**Erratum: Searching for low mass dark matter
via phonon creation in superfluid ^4He
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In Eq. (55), the limits on the range of the integration over q_1 should be $(\omega/s - q)/2$ and $(\omega/s + q)/2$. The text that follows Eq. (55) should read:

Doing the q_1 integral, we find

$$S_2(q, \omega) = \frac{3}{16} \frac{q^4}{k_D^3 m_4^2 s^3} \left(\frac{(u-1)}{2} + \frac{\mathcal{M}\omega}{sk_D} \right)^2, \quad (56)$$

where we let $\nu \rightarrow -1$ for approximately back-to-back phonons. This equation agrees with Eq. (C3). In the regime of ω that can produce two phonons, $S(q, \omega)$ is approximately a quadratic function of ω .

The rate of two phonon emission in this regime is given by Eq. (9) with Eq. (56) above, with the upper limit on the ω integral essentially $2sk_D$. Thus

$$\begin{aligned} \frac{d\Gamma_2}{dq} &= \frac{\Gamma_0}{4} \frac{rq^5}{(kk_D m_4 s)^2} \\ &\simeq \frac{rq^3}{k_D^2 m_4 s} \frac{d\Gamma_1}{dq}. \end{aligned} \quad (57)$$

Here $r = \mathcal{M}^2 + (3/4)\mathcal{M}(u-1) + (3/16)(u-1)^2$, which for the two allowed values of $\mathcal{M}$ is 0.77 for $\mathcal{M} = -1.47$ and 1.04 for $\mathcal{M} = 0.25$. This estimate is consistent with the sum rule result, Eq. (23).

Integrating over q from 0 to $2k = 2m_\chi v$ and averaging the velocity v using the halo model as above, we find that the total zero-threshold two-phonon rate is given by

$$\langle \Gamma_2(\omega > 0) \rangle = \frac{8r}{3} \frac{\sigma_{\chi_4} n_4 \rho_\chi}{k_D^2 (m_4 s)^2} m_\chi^3 I, \quad (58)$$

where the velocity integral $I = \int dv v^5 f(v) \simeq (427 \text{ km/s})^5$. Numerically,

$$\langle \Gamma_2(\omega > 0) \rangle \approx 1.0 \times 10^{-8} \text{ cm}^{-3} \text{ s}^{-1} r \frac{\sigma_{\chi_4}}{10^{-40} \text{ cm}^2} \left(\frac{m_\chi}{1 \text{ MeV}} \right)^3. \quad (59)$$

The two-phonon rate is less than one percent of the one-phonon rate for $m_\chi \lesssim 200 \text{ keV}$; the two averaged rates are approximately equal for $m_\chi \sim 0.9 \text{ MeV}$.

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