two additional hidden-strangeness mesons, σ^* and ϕ, which were originally introduced to obtain the strong attractive $\Lambda\Lambda$ interaction deduced from the earlier measurement [41]. A recent observation of the double-Λ hypernucleus ${}^{6}_{\Lambda\Lambda}$He, called the Nagara event [42], has had a significant impact on strangeness nuclear physics. The Nagara event provides unambiguous identification of ${}^{6}_{\Lambda\Lambda}$He production with a precise $\Lambda\Lambda$ binding energy value $B_{\Lambda\Lambda} = 7.25 \pm 0.19^{+0.18}_{-0.11}$ MeV, which suggests that the effective $\Lambda\Lambda$ interaction should be considerably weaker ($\triangle B_{\Lambda\Lambda} \simeq 1$ MeV) than that deduced from the earlier measurement ($\triangle B_{\Lambda\Lambda} \simeq 4$–5 MeV). The weak hyperon-hyperon (YY) interaction suggested by the Nagara event has been used to reinvestigate the properties of multistrange systems, and it has been found that the change of YY interactions affects the properties of strange hadronic matter dramatically [11, 43–45]. We would like to examine whether the ${}^{1}S_0$ superfluidity of Λ hyperons exists in neutron star matter, and how large the pairing gap can be if it does, by considering recent developments in hypernuclear physics.

The aim of this article is to investigate the possibility of forming a Λ superfluid in neutron stars. It has been suggested that hyperon superfluidity could significantly suppress the neutrino emission in the core of a neutron star and play a key role in neutron star cooling [24, 25]. Over the last decade, there has been some discussion in the literature about hyperon pairing in dense matter [20–24, 46]. In the work of Balberg and Barnea [20], the ${}^{1}S_0$ superfluidity of Λ hyperons has been studied by using an effective $\Lambda\Lambda$ interaction based on a G matrix calculation and an approximation of nonrelativistic effective mass obtained from single-particle energies. Their calculation predicts a gap energy of a few tenths of a MeV for Λ Fermi momenta up to about 1.3 fm^{-1}. In Refs. [21, 22], Takatsuka and Tamagaki studied Λ superfluidity using two types of bare $\Lambda\Lambda$ interactions based on the one-boson-exchange (OBE) model and two types of hyperon core models. They found that Λ superfluidity could exist in a density region between $2\rho_0$ and $(2.6$–$4.6)\rho_0$, depending on the pairing interaction and the hyperon core model. A study of $\Lambda\Lambda$ pairing in a pure neutron background has been presented by Tanigawa *et al.* [23] using the relativistic Hartree-Bogoliubov model, where the $\Lambda\Lambda$ pairing gap was found to decrease with increasing background density and decreasing $\Lambda\Lambda$ attraction. Both Λ and Σ^- superfluidities in neutron star matter have been investigated by Takatsuka *et al.* [24] using three pairing interactions based on the OBE model and several nonrelativistic EOS with different incompressibilities. It was found that both Λ and Σ^- are superfluid as soon as they begin to appear at around $4\rho_0$, although the pairing gap and the