Contribution ID: **112** Type: **Talk**

# Probing hadron-quark phase transition in twin stars using f-modes

*Tuesday 27 May 2025 12:30 (12 minutes)*

Although it is conjectured that a phase transition from hadronic to deconfined quark matter is possible in the ultrahigh density environment in Neutron Stars, the nature of such a transition is still unknown. Depending on whether there is a sharp or slow phase transition, one may expect a third family of stable compact stars or "twin stars"to appear, with the same mass but different radii compared to Neutron stars. The possibility of identifying twin stars using astrophysical observations has been a subject of interest, which has gained further momentum with the recent detection of gravitational waves from binary neutron stars. In this work, we investigate for the first time the prospect of probing the nature of hadron-quark phase transition with future detection of gravitational waves from unstable fundamental f-mode oscillations in Neutron Stars. By employing a recently developed model that parametrizes the nature of the hadron-quark phase transition via "pasta phases", we calculate f-mode characteristics within a full general relativistic formalism. We then recover the stellar properties from the detected mode parameters using Universal Relations in gravitational wave asteroseismology. Our investigations suggest that the detection of gravitational waves emanating from the f-modes with the third-generation gravitational wave detectors offers a promising scenario for confirming the existence of the twin stars. We also estimate the various uncertainties associated with the determination of the mode parameters and conclude that these uncertainties make the situation more challenging to identify the nature of the hadron-quark phase transition. The f-mode in neutron stars is associated with pulsar glitches which can be studied through multi-messenger observation techniques.

**Primary author:** ALVAREZ CASTILLO, David Edwin (Institute of Nuclear Physics Polish Academy of Sciences)

**Presenter:** ALVAREZ CASTILLO, David Edwin (Institute of Nuclear Physics Polish Academy of Sciences)

**Session Classification:** Observational Science (OSB)

**Track Classification:** Observational Science (OSB): Div6