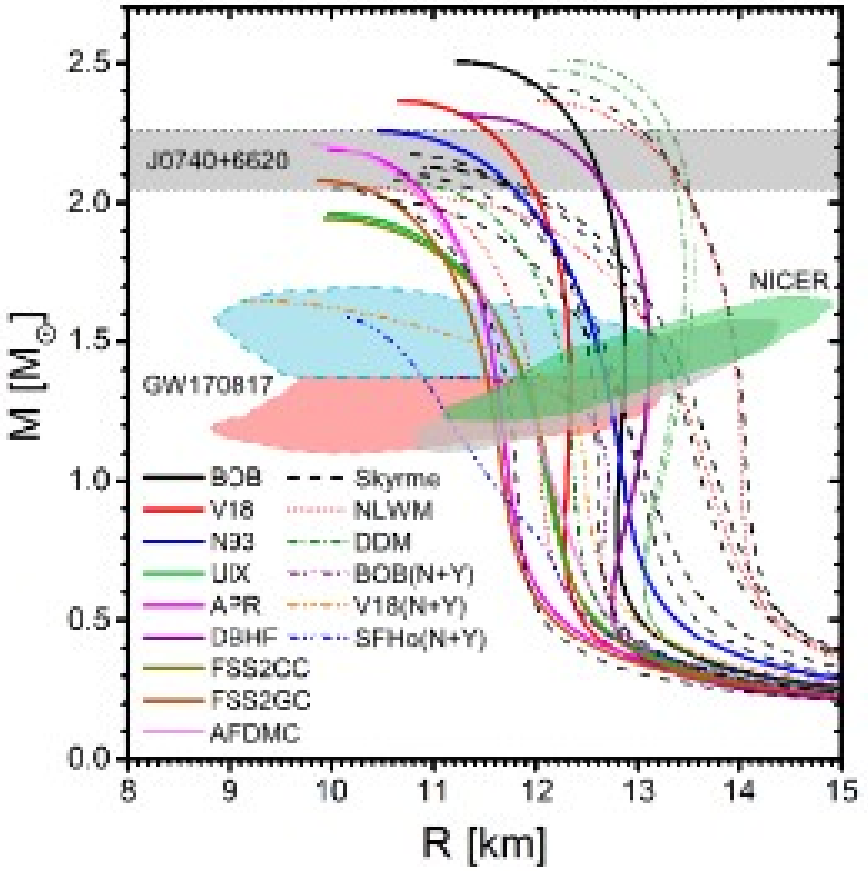
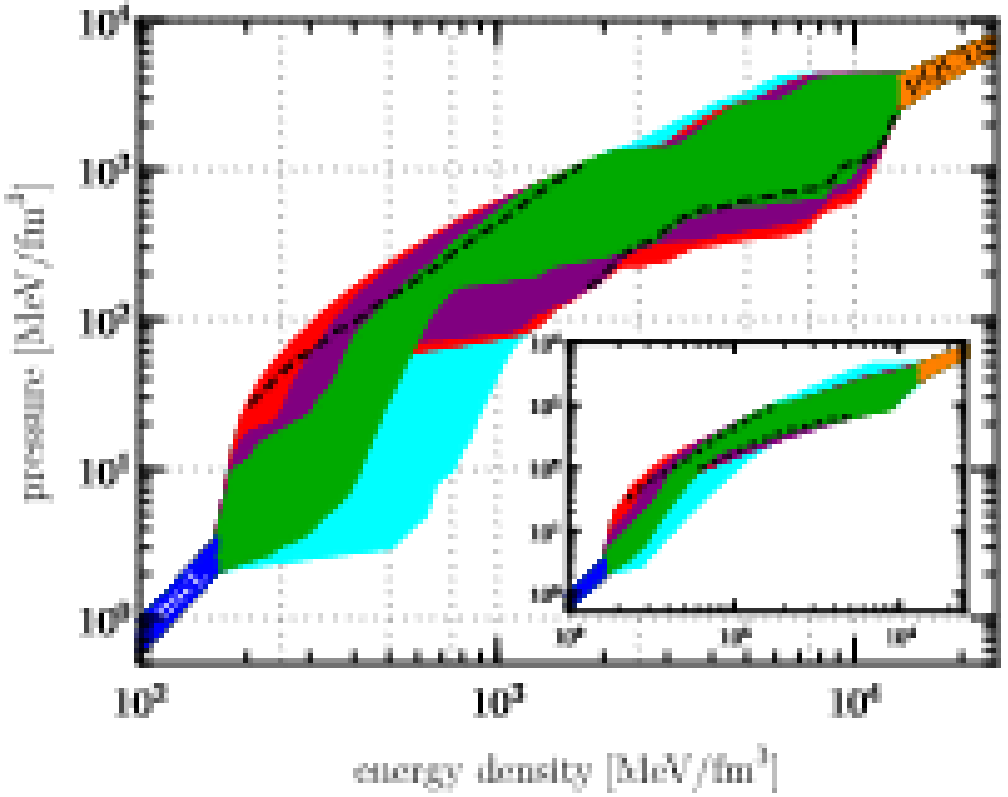
Neutron Star (M,R) and NS matter EOS

- (M,R) → P(ε)
- P(ε) is enough to calculate M, R, Λ (tidal deformability).



G. F. Burgio et al. [2105.03747]



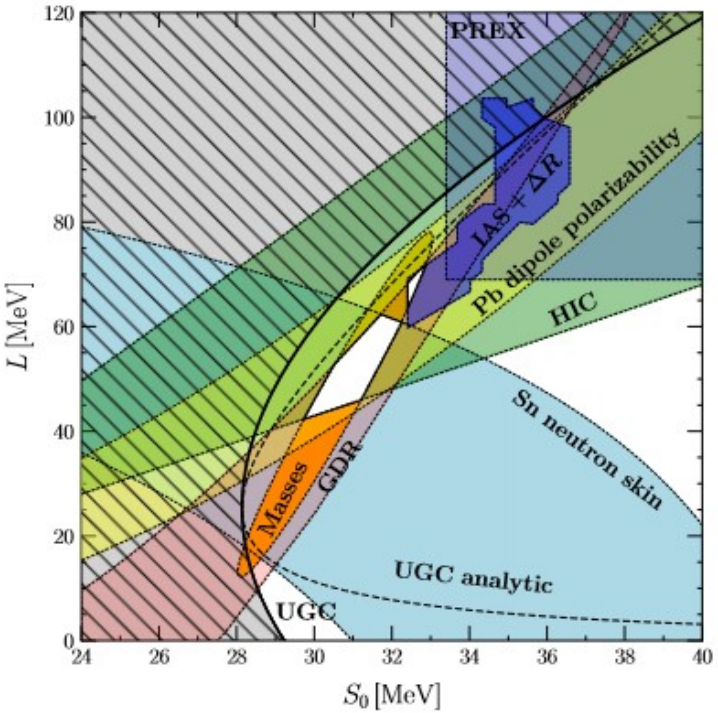
E. Annala et al. [1711.02644]

Nuclear Matter EOS

- P(ε) is not enough for dynamical processes
  - Supernova Explosion, Failed SN Explosion (Black hole formation) → neutrino processes are essential
  - SNE, BHF, Binary Neutron Star Mergers, … → Magnetic field plays a decisive role
- "Minimum" EOS

$$F(\rho_B, T, Y_Q)/V \quad (Y_Q = Q_h/B)$$

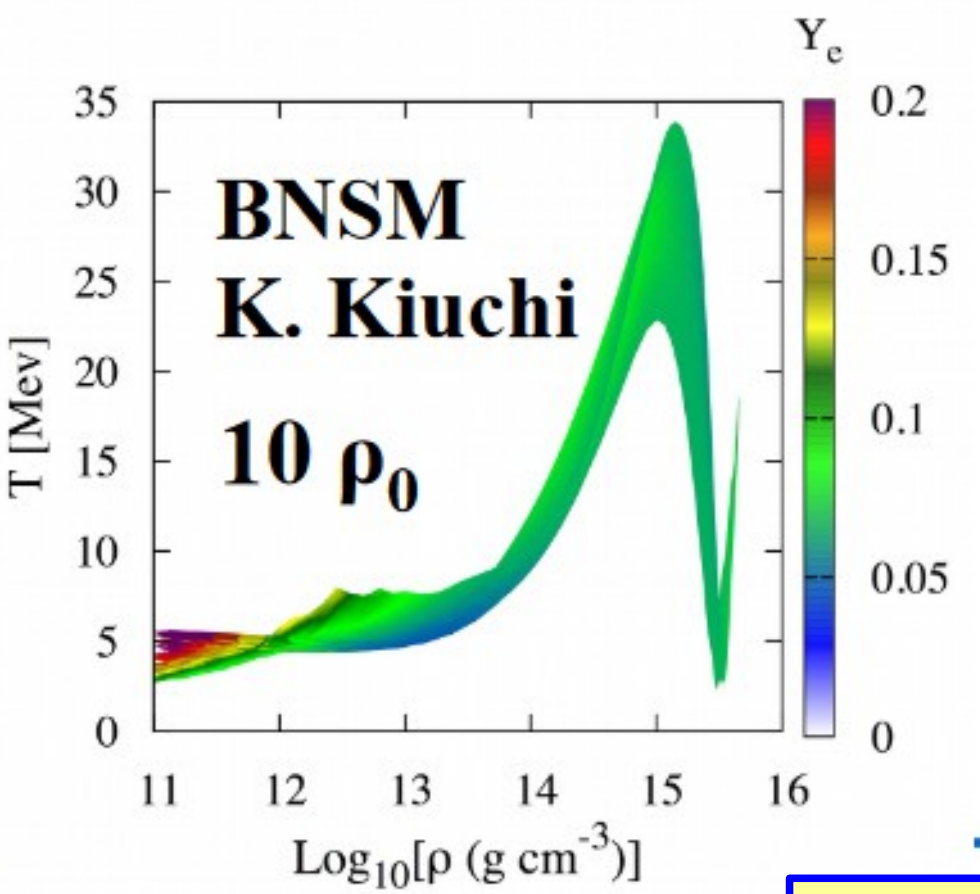
  - Symmetry energy is needed.
  - Hopefully with hadron/nuclear/quark compositions



Tews, Lattimer, AO, Kolomeitsev, [1611.07133]

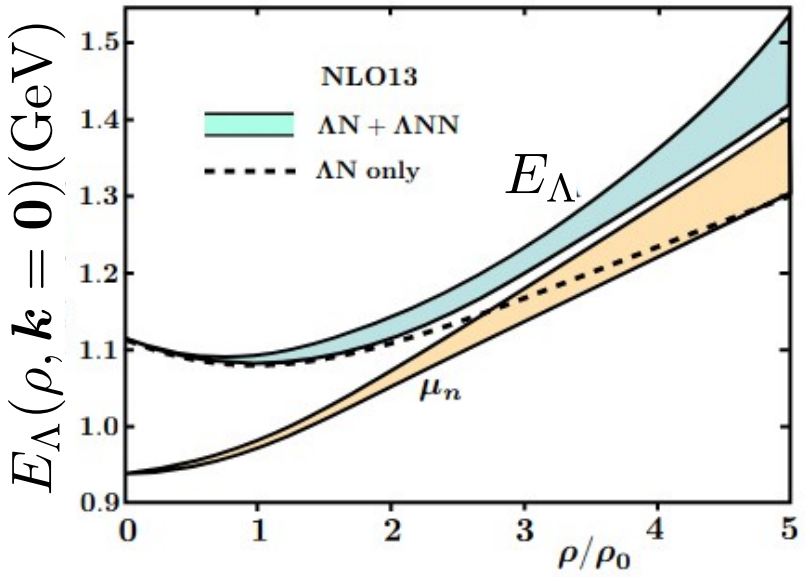
New degrees of freedom

- **BNSM probes warm-dense matter, $10\rho_0$, T=30 MeV**
  → One naturally expects emergence of other DOF appears



Calculation by K. Kiuchi based on results from M. Shibata [1710.07579]

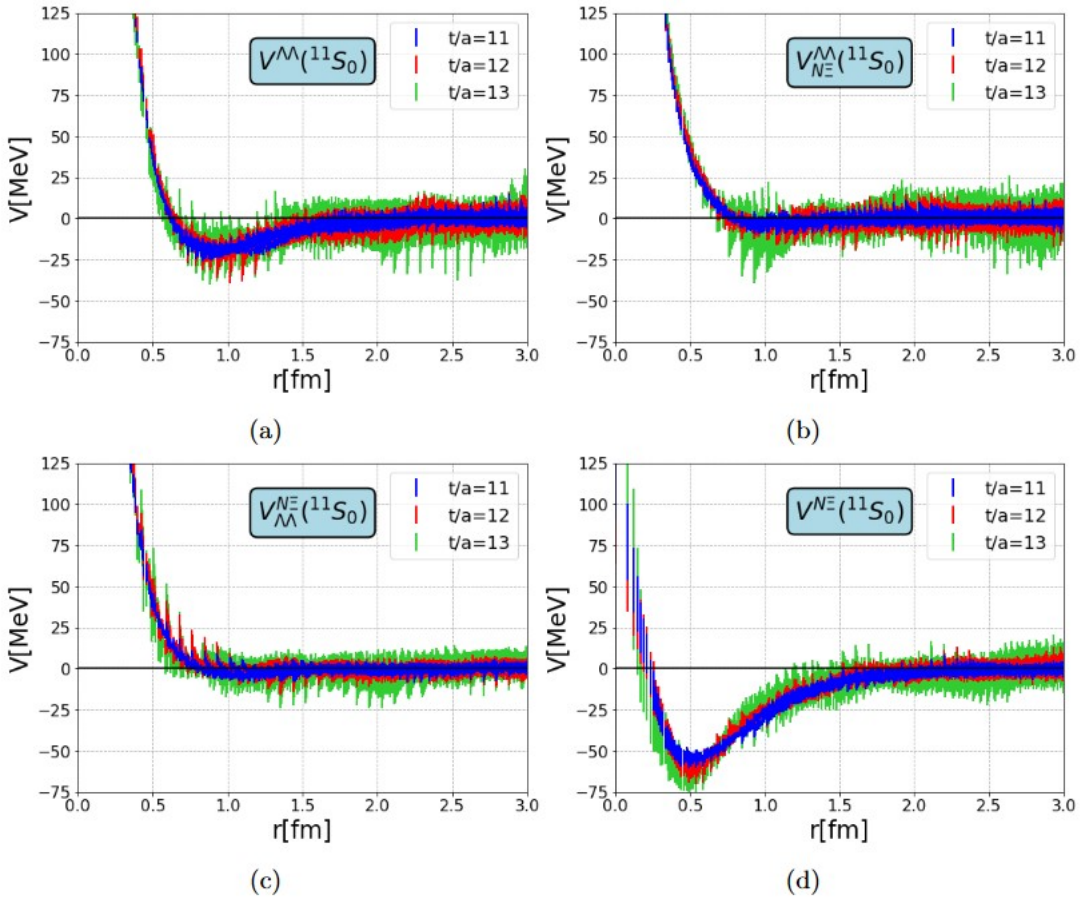
Hyperons may be introduced using chiral EFT results in transport models

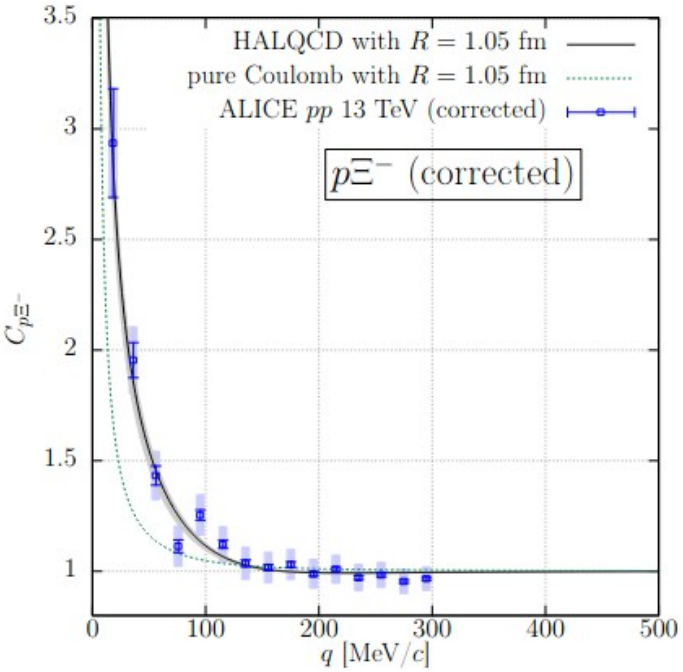


Gerstung, Kaiser, Weise ('20)

quarks, gluons, diquarks, mesons, …
→ Try and error from models

Status of lattice hadron-hadron interactions



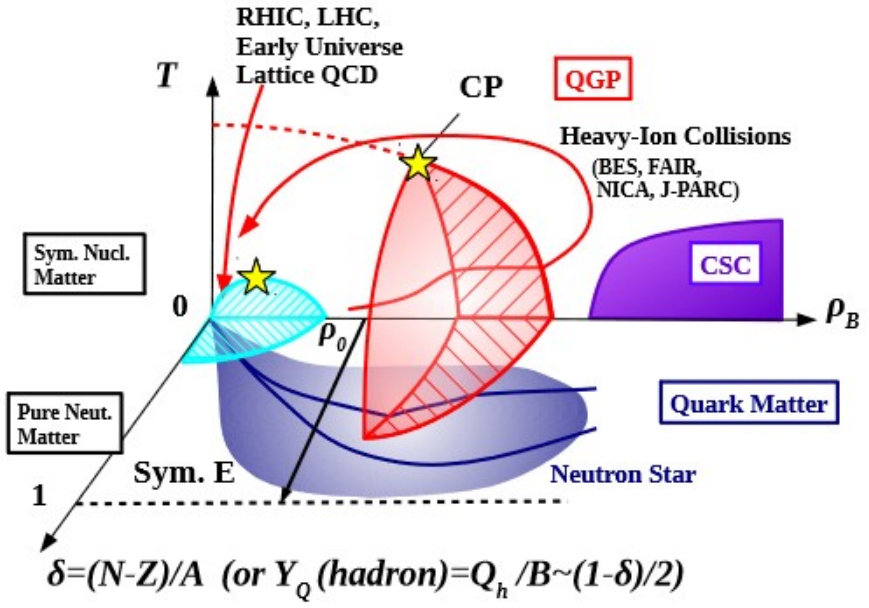


K. Sasaki+ [HAL QCD], 1912.08630

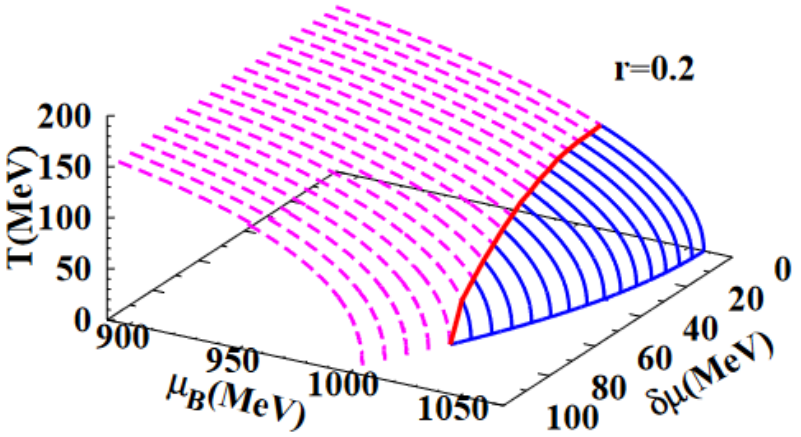
Y.Kamiya, K.Sasaki, et al., (2108.09644)
S. Acharya et al. [ALICE], Nature 588 (2020) [2005.11495].

Relevance to 3D Phase Diagram

- **BNSM probes warm-dense matter, $10\rho_0$, T=30 MeV**
  → One naturally expects emergence of other DOF appears
  → Ideal site to probe finite density QCD phase transition

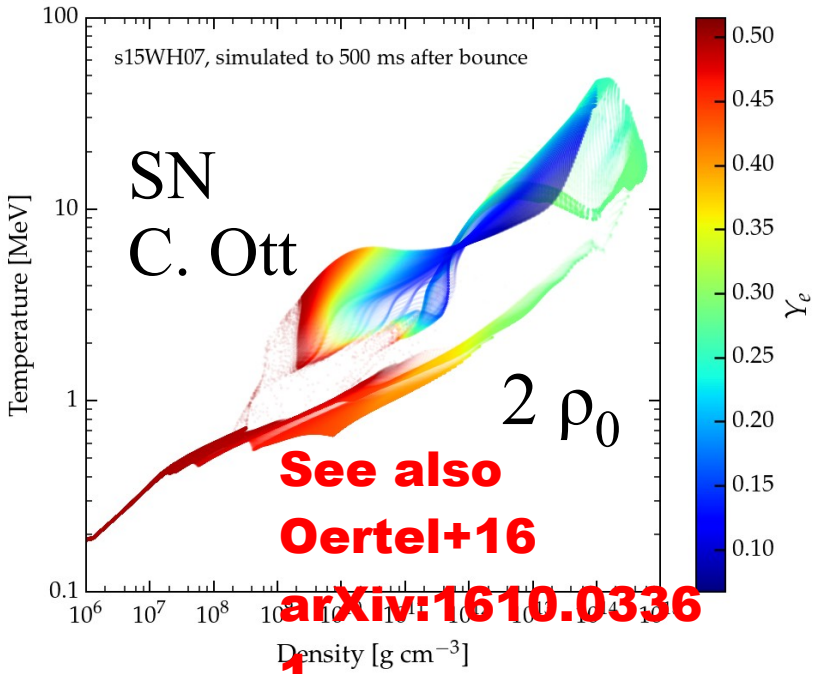


AO, JPS Conf.Proc.20 ('18), 011035

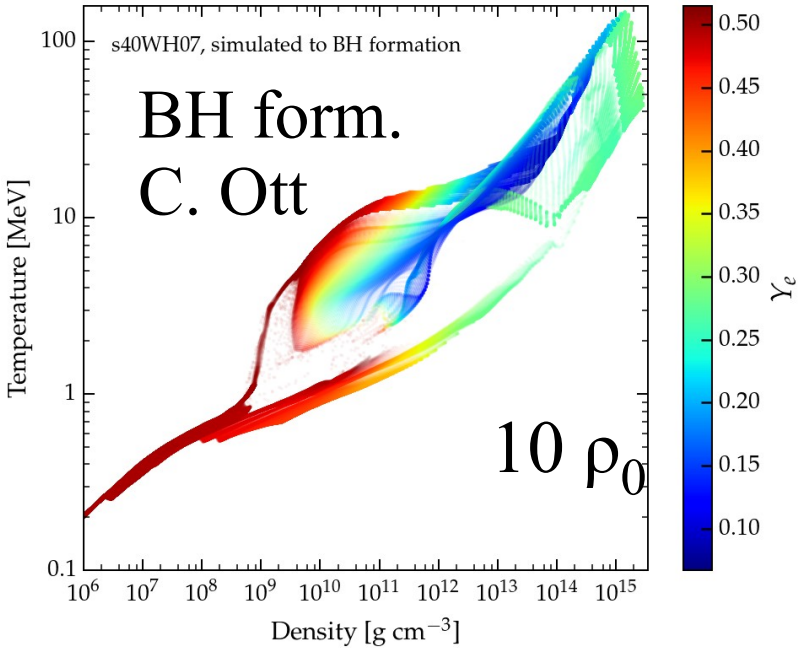


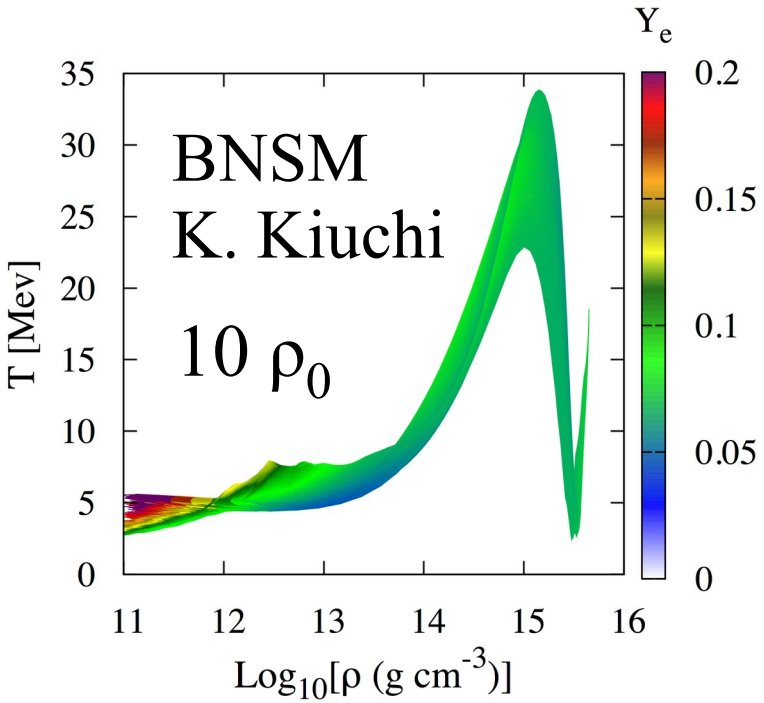
Ueda, Nakano, AO, Ruggieri, Sumiyoshi, [1304.4331]

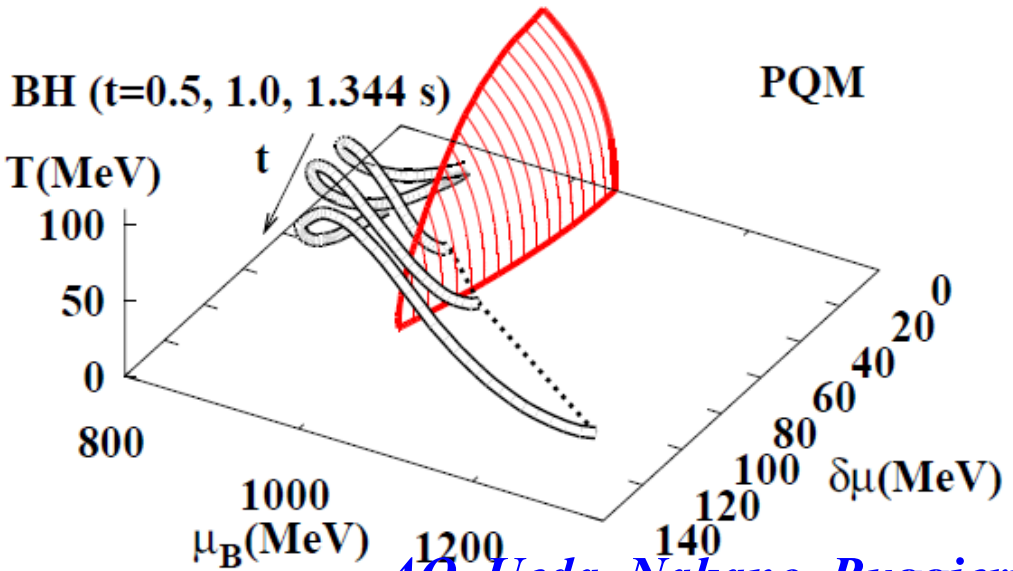
(ρ, T, Y_e) during SN, BH formation, BNSM



See also
Oertel+16
arXiv:1610.03361







AO, Ueda, Nakano, Ruggieri, Sumiyoshi, PLB704('11),284