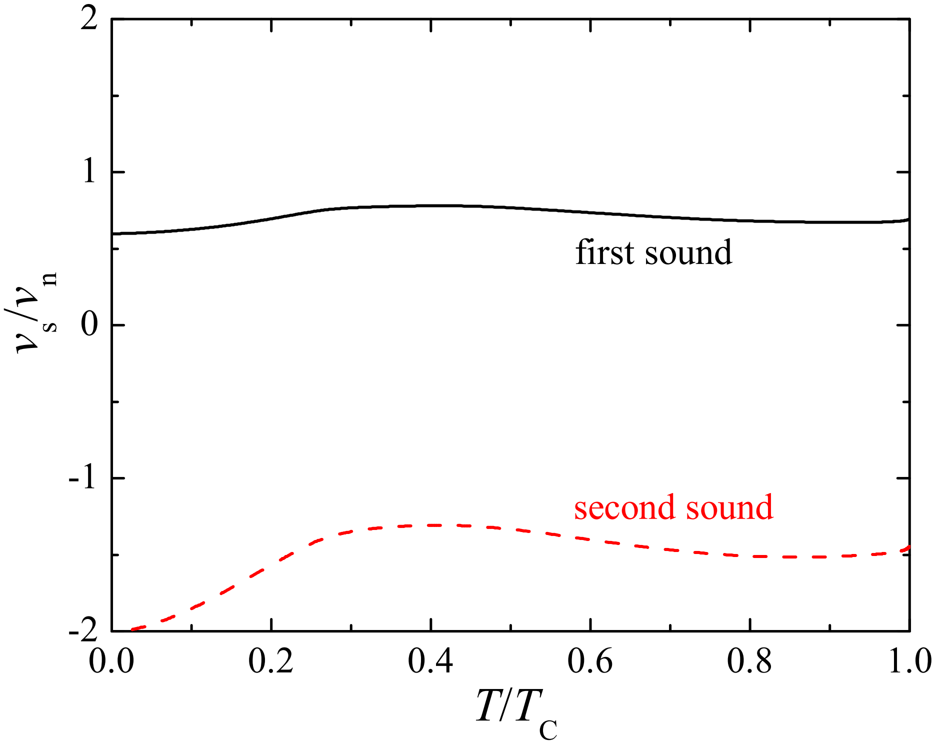


FIG. 10: Superfluid and normal fluid velocity fields associated with first and second sound in a unitary Fermi superfluid. The solid (black) line shows the ratio $v_s^{(1)}/v_n^{(2)}$ of the superfluid and normal fluid velocity fields involved with first sound, (B8). The dashed (red) line shows the ratio $\rho_{s0}v_s^{(2)}/\rho_{n0}v_n^{(2)}$ of the superfluid and normal fluid currents associated with second sound, (B9). If we set $\epsilon_{\rm LP}=0$, these ratios would be 1 and $-1$, respectively, describing the velocity fields for pure density and temperature oscillations.

and second sound are significantly different from those given in (B2). This is a reflection of the fact that first and second sound are not pure uncoupled density and temperature waves, respectively, which would be described by (B2) and correspond to $\epsilon_{\rm LP}=0$ (and $\rho_{n0}\neq 0$). As we have shown in [8], such in-phase ($\mathbf{v}_s=\mathbf{v}_n$) and out-of-phase zero current ($\mathbf{j}=0$) solutions correspond to first and second sound velocities given by

$$u_1^2=v_{\bar{s}}^2,\quad u_2^2=T\frac{\bar{s}_0^2}{\bar{c}_v}\frac{\rho_{s0}}{\rho_{n0}}\equiv v^2. \tag{B12}$$

As we show in figure 2 of [8], these sound velocities are in good agreement with a full calculation including the coupling associated with $\epsilon_{\rm LP}$. In this Appendix and section IV, we have carried out a careful analysis based on expanding to first order in the parameter $\epsilon_{\rm LP}x$, which is small ($\ll 1$) at all temperatures [14, 15]. The results in figure 10 show that the