

$$\frac{1}{L^3} \left(\frac{dS_P[U_{\mathbf{x}}(a_{\mathbf{k}})]}{da_{\mathbf{k}}} \right)_{a_{\mathbf{k}}=\alpha} = \begin{cases} \alpha(\frac{1}{2}c_1 - 2c_2\tilde{Q}(k_L)) & k_L \neq 0 \\ 2\alpha(\frac{1}{2}c_1 - 2c_2\tilde{Q}(0)) & k_L = 0 \end{cases}.$$