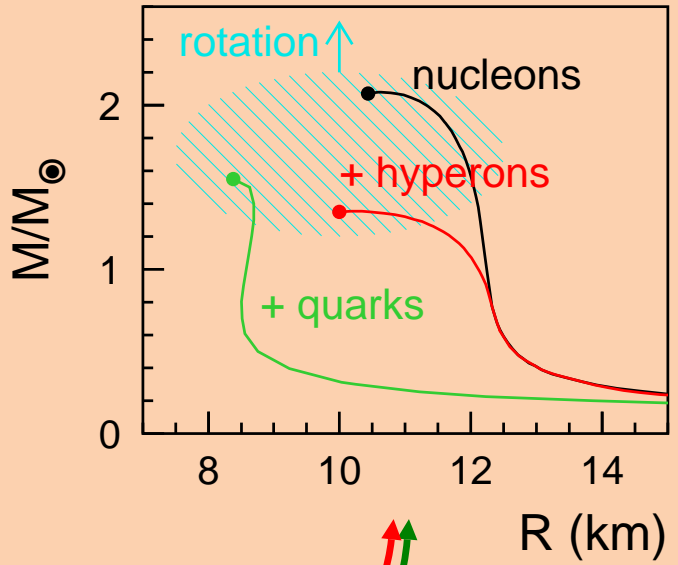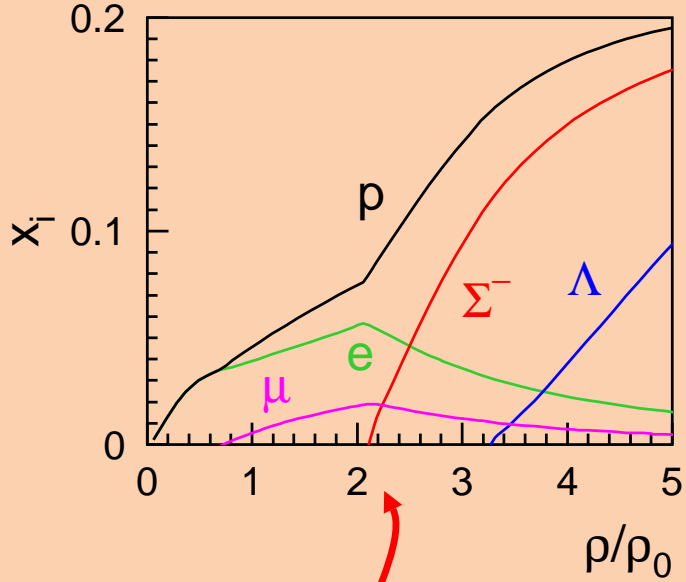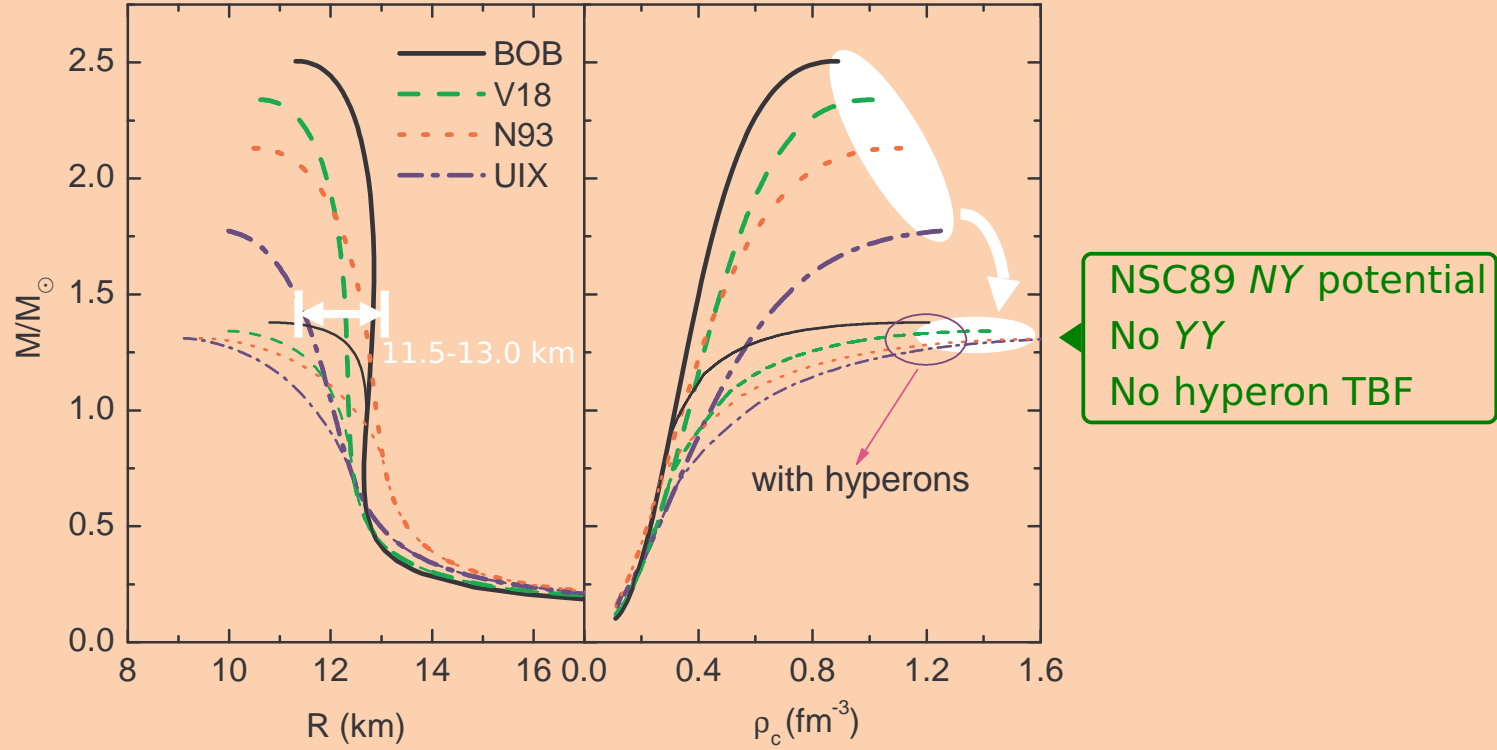- **Generic implications for EOS and stellar structure:**
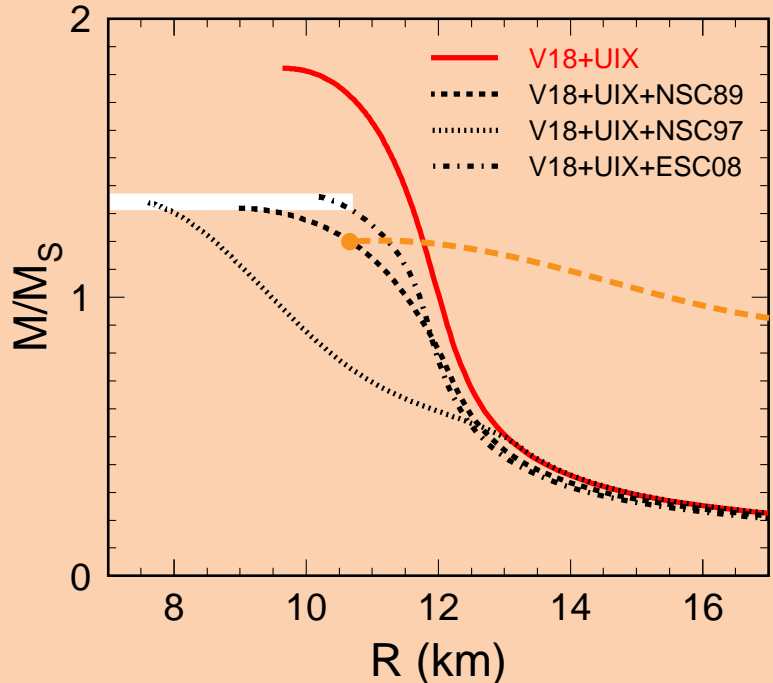


- **Hyperon onset occurs at $\rho \sim 2...3\,\rho_0$**
- **Softer EOS**
- **NS structure including hyperons ... and including quark matter**

- **Mass-radius relations with different nucleonic TBF:**



Legend for left panel:
- BOB (solid black)
- V18 (green dashed)
- N93 (orange dotted)
- UIX (purple dash-dot)

11.5-13.0 km

NSC89 $NY$ potential
No $YY$
No hyperon TBF

with hyperons

Left axis: $M/M_\odot$; Left x-axis: $R$ (km); Right x-axis: $\rho_c$ (fm$^{-3}$)
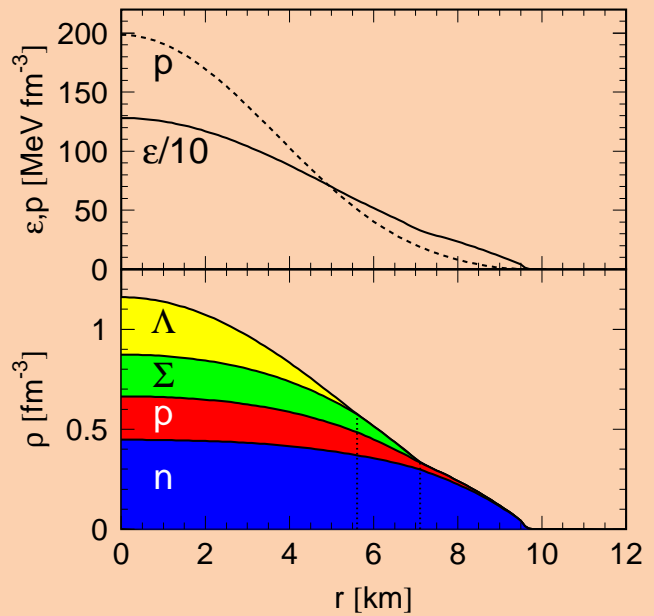
→ Large variation of $M_{max}$ with nucleonic TBF
Self-regulating softening due to hyperon appearance
(stiffer nucleonic EOS → earlier hyperon onset)

# • Mass-radius relations using different *NY* potentials:



**Maximum mass independent of potentials !**
**Maximum mass too low ($< 1.4\,M_\odot$) !**
**Proof for "quark" matter inside neutron stars ?**

- **Effect of *YY* Interactions:**



V18 + TBF + ESC08

Legend (left plot):
- V18+TBF
- V18+TBF+FREE
- V18+TBF+NSC89(NY)
- V18+TBF+ESC08(NY)
- V18+TBF+ESC08(NY+YY)
- V18+TBF+NSC97(NY+YY)

Mass increase to $\lesssim 1.7 M_\odot$

$\Lambda\Lambda, \Sigma^-\Sigma^-$ repulsive
$\Lambda\Sigma^-$ attractive !

- Hyperon TBF (*YNN, YYN, YYY*) unknown (exp. and theor.) !
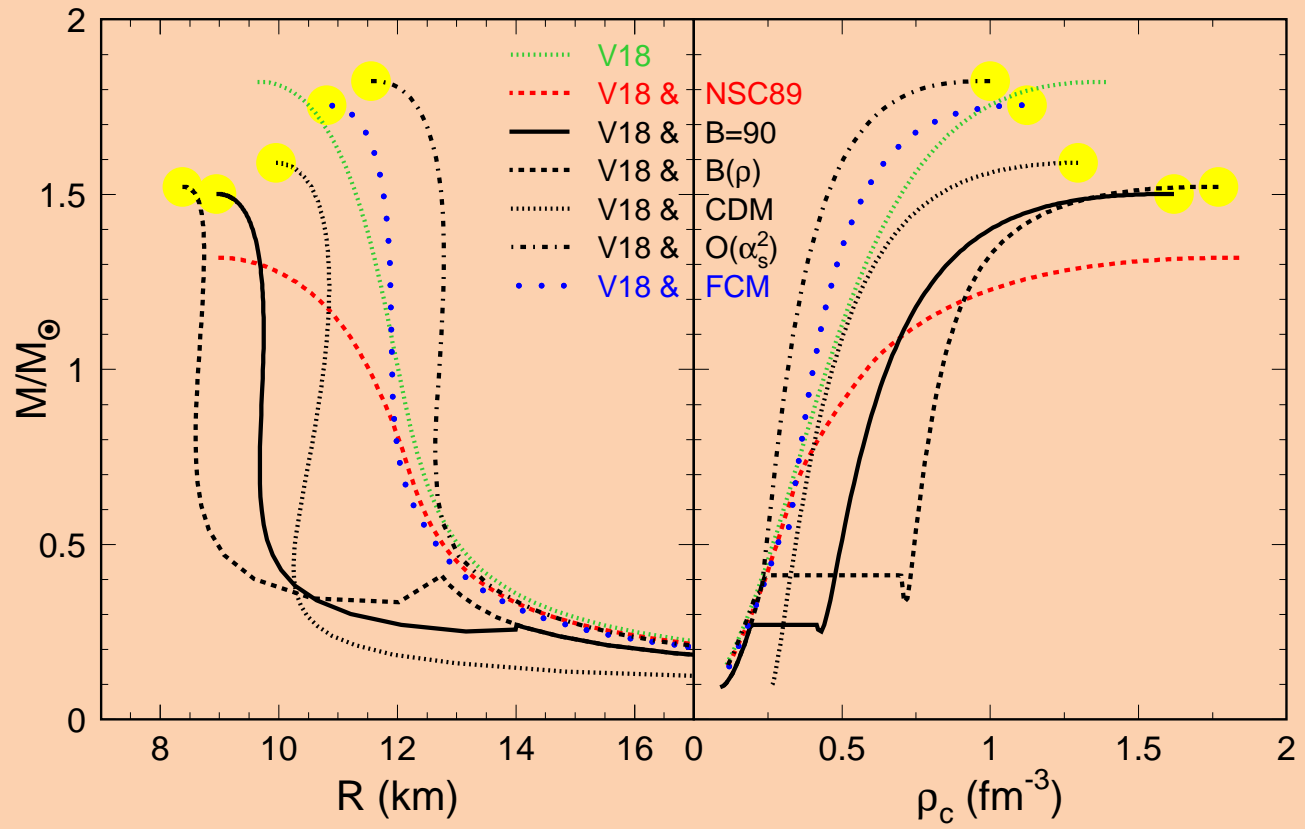
# Quark Matter EOS of Dense Matter:

- Problem: No "exact" results from QCD:
  Large theoretical uncertainties, limited predictive power

- Current strategy:
  Use available eff. quark models (MIT, NJL, CDM, DSM, ...)
  in combination with the hadronic EOS

- An important constraint (from heavy ion collisions):
  In symmetric matter phase transition not below $\approx 3\rho_0$

⟶ E.g., the simplest (MIT) quark model requires
  a density-dependent bag "constant":

$$\epsilon_Q = B + \epsilon_{\text{kin}} + \alpha_s \times \ldots$$

$$B(\rho) = B_\infty + (B_0 - B_\infty) \exp\left[-\beta\left(\rho/\rho_0\right)^2\right]$$

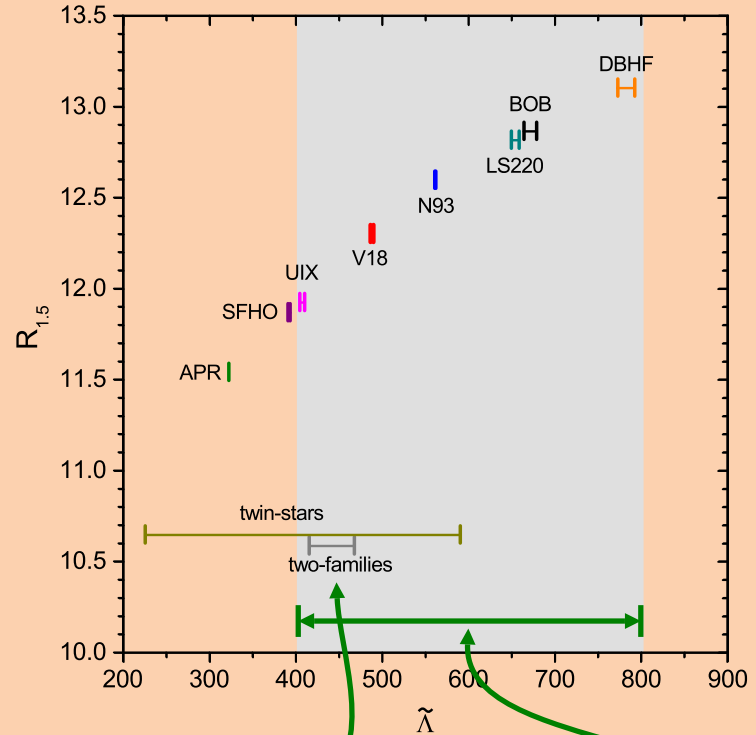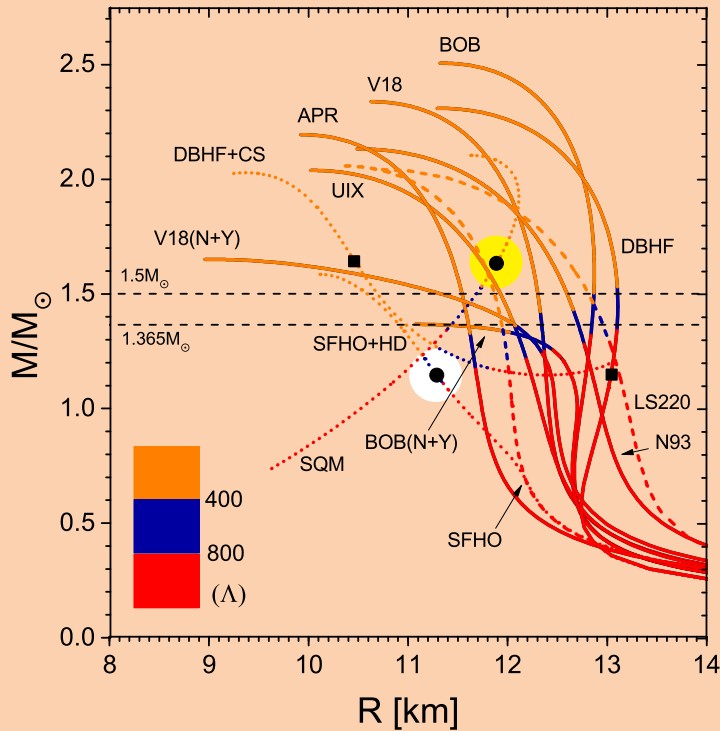- **Different quark EOS's: bag models, color dielectric model:**



NJL, FCM, Dyson-Schwinger models: hyperons prevent phase transition

➡️ Maximum masses: $1.5...1.9\,M_\odot$, Radii are different !

# Some recent results with BHF (hyperonic) EOSs:

- In the *two-families* scenario could coexist
  low-mass hyperon stars and high-mass strange quark stars:



Variation due to allowed mass asymmetry $q = M_2/M_1$

Constrained by GW170817 analyses