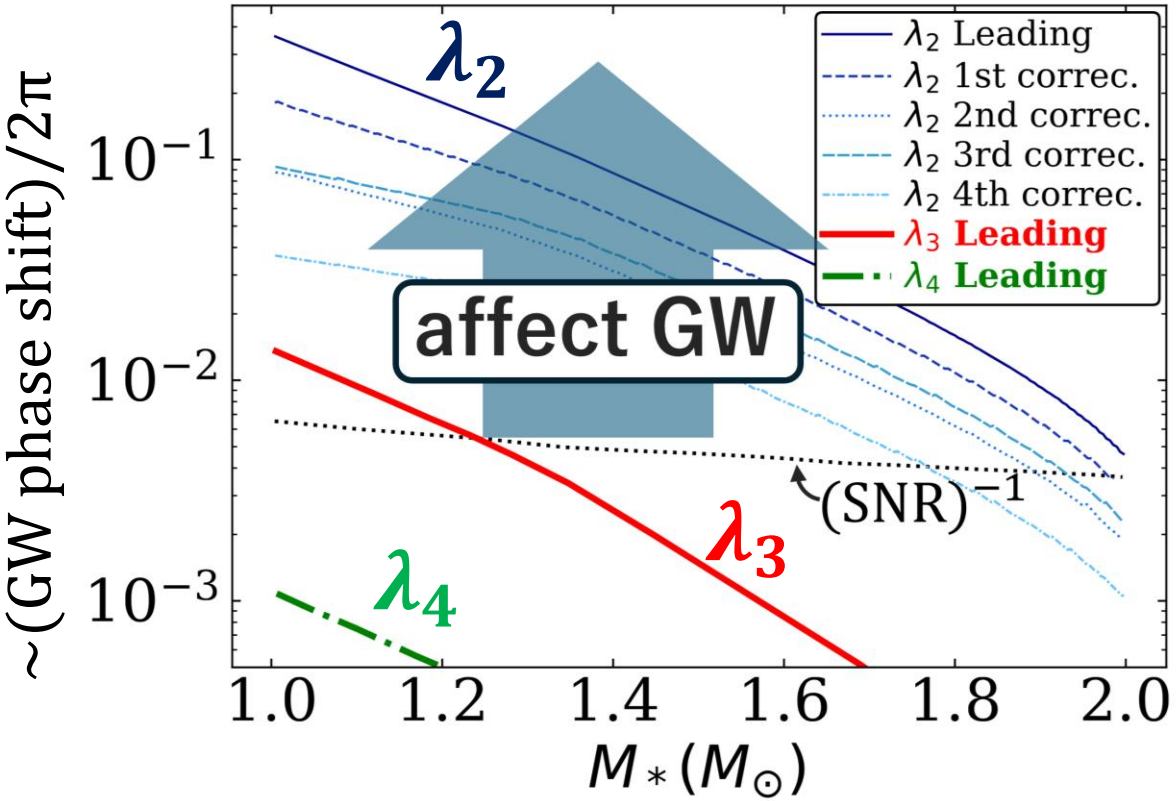




lower λ
→ softer Equations of State

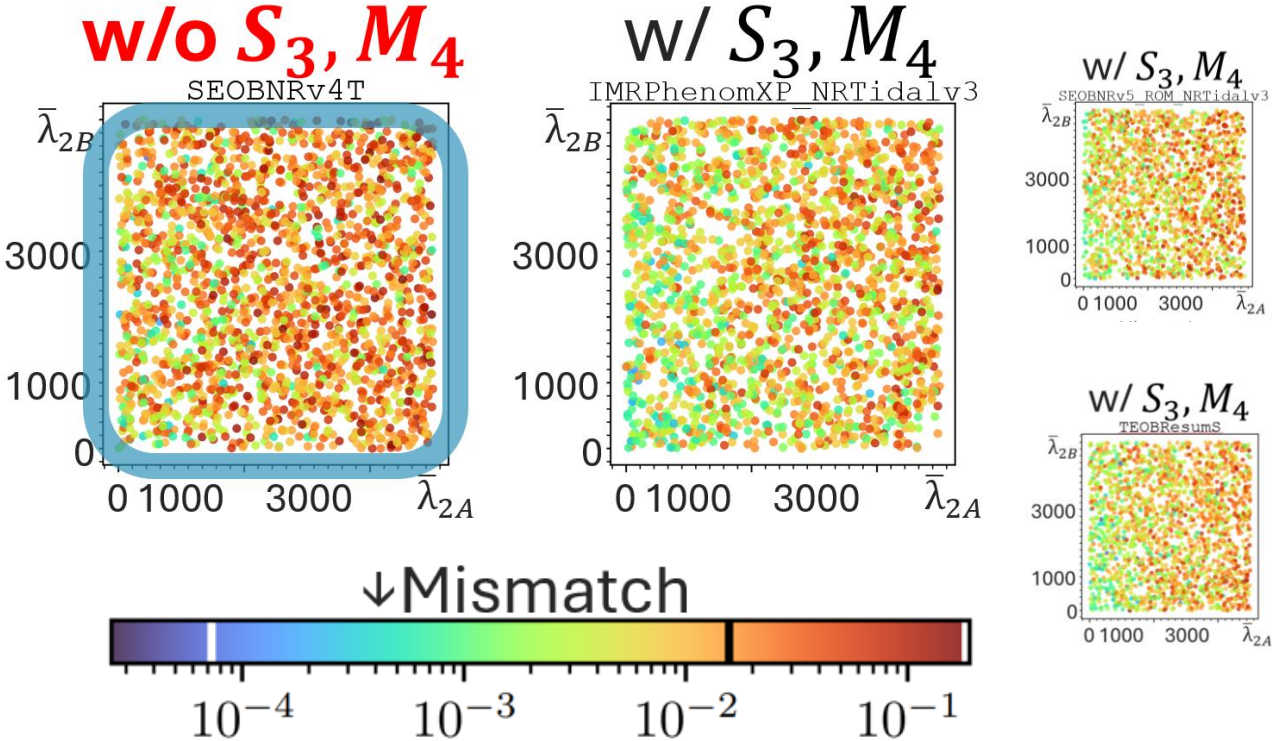
Higher-Order Tidal Deformabilities λ_3, λ_4 & Spin-Induced Multipole Moments S_3, M_4 Needed in GW Template

EoS=SLy4, D=100Mpc, Einstein Telescope



(left) K. Yagi, Phys. Rev. **D89**, 043011 (2014) modified

SEOBNRv5THM (w/ S_3, M_4) v.s. …



(right) M. Haberland et al., Phys. Rev. **D112**, 084024 (2025)

EoS-insensitive Universal Relations

more # of params in GW template → degeneracy

universal relations

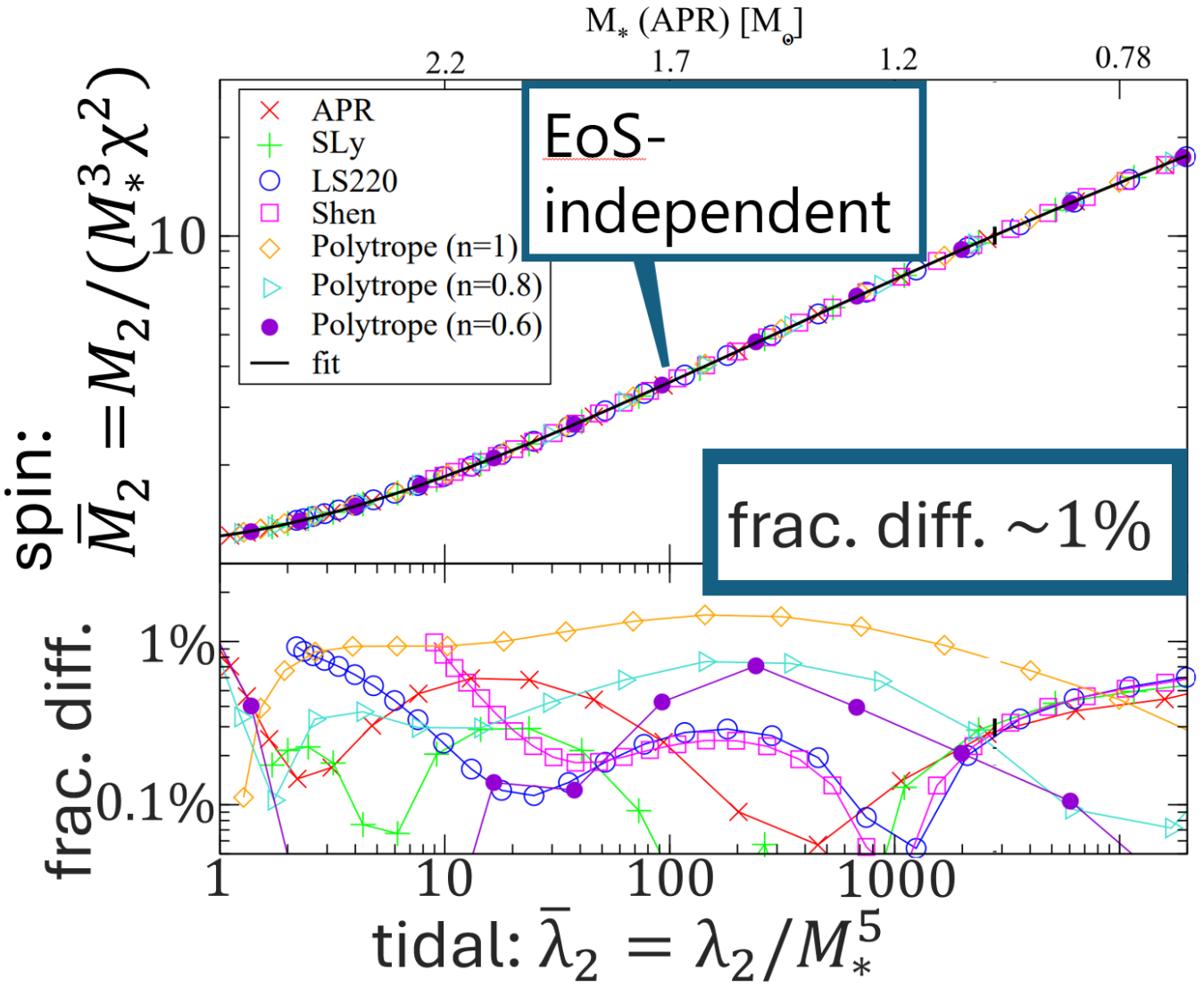
e.g., $\bar{M}_2 = \bar{M}_2(\bar{\lambda}_2)$

(Yagi and Yunes (2013))

allow $\lambda_3, \lambda_4, S_3, M_4$ to be included w/o adding independent parameters.

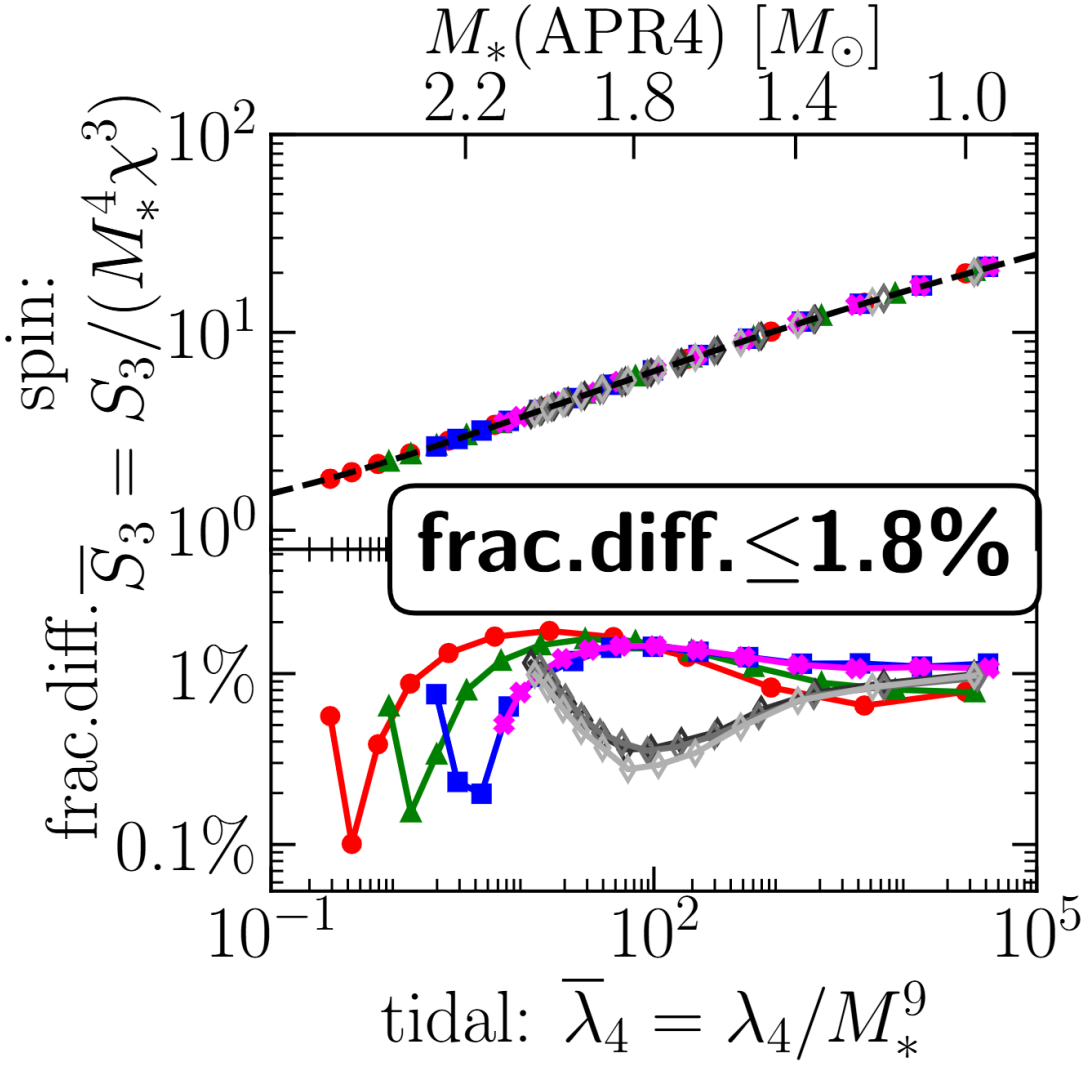
Previous:10-20% frac. diff.

Improve?



K. Yagi and N. Yunes, Phys. Rev. D 88, 023009 (2013)

Result： O(1)% Universal Relations & Explanation of Tendency of Frac. Diff.



Max frac. diff. (%)

y_i \ x_i	$\bar{\lambda}_2$	$\bar{\lambda}_3$	$\bar{\lambda}_4$
$\bar{M}_2$	0.57	1.3	2.6
$\bar{S}_3$	5.1	2.9	1.8
$\bar{M}_4$	11	6.7	3.9

↑Explain these by the power of compactness= M_*/R_*