Study of the Equation of State of Hot Ultra-Dense Matter in Binary Neutron Star Mergers

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Introduction

BNS mergers are one of the most extreme events occuring in the universe. The high density and temperature, that depend on nuclear interaction, allow the following reactions to occur:

$$n + e^+ \rightarrow p + \bar{\nu}_e \, , \qquad p + e^- \rightarrow n + \nu_e \, .$$

The contributions of all the BNS mergers occurring in the universe produce a background of neutrinos.

- Does the EoS of ultra-dense matter have an impact on the BNS merger neutrino background?
- Can we detect this effect in neutrino observatories?
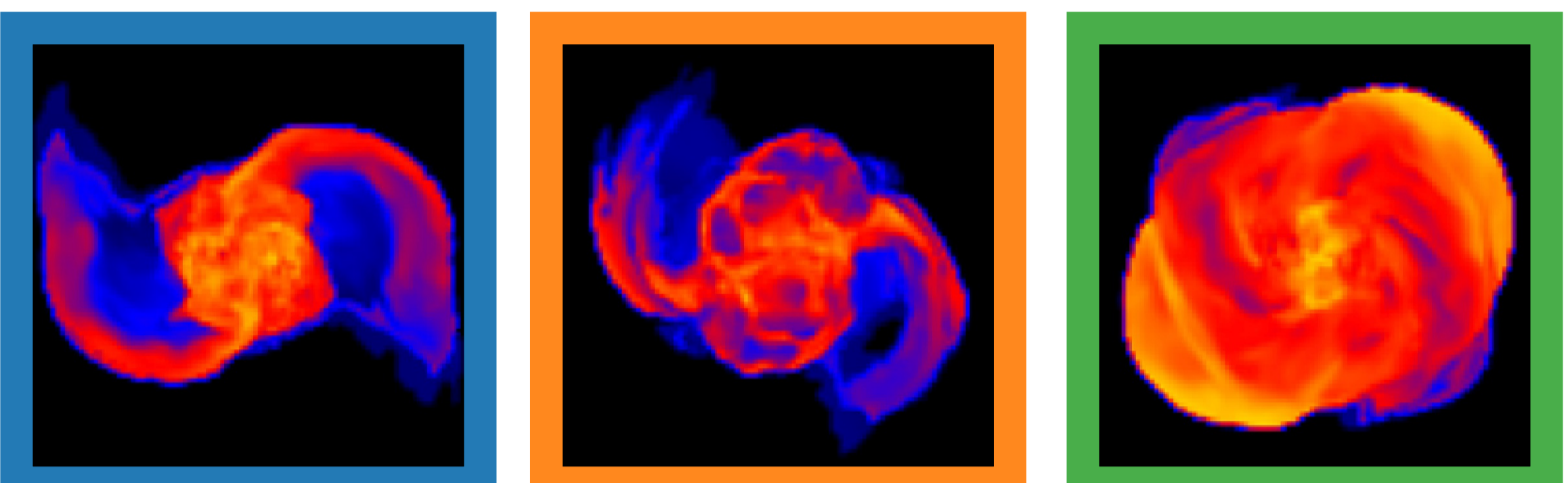
Methods

Fig1: *Neutrino surfaces for the EoS DD2, NL3 and SFHo obtained with hydrodyamic simulations [1].*
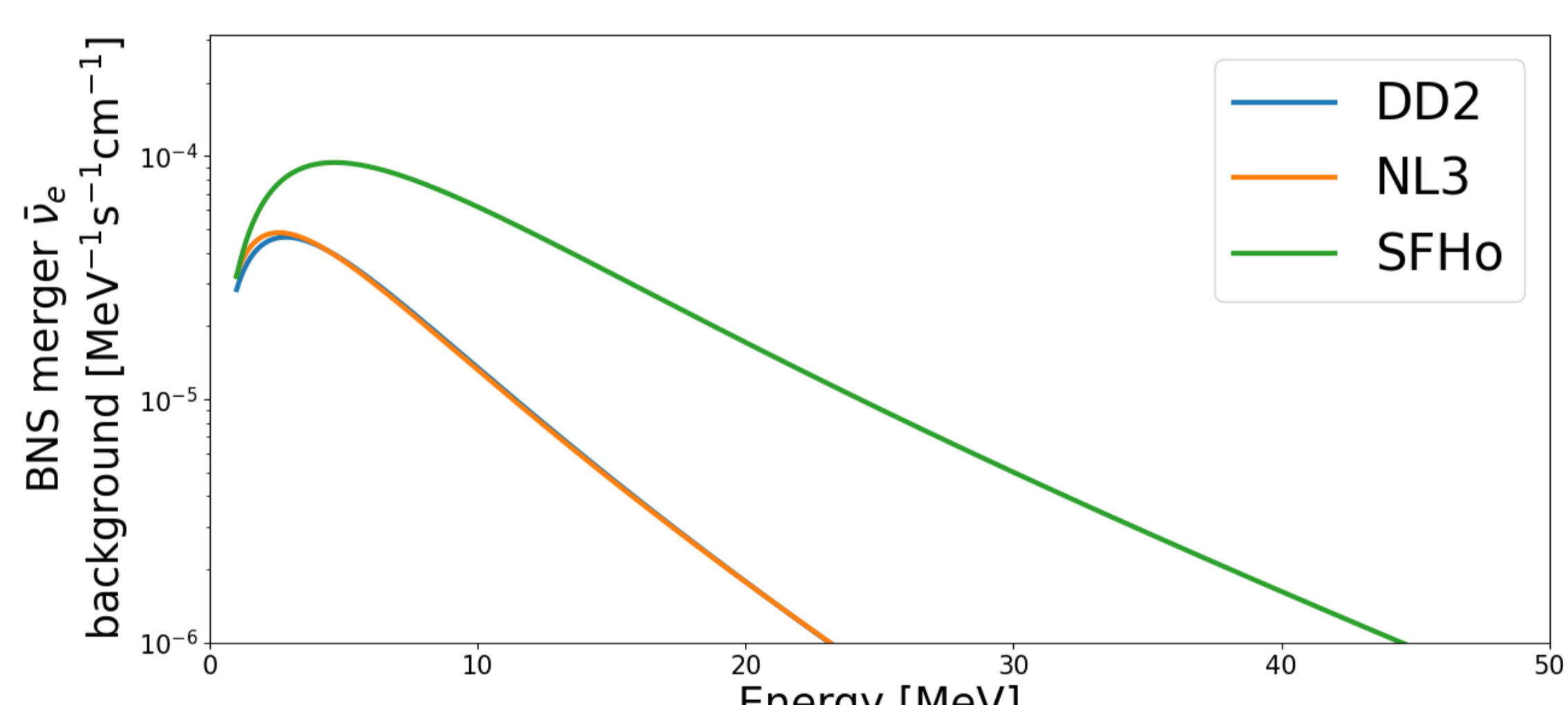
Results

Fig2: *Antineutrino BNS merger background for the 3 EoS.*

Discussion

This analysis was done for neutrinos. A more in-depth understanding of reactions in neutrino observatories to fully characterize the background, as well as the use of other "messengers" (photons, GW) to measure the impact of the EoS on other observables, will allow us to put more constraints on the EoS used to describe BNS mergers.

References

[1] Palenzuela, C., Liebling, S. L., Neilsen, D., Lehner, L., Caballero, O. L., O'Connor, E., & Anderson, M. (2015). Effects of the microphysical equation of state in the mergers of magnetized neutron stars with neutrino cooling. *Physical Review D, 92*(4), 044045.

What is happening during a **binary neutron star merger** depends on the behaviour of the **nuclear matter.**

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