

Reconciling constraints from the multi-messenger constraints with the parity doublet model

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The recent discovery of a central compact object (CCO) within the supernova remnant HESS J1731-347, characterized by a mass of approximately $1.4 M_{\odot}$ and a radius of about 2 km, has opened up a new window for the study of compact objects. This CCO is particularly intriguing because it is the lightest and smallest compact object ever observed, raising questions and challenging the existing theories. To account for this light compact star, a mean-field model within the framework of parity doublet structure is applied to describe the hadron matter. Inside the model, part of the nucleon mass is associated with the chiral symmetry breaking while the other part is from the chiral invariant mass which is insensitive to the temperature/density. The value of χ affects the nuclear equation of state for uniform nuclear matter at low density and exhibits strong correlations with the radii of neutron stars. We point out that HESS J1731-347 can be explained as the lightest neutron star for $\chi \sim 100$ MeV.

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