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Diffrentially rotating quark stars with realistic Ω profile

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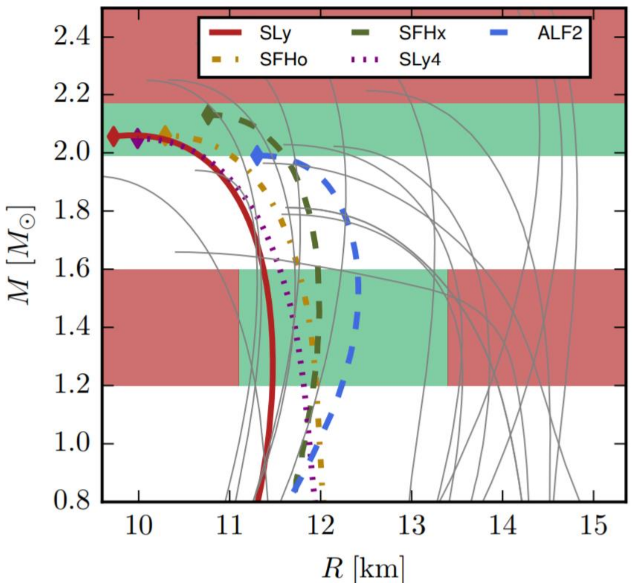
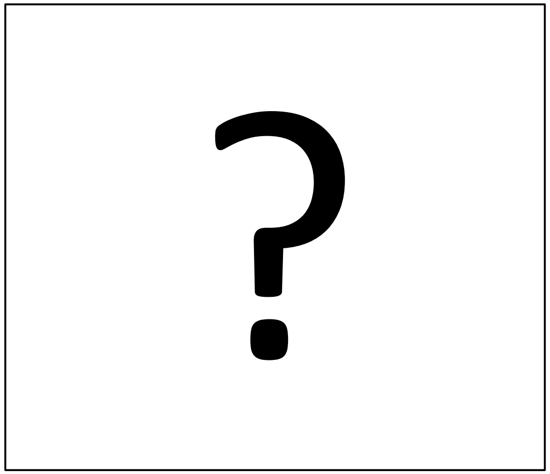
Based on: PRD 100 023015 (2019) & PRD 100 043015(2019)

Constraining EoS in GW era



Coughlin et al
Arxiv:1812.04803



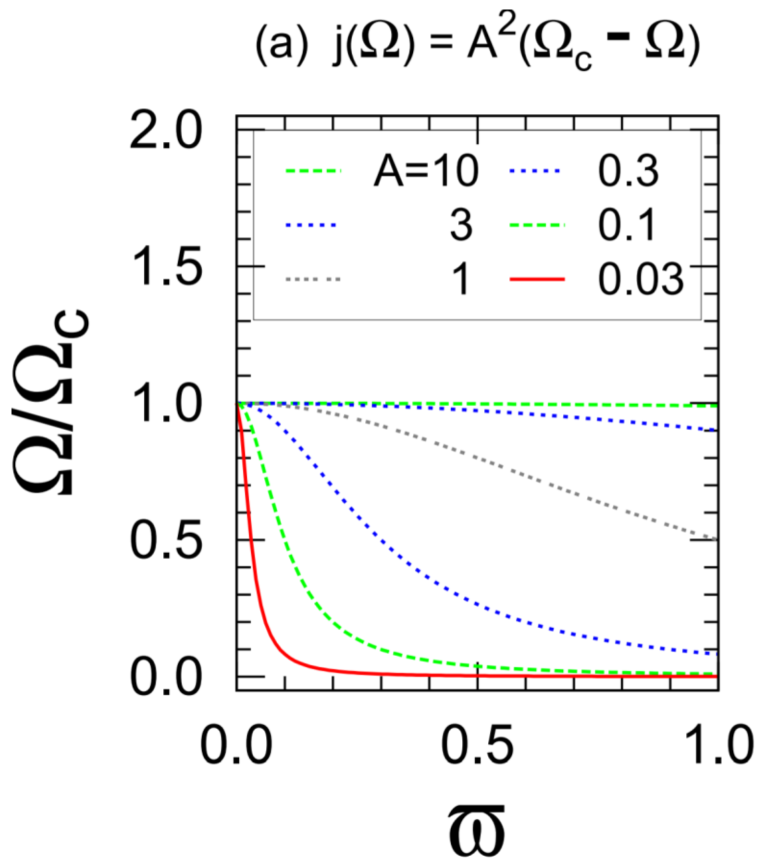
If QS model is considered, the constraints become unclear

Tidal deformability -> Radius constraint
Merger product -> Mtov constraint
No prompt collapse -> Radius constraint

Tidal deformability requires a surface correction;
Rigidly rotating QSs reaches higher mass increase than NSs;
Prompt collapse threshold mass, unclear for QSs.

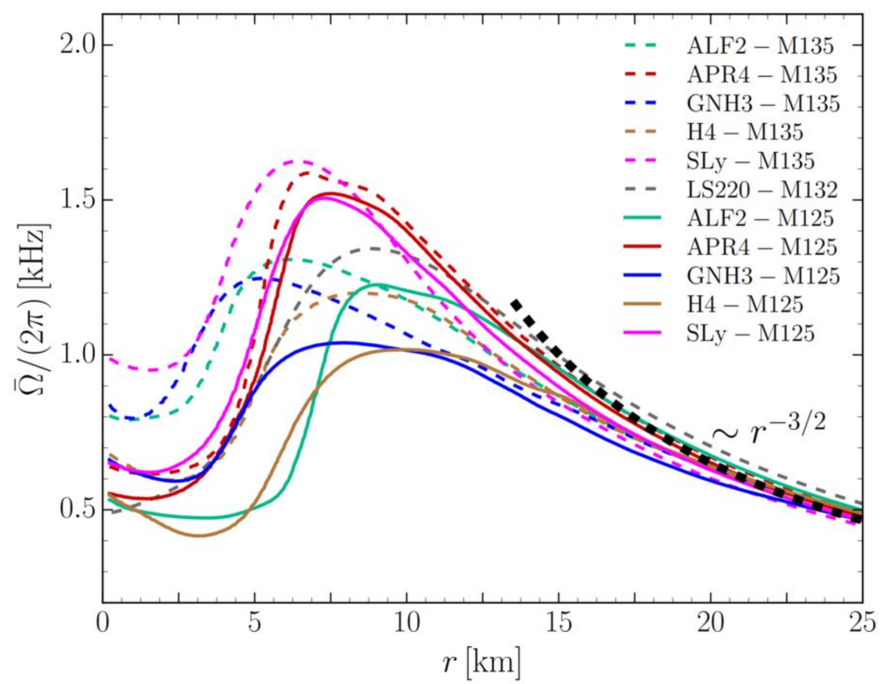
Rotation laws

Previous studies are not realistic



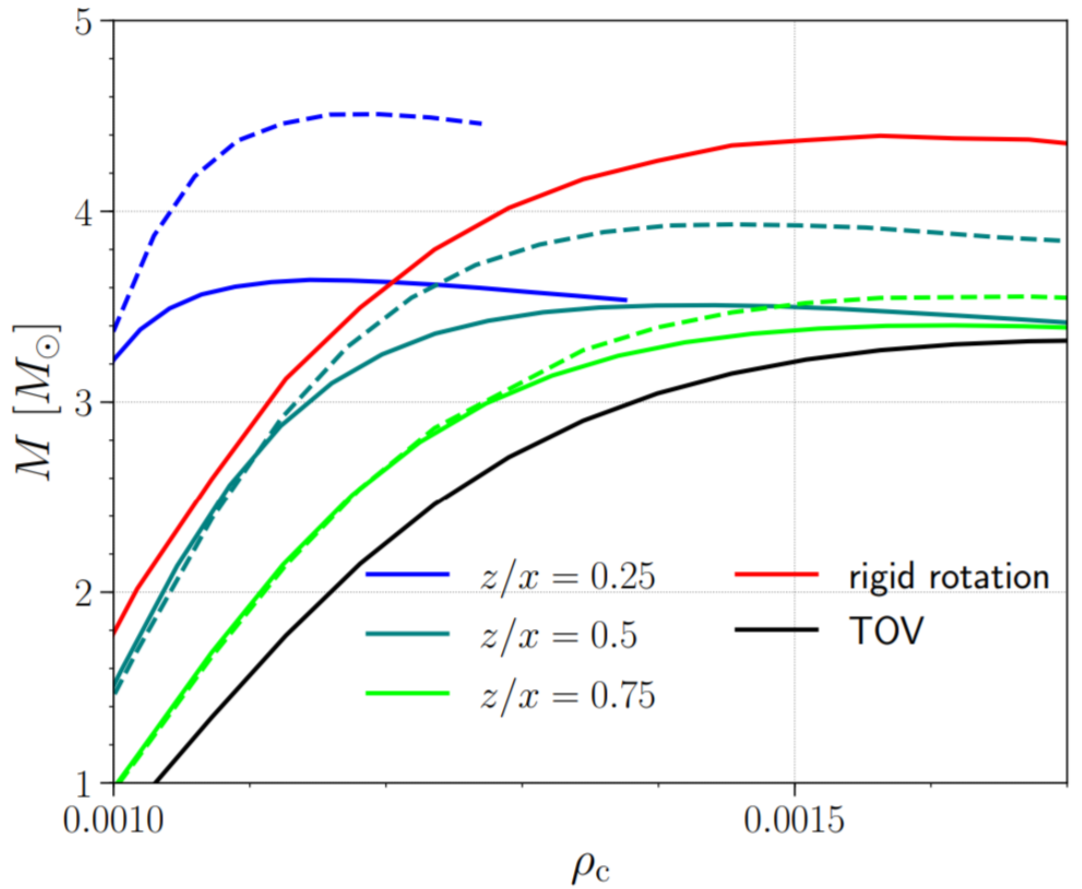
J-const law used in previous studies.
A monotonic omega profile

$$\Omega = \Omega_c \frac{1 + (j/B^2\Omega_c)^p}{1 + (j/A^2\Omega_c)^{q+p}}$$



Actual omega profile seen in NR simulations
Hanauske et al. 2016

Results: maximum mass



Initial data code COCAL is adopted for the calculation of QSs

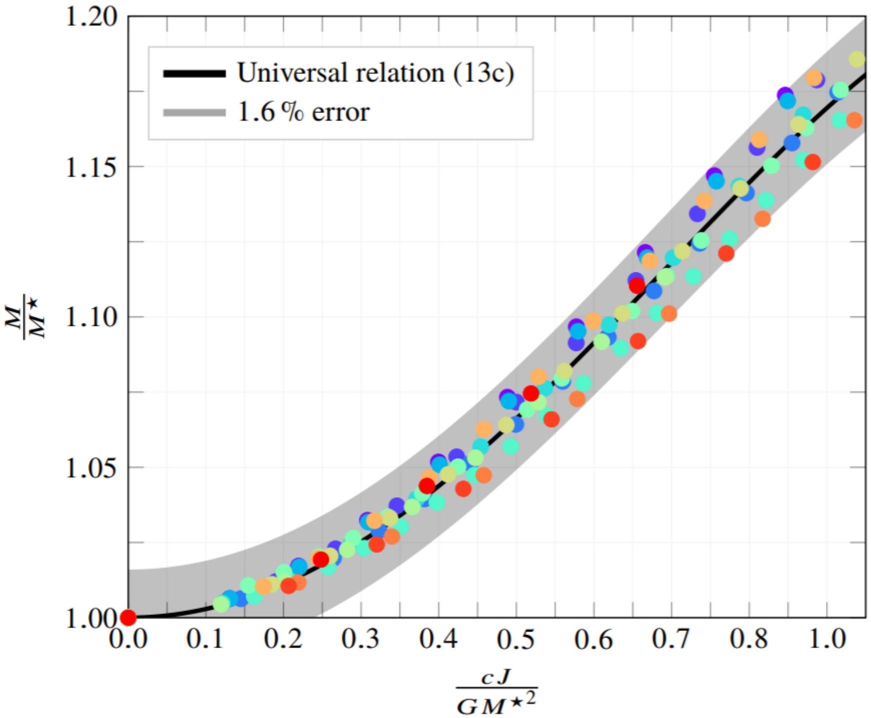
Zhou et al. 2019

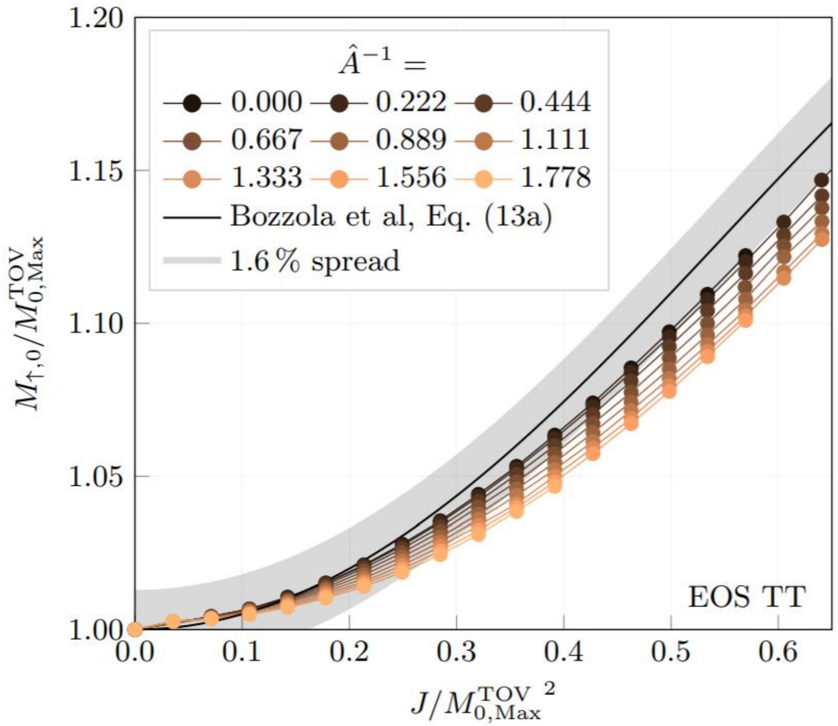
For HMQS with strangeon star EoS

The new differential rotation law can increase the maximum mass if the deformation is large.

Angular momentum and kinetic energy will become much larger as a trade off.

Results: the turning points

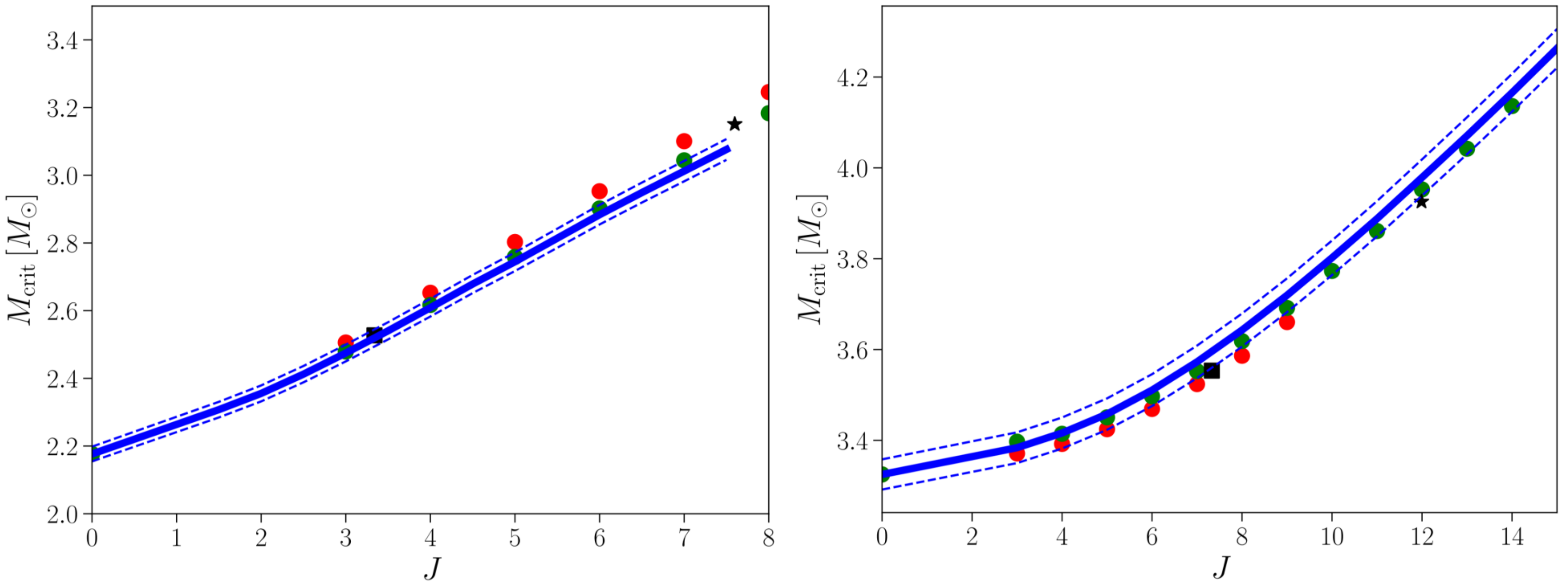




Bozzola et al. 2017
EoS-independent relation for j-const law

Bozzola et al. 2019
Deviations realized when hybrid stars are considered

Results: the turning points

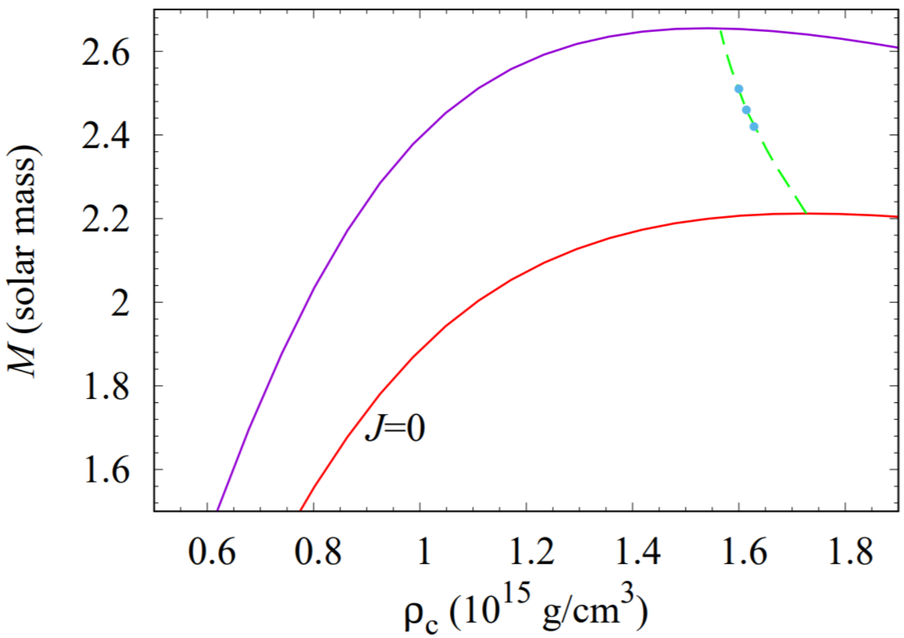


Zhou et al. 2019

For 2 different QS models as well as the new drot law

Results: the turning points

- A merit of such a relation: allowing us to determine the quantities of the merger remnant at the onset of collapsing to BH, without having to know whether it's dr/ur, which type of dr is it.

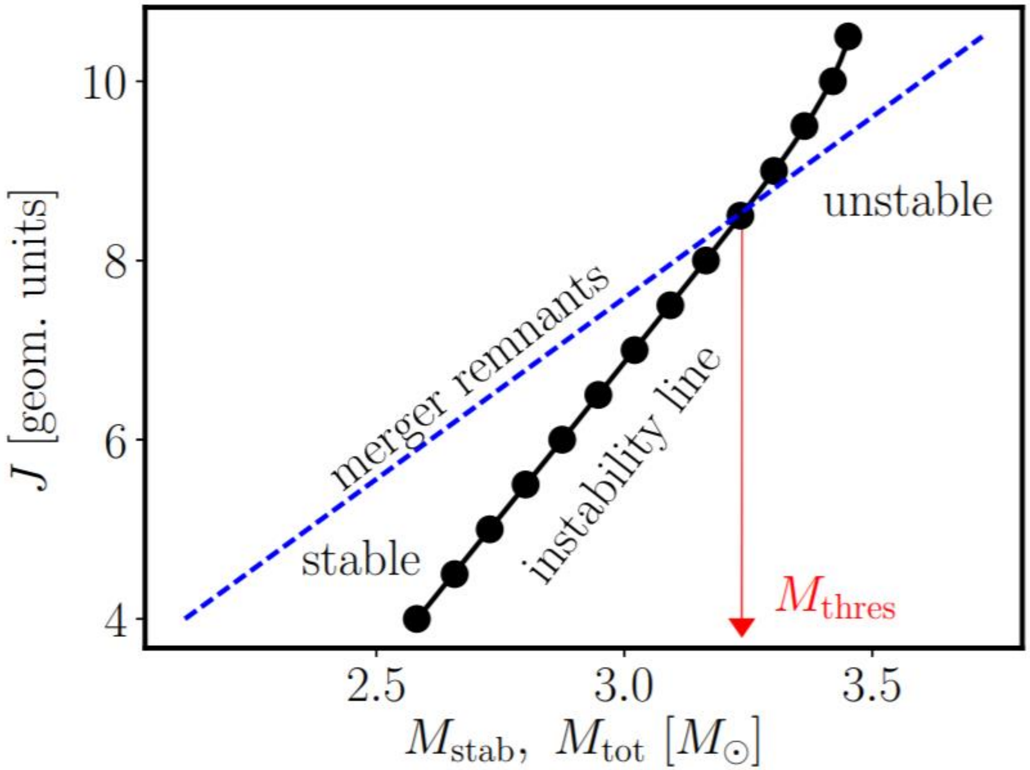


Previous constraints:
M_TOV <~ 2.17

Our new analysis:
2.1 < M_TOV < 2.35

Shibata, **EZ**, Kiuchi, Fujibayashi 2019
Using conservation laws to infer the quantities of the merger remnant when it collapses to BH and constrain Mtov

Results: semi-analytical approach of the threshold mass

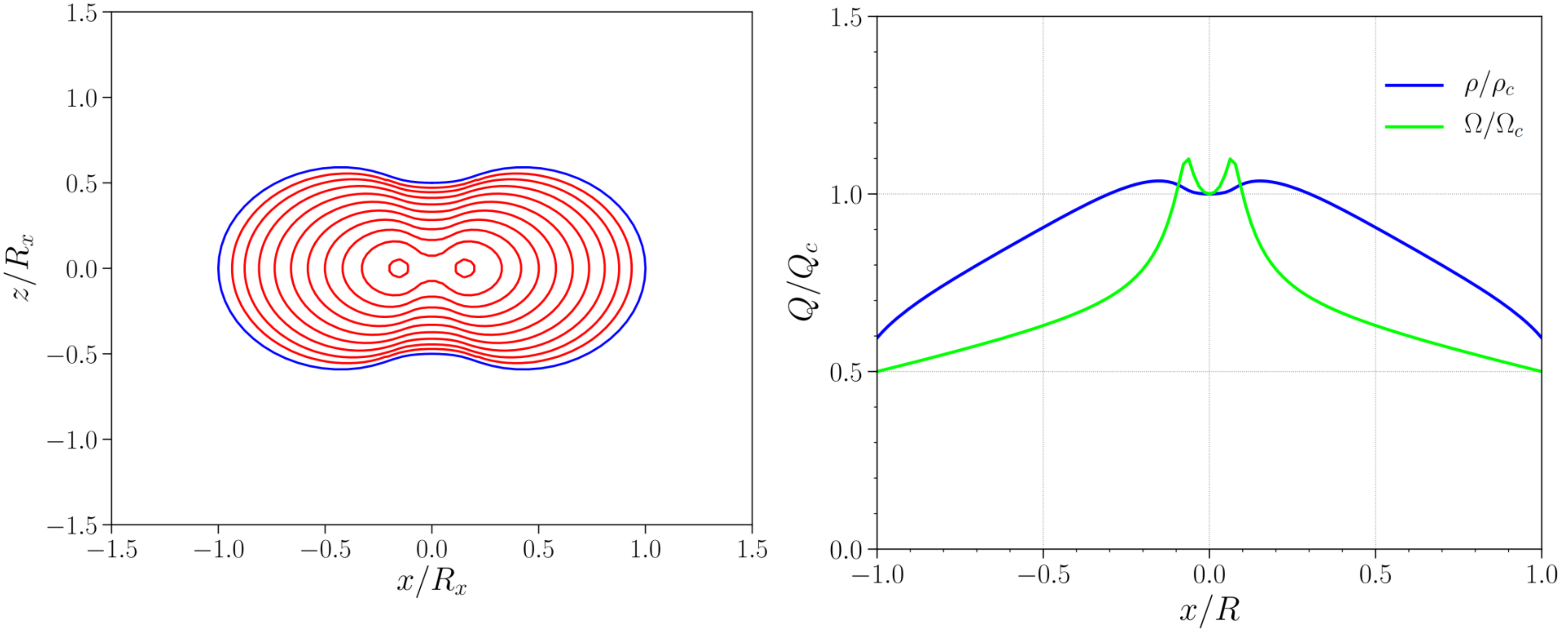


Bauswein & Stergioulas 2017

Preliminary results for threshold mass of QSs obtained by this method:

For MIT bag model:
M_threshold / M_TOV ~ 1.45-1.55

Results: type C solutions



Type C solutions are related to instability/GW radiation of the merger product.
Type C solutions also identified for the new differential rotation law and for QSs.

Evolution of spin period and magnetic field of a QS remnant would be significantly different from that of a NS. (also see Dr. Shuang Du's Poster)

Discussion

- Considering QSs will lead to different interpretation from GW170817/AT2017gfo/GRB170817A
- Quantitatively, drot QSs might be more unstable compared with drot NSs.
- The properties of turning points of differentially rotating quark stars are similar to that of uniformly rotating quark stars, even with the more realistic differential rotation law.

- Thanks for your attention!