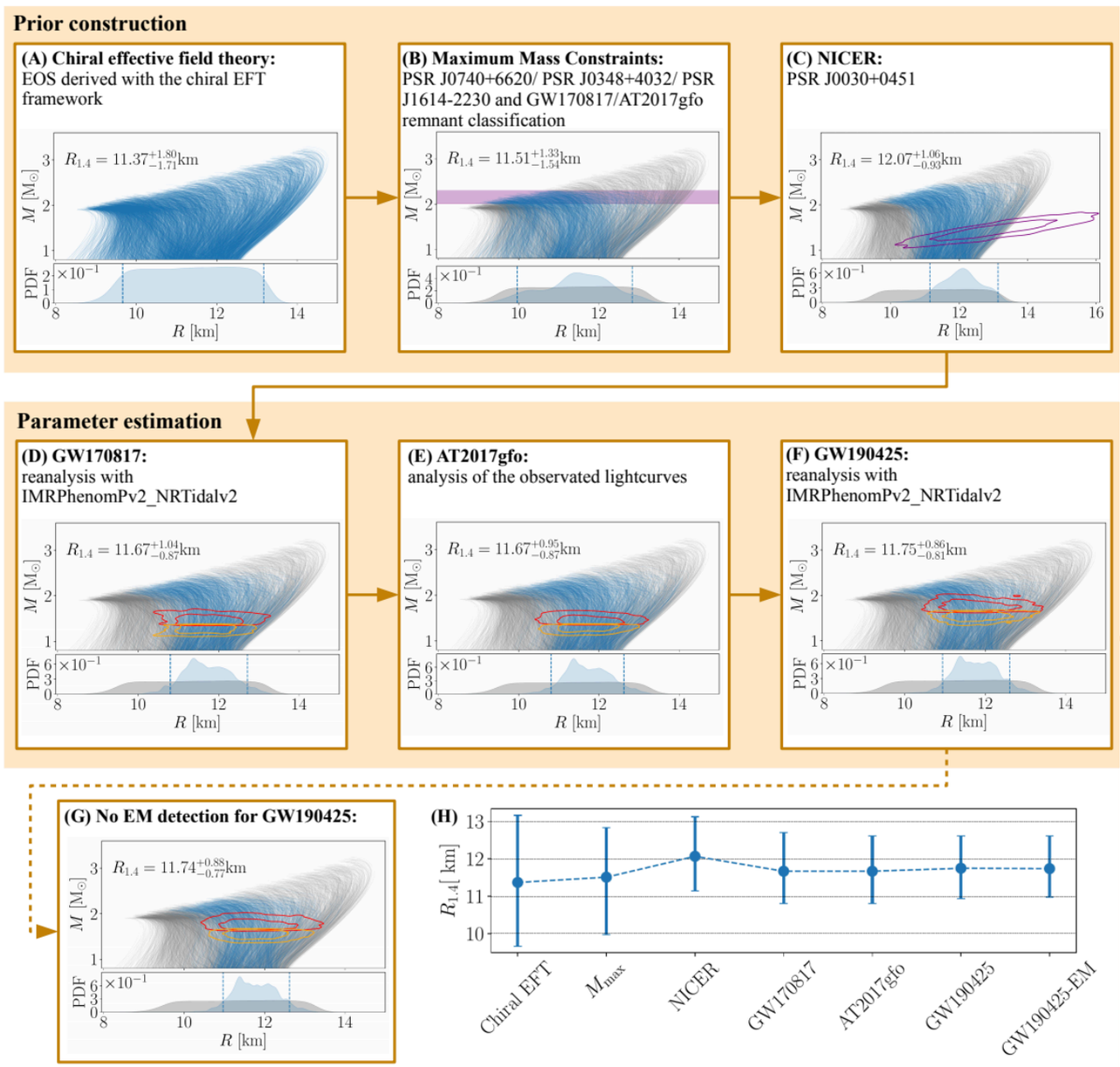
Multimessenger constraints on the neutron-star equation of state and the Hubble constant

U.S. DEPARTMENT OF ENERGY | Office of Science

NUCLEI Nuclear Computational Low-Energy Initiative

Objectives

- We combine EOS constrained by Quantum Monte Carlo (QMC) calculations with neutron-star (NS) data from gravitational-wave and electromagnetic observations of NS mergers, NICER, and NS mass measurements.



Evolution of neutron-star mass-radius relation as more astrophysical data is included. Insets show the radius posterior of a typical 1.4 M_{sol} neutron star.

Impact

- The robust statistical analysis of all available data from NSs and NS mergers provides the most stringent constraints on the radius of a typical 1.4 M_{sol} NS:

$$R_{1.4} = 11.75^{+0.86}_{-0.81}\mathrm{km}$$

- Our analysis also allows us to measure the expansion rate of the Universe described by the Hubble constant H_0. Previous determination using type I-a supernovae or the Cosmic Microwave Background (CMB) disagree, know as Hubble tension. Our findings agree with the CMB:

$$H_0 = 66.2^{+4.4}_{-4.2}\mathrm{km\ Mpc^{-1}}s^{-1}$$

- We also use our framework to address the recent NS merger GW190814, whose nature cannot be determined from observations alone. We find that this system likely was a binary black-hole merger.

Accomplishments

- C. Capano, I. Tews, et al., Nat. Astron. **4**, 625 (2020)
- T. Dietrich et al., Science **370**, Iss. 6523, 1450 (2020)
- I. Tews et al., Astrophys. J. Lett. **908**, L1 (2021)
- Highlighted by the DOE Office of Science
- Research featured in Scientific American, Forbes, Phys.org (here and here) and others.

LA-UR-21-22499