





QUANTUM ESPRESSO













\hbar  $2M\omega_{qv}$

1/2





dV_{SCF}

 $d\hat{u}_{qv}$







d^3k  Ω_{BZ}

$$\gamma_{qv}$$

$$\pi \hbar N(e_F) \omega_{qv}^2$$

$$1$$

$$2\pi N(e_F)$$



$\gamma q \nu$

$\hbar \omega q \nu$

$$a^2 F(\omega)$$

$$\omega$$

QD

1.45



$$-1.04(1+\lambda)$$

$$\lambda(1-0.62\mu^*)-\mu^*$$



Wlog



1.2







