Contribution ID: **324** Type: **Talk in the parallel session**

Bosonic Dark Matter in Neutron Stars and Gravitational Waves

Thursday, 8 July 2021 18:50 (20 minutes)

Compact astrophysical objects such as neutron stars (NSs) offer natural laboratories that can accrete sizable amount of Dark Matter (DM) in extreme density regimes. In this work, we study the presence of self-interacting bosonic DM in NSs through its effect on various properties of NSs. In our scenario, the bosonic DM and baryonic matter (BM) are mixed together which are interacting only through gravitational force. We show that depending on DM model parameters and the amount of DM fraction, DM can exist as a core inside the compact star or as an extended halo around it. Thanks to the recent detection of gravitational waves from binary NSs, in addition to the maximum mass of a compact object, we consider the tidal deformability as a new probe for the presence of DM coexisting with BM in NSs and to check the consistency with observational constraints. In this work, the parameter space of self-interacting bosonic DM such as the mass and the coupling have been explored from the mass-radius relation and the tidal deformability by considering various amounts of DM in the system.

As the conclusion, we show that a DM core decreases the total mass of the compact object and the tidal deformability while a DM halo could increase both of them. Finally, considering various DM fractions, boson's masses and coupling constants, some constraints have been obtained on our DM model by taking into account the maximum mass limit of NS, $M \geq 2M\odot$ ($M\odot \equiv$ Mass of the sun) and the tidal deformability upper limit from GW170817 event, $\Lambda < 800$ for $M = 1.4M\odot$.

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Session Classification: Dense Matter in Compact Stars

Track Classification: Neutron Stars: Dense matter in compact stars