Dzyaloshinskii-Moriya (DM) interaction plays a key role in skyrmion physics. Particularly in metallic systems, DM interaction can be sensitive to external parameters such as pressure and chemical potential. In fact, recently it has been shown that the DM interaction in Mn$_{1-x}$Fe$_x$Ge exhibits drastic carrier-density dependence. Here, we use a simple approach to evaluate the continuum limit of the DM interaction in metallic systems from first-principles calculations. Using this approach, we demonstrate that the sign of DM interaction changes depending on the carrier density in Mn$_{1-x}$Fe$_x$Ge, which is consistent with the experiment. The origin of the sign change is discussed in terms of spin mixing due to spin-orbit coupling in the band structure.