7.1 Quantisierung freier elm. Felder

Wellengleichung $\left(\frac{1}{v^2}\frac{\partial^2}{\partial t^2} - \Delta\right)\vec{A}(\vec{r},t) = 0$

oder $\Box\,\vec{A}(\vec{r},t) = 0$ mit $\Box = \frac{1}{v^2}\frac{\partial^2}{\partial t^2} - \Delta = \varepsilon\mu\frac{\partial^2}{\partial t^2} - \Delta$

und $\nabla\cdot\vec{A} = 0$ Strahlungseichung

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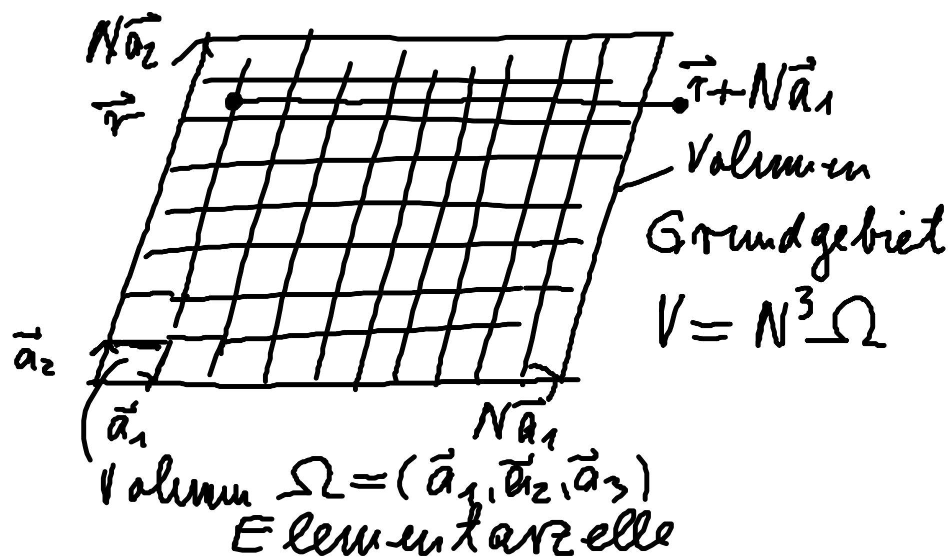
diskrete ebene Wellen $\varphi_{\vec{q}}(\vec{r}) = \frac{1}{\sqrt{V}}\exp\{i\,\vec{q}\cdot\vec{r}\}$

periodische Randbedingung bezüglich V:

$\varphi_{\vec{q}}(\vec{r}+N\vec{a}_j) = \varphi_{\vec{q}}(\vec{r})$



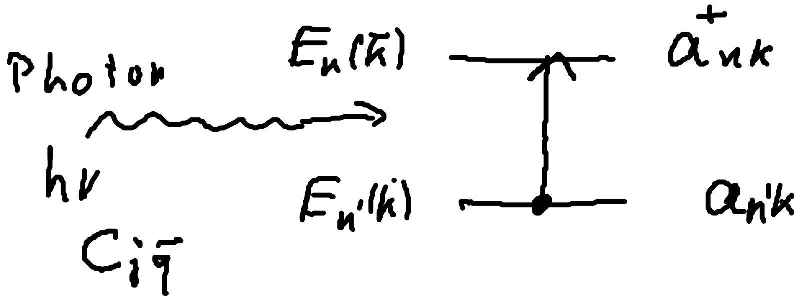
$$[c, c^+] = 1 \Rightarrow c\,c^+ = c^+c + 1$$

$$[c^+c, c] = c^+c\,c - c\,c^+c = c\,c^+c - c - c\,c^+c = -c$$

$$[c^+c, c^+] = c^+c\,c^+ - c^+c^+c = c^+c^+c + c^+ - c^+c^+c = +c^+$$

$$\hat{E} = \cdots\sum\sum\cdots[\cdots c \pm \cdots c^+] \Rightarrow \langle n|\hat{E}|n\rangle =$$

TZO: $\hat{N} = \sum c^+c \Rightarrow \langle n|c^+c|n\rangle = n$


Photon
$h\nu$
$c_{i\vec{q}}$
$E_n(\vec{k})$
a^+_{nk}
$E_{n'}(k)$
$a_{n'k}$