Neutron Star crust-core transition

Thermodynamic vs. Dynamical Instability Criteria

Athul Kunjipurayil
Supervisor: Jorge Piekarewicz
Florida State University

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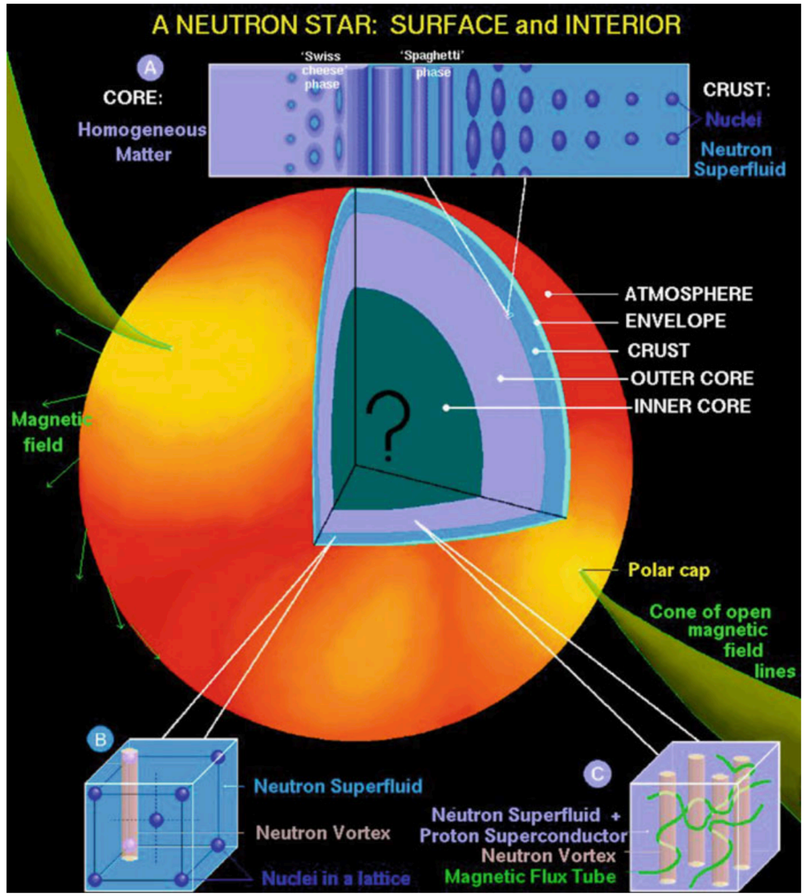
Motivation

Where does neutron star crust end and uniform liquid core begin?

- The transition from the *nonuniform crust* to the *uniform core* may be viewed as an instability of homogeneous nuclear matter against density fluctuations.

- Why does it matter? The transition density affects the crust thickness, crust mass, moment of inertia, and observable phenomena such as pulsar glitches.



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Descriptions of the crust-core instability

Two broad approaches

- Thermodynamic approach
  The transition is driven by the loss of bulk stability in the uniform phase. Its onset is marked by the vanishing of the generalized incompressibility coefficient K_μ.

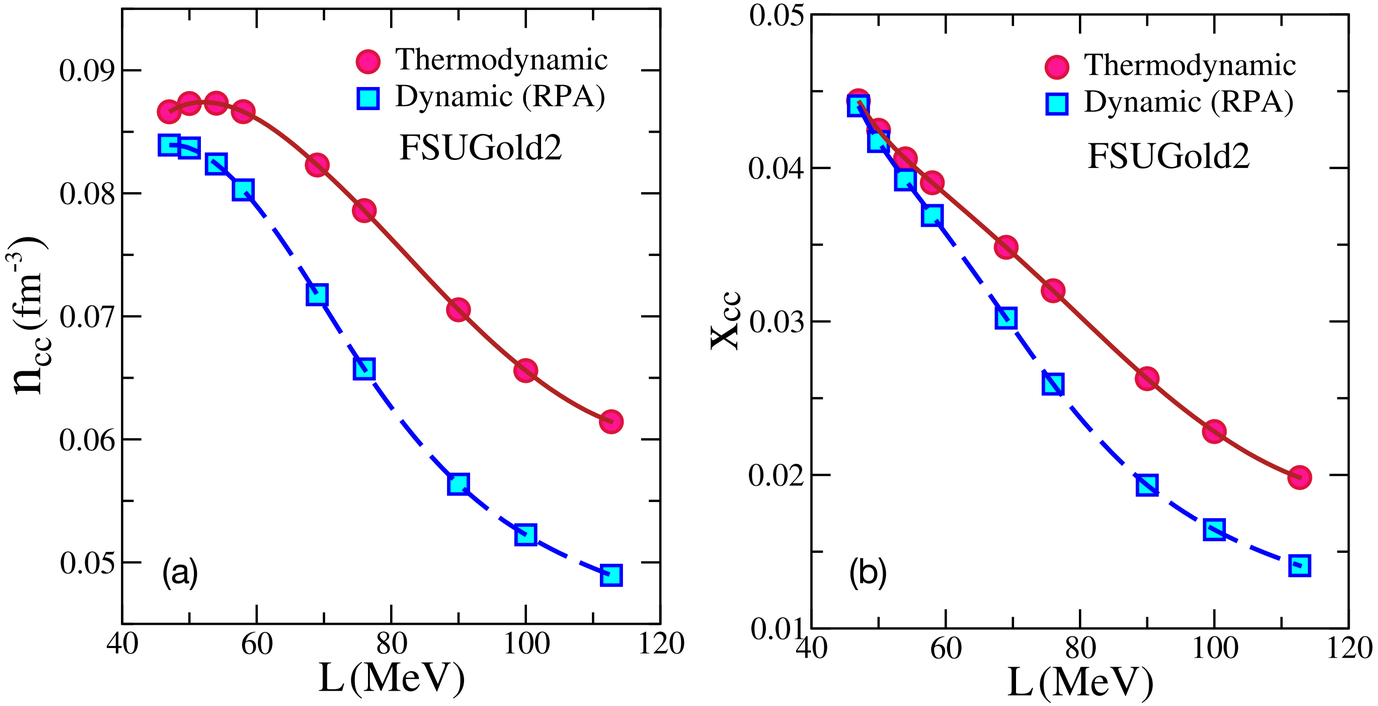
- Dynamical approach
  This approach uses the relativistic random-phase approximation (RPA) for a fully microscopic, linear-response treatment of the transition. The instability is determined from the longitudinal dielectric function $\epsilon_L(q)$. (at finite momentum transfer q_c)

  Coulomb screening and finite-range nuclear interactions are included.

Results

The RPA predicts systematically lower transition densities

- This is examined through FSUGold2 family of covariant energy density functionals
- Discrepancy between the two increases with symmetry-energy slope parameter (L).
- In the $q \rightarrow 0$ limit, Coulomb and gradient contributions become negligible, and the RPA criterion reduces smoothly to the thermodynamic condition.

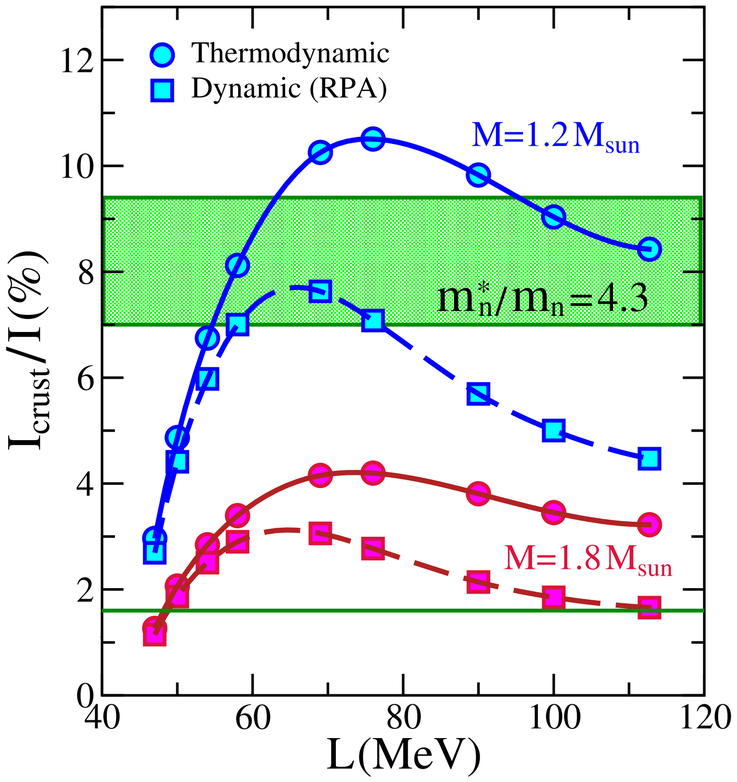


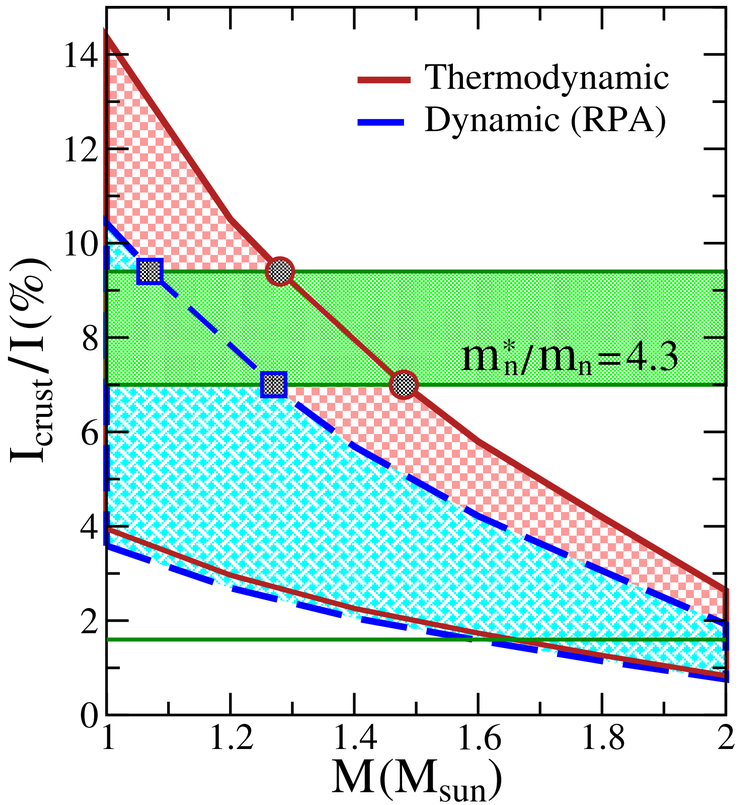
Astrophysical implications

Differences in the instability criteria propagate to astrophysical observables.

- Thermodynamic Instability predicts higher transition pressures, and thicker crusts, and larger crustal moment of Inertia.

- Maximum stellar mass compatible with the Vela glitch constraints are different.





Thank You!

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