$M_A \equiv M_1$, $M_B \equiv M_2$

3. Let's simplify notation: $\bar{K} \equiv \frac{1}{2}(K+K')$, $\bar{M} = \frac{1}{2}(M_A+M_B)$ $\left\{\begin{matrix}\text{mean}\\ \text{values}\end{matrix}\right\}$

$\tilde{M} = \sqrt{M_A M_B}$ = geometric mean. $M_A/M_B = \varepsilon$ (small); $\Delta M = M_B - M_A$

$\omega_\pm = A \pm \sqrt{B^2+C^2+D^2}$, $A = 2\bar{K}\bar{M}/\tilde{M}^2$, $B = \frac{\bar{K}}{\tilde{M}}\frac{\Delta M}{\tilde{M}} = \frac{\bar{K}}{M_A}(1+\varepsilon)$

$C = -\frac{1}{\tilde{M}}(K+K'\cos ka)$, $D = -\frac{K'}{\tilde{M}}\sin ka$.

Consider $k=0$ (simplest case). Then $D=0$

and
$$\omega_\pm = \frac{2\bar{K}}{\tilde{M}}\frac{\bar{M}}{\tilde{M}} = \frac{2\bar{K}}{M_A}(1+\varepsilon) \approx \frac{2\bar{K}}{M_A} \text{ for } + \text{; } \omega_- \equiv 0 \text{ (of course)}$$

As M_A gets small, the upper (optic) frequency gets large as $1/M_A$. Physically, this small mass is coupled to the two large (M_A) masses on each side, which cannot vibrate at the same high frequency as the small mass.

Small mass vibrating by itself.

Extra info: If you would look at the zone boundary π/a, the $\omega_+(\pi/a)$ frequency would be almost the same: the frequency is almost dispersionless. Checking the eigenvector would show that the heavy mass is hardly moving at all for the optic mode. The acoustic mode, on the other hand, is mostly heavy mass motion, with the light mass just staying halfway between heavy masses.