

# F-mode Oscillations of Neutron Stars with Hyperons, Sexaquarks, and Quark Matter

**Davood Rafiei Karkevandi**

Institute of Theoretical Physics,  
Wroclaw University, Poland



Mahboubeh Shahrbaft



Prashant Thakur

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Uniwersytet  
Wrocławski

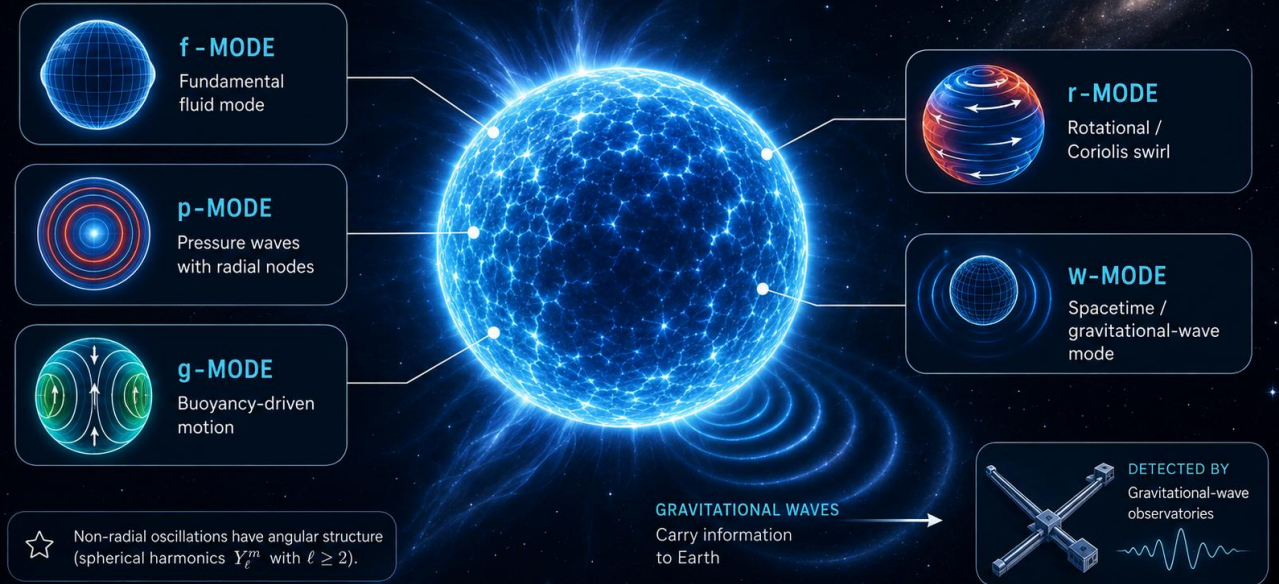


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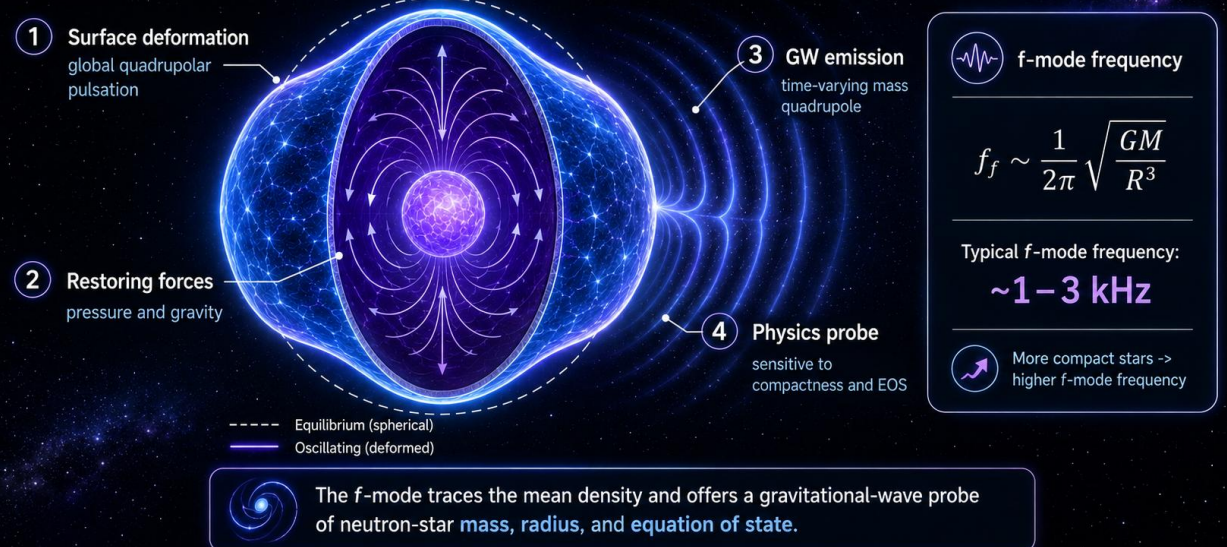
## NEUTRON-STAR ASTEROSEISMOLOGY

NON-RADIAL OSCILLATIONS



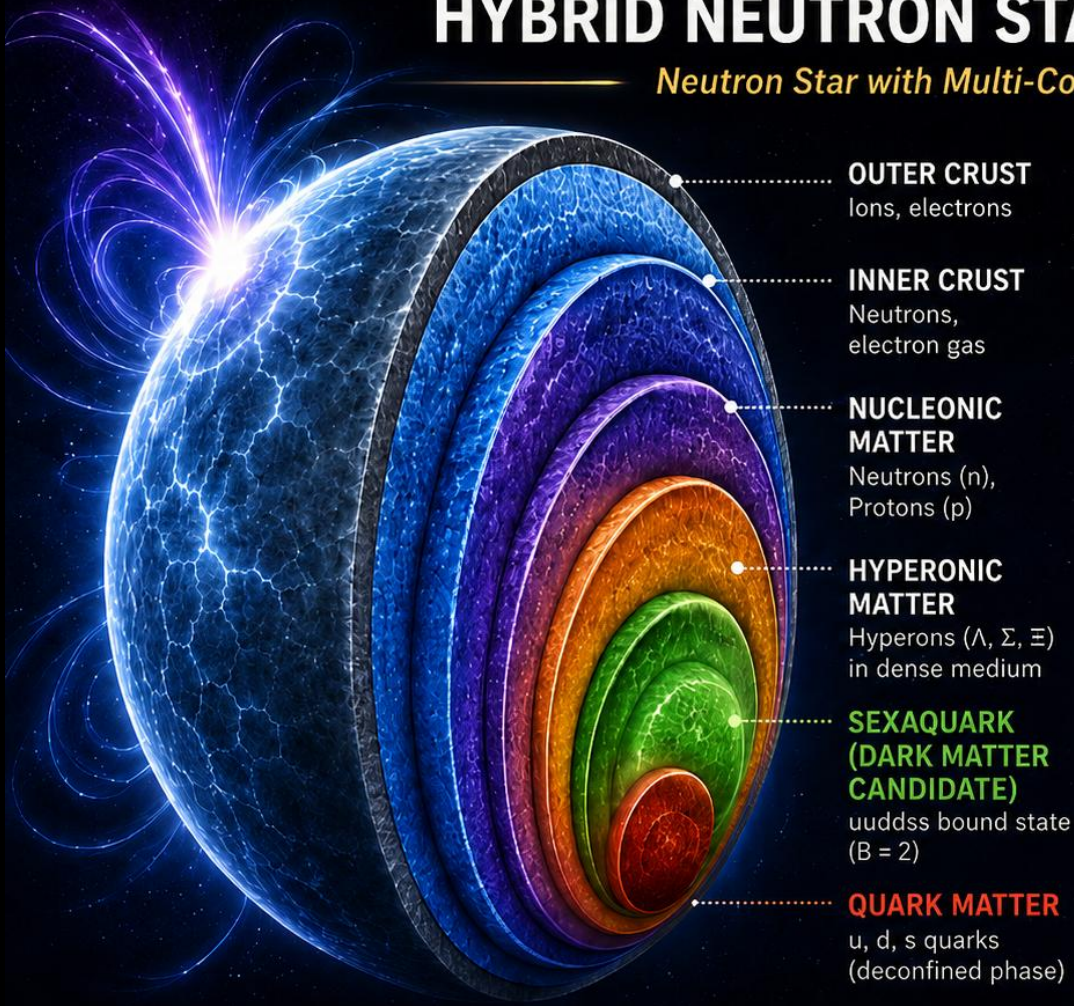
## f-mode oscillations of neutron stars

Fundamental fluid mode and gravitational-wave probe of stellar structure



# HYBRID NEUTRON STAR STRUCTURE

*Neutron Star with Multi-Component Core*



## PARTICLE COMPOSITION

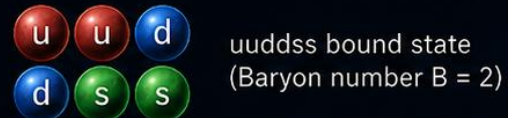
### NUCLEONIC MATTER



### HYPERONIC MATTER



### SEXAQUARK (DARK MATTER CANDIDATE)

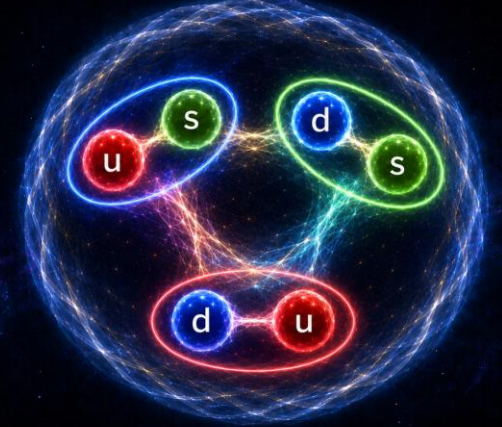


### QUARK MATTER



## Sexaquark

deeply bound H-dibaryon (uuddss)



# $f$ -mode analysis and main results

Mass-radius structure, oscillation properties, and the imprint of exotic matter on quasi-universal relations

## 1 What we did



Checked mass-radius and tidal deformability



Explored different phases of dense matter



Varied the sexaquark mass

Observables:  $M$ ,  $R$ ,  $\Lambda$

## 2 $f$ -mode quantities



Computed  $f$ -mode frequency  $f$



Computed damping time  $\tau$

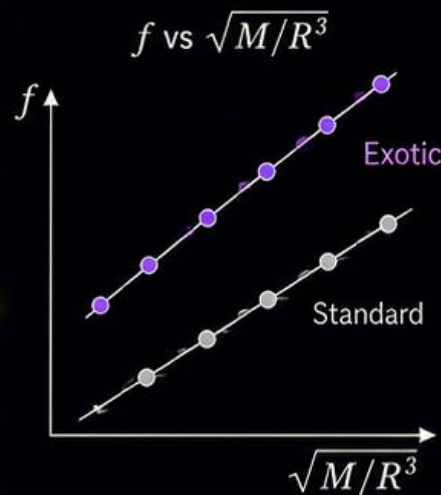


Tracked trends with neutron-star observables

Outputs:  $f$ ,  $\tau$

$M$  +  $R$  +  $C$  +  $\Lambda$

## 3 Main result



Shifted relative to standard cases

$f, \tau \rightarrow M, R, C, \Lambda$

1 Exotic structure modifies the quasi-universal relation

2 Hyperons, sexaquark dark matter, and quark matter leave a noticeable imprint

3 Relations remain tight across the explored sexaquark masses

**Takeaway:** quasi-universal  $f$ -mode relations can reveal the imprint of exotic neutron-star interiors.

