Especially we want to write electromagnetic dipole radiation consisting of many $n$=1,2 ... $N$ ***double±subtons*** the effect of the phase angles $\theta_n = \theta_d + \Delta\theta_n$ where any phase noise can be considered negligible mean $\overline{\Delta\theta_n} \approx 0 \;\Rightarrow\; \theta_d \approx \overline{\theta_n}$. Hence, that $\theta_d$ represents the angular ***direction*** in space of the generating dipoles[126] as a macroscopic common.
The intuition of (3.249) with polarization ***direction*** $\mathbf{e}_{\theta_d} \| \odot \perp \mathbf{e}_3$ is then

(3.250) $$\left|\psi^{\vec{2}}_{\Sigma^N \pm \odot \perp \omega \boldsymbol{e}_3}(t)\right\rangle_{\mathbf{e}_{\theta_d}} = AN4\tilde{r}(\rho)\odot\cos(\omega t+\theta_d)_{\perp\mathbf{e}_3}, \text{ for } \forall\rho \geq 0 \quad \text{and } AN=½, \text{ as } \langle\psi|\psi\rangle=1.$$

This is apparently in line with a traditional way of describing linear polarization, but we must note that the paired quantum mechanical angles are the same $\theta_d$ as a macroscopic$_N$ angular ***direction*** in space, resulting from the simultaneous creation of (3.250) as a macroscopic cause.
The ***direction*** of the causative $\mathbf{e}_{\theta_d}$ (a oscillating dipole) controls the linear polarization of the macroscopic field with the amplitude $E_a \in \mathbb{R}$, the power $|E_a|^2$ (energy flow) is proportional to the number $N$ of ***subtons***, that is, according to (3.236) $|E_a| \sim \sqrt{N}$, and we call the field amplitude of one ***subton±pair*** for $E_d$, this field is then written[127]

(3.251) $$\vec{E} = E\mathbf{e}_{\theta_d} = E_a\cos(\omega t)\,\mathbf{e}_{\theta_d} = \sqrt{N}E_d 2\cos(\omega t)\,\mathbf{e}_{\theta_d}, \quad \perp\mathbf{e}_3.$$

The common quantum pairs of the phase angle difference are now omitted and hidden in the dipole ***direction*** $\mathbf{e}_{\theta_d}$. The *physical linear* field polarisation lies in that ***direction*** $\mathbf{e}_{\theta_d}$ is multiplied by a real number $\sqrt{N}E_d 2\cos(\omega\, t) \in \mathbb{R}$.

The individual quantum phases of the ensemble (3.250) is now stored in the unitary circle group $\odot = \{U_\theta : \theta \to e^{i\theta} \in U(1) \,|\, \forall\theta \in \mathbb{R}\}$, that here includes the transversal idea in our intuition.(3.250)(3.229)(3.232)(3.222)
All subtons is created in one ***direction*** according to the motto (3.222). This requires our intuition for the form of development $\odot\perp\mathbf{e}_3 \to \odot\perp\omega\mathbf{e}_3 \to \odot\perp\,\omega t\mathbf{e}_3 \sim \odot\perp\phi\mathbf{e}_3 \to \odot\perp x_3\mathbf{e}_3$,
that the ***direction*** $\widehat{\widehat{\omega}} \| \mathbf{e}_3$ is preserved into the future, given from the past.
Looking at a particular 'place'[128] in ' time' $x_3 = ct_3$ along the line $x_3\mathbf{e}_3$, we get

(3.252) $$\vec{E}(t,x_3) = \sqrt{N}E_d 2\cos\left(\omega t - \frac{\omega x_3}{c}\right)\mathbf{e}_{\theta_d} = \sqrt{N}E_d 2\cos(\omega t - k_3 x_3)\,\mathbf{e}_{\theta_d}, \quad k_3 = \frac{\omega}{c}, \quad \mathbf{e}_{\theta_d}\perp\mathbf{e}_3.$$

This is the traditional formula for a transverse field $\vec{E}(t,x_3)_{\|\mathbf{e}_{\theta_d}\perp\mathbf{e}_3}$ propagating along the ***direction*** $\mathbf{e}_3$. For this intuition of the amplitude of the field, it is again important to note, that this is essentially different from the transversal extension of the ***subton*** beam that is normalized by $\langle\psi|\psi\rangle=1$ to $AN=½$ according to (3.250) from (3.188). Therefore, intuited as a macroscopic beam with a transversal radius of the order[129]

(3.253) $$\overset{\odot}{r}(\vec{\omega}) = \frac{c}{\omega} = \frac{\lambda}{2\pi}.$$

The 'Beam' created from one point in one ***direction***[130] is by definition in this intuition straight as a rectitude line[131] with this 'thickness'. (A laser beam, which aperture radius $\geqq \frac{\lambda}{2\pi}$ of cause).
We see (3.251) a signal field that can be modulated by changing the number $N$ of simultaneously created ***double±subtons***. This modulation is called amplitude modulation, in that it changes field amplitude $E_a \propto \sqrt{N}$, but be aware that it does not change the 'thickness' of the beam.

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[126] A dipole can be considered a *linear* harmonic oscillator (in one dimension). It has the polarization ***direction*** along this in the transversal plane with the radiation ***direction*** perpendicular to this plane.
[127] Here, factor 2 is retained even though it could be hidden in the field factor $E_d$; to indicate dipole parity opposition + and −.
[128] In the substance of this autonomous ontology *a place* is found by counting radians along the development axis, see Figure 3.13.
[129] I have previously (3.194) symbolised the transversal distribution as ◎
[130] This restriction is because we only involve propagation in one ***direction*** in all these deliberations.
[131] The only way to verify whether a ruler is rectilinear is to aim with light along its egg.







## 3.5. Modulation of a Quantum Mechanical Field

### 3.5.1. The Macroscopic Modulation

Here I will draw attention to what we call modulation, as we know it from electromagnetic wave communications by radio, in cables or optic fibres.
In the concept of modulation, there are two vastly different basic ideas behind the types of macroscopic modulation: **amplitude** modulation, and **phase** modulation.
In the formula (3.251) the 'radio' modulation is not shown explicitly, this is implicitly included in the number ***quantity*** N for the amplitude $\sqrt{N}$, and the phase angle ***quantity*** $\phi_m = \omega t$.
The phase modulation is the ***quantum*** phase angle divided into two ***quantities*** the angular frequency $\omega$ and development parameter $t$. As we have seen through Fourier integral theory in section 1.7.7-1.7.8 these two ***quantities*** complement each other.
A modulated ***quantity*** as a function of the development parameter

(3.254) $$q_m(t) = \int_{\mathbb{R}} \tilde{q}_m(\omega)e^{-i\omega t}\,d\omega$$

is complemented by a modulated ***spectrum*** as an amplitude function

(3.255) $$\tilde{q}_m(\omega) = \frac{1}{2\pi}\int_{\mathbb{R}} q_m(t)\,e^{i\omega t}\,dt.$$

To make the concept of modulation interesting for our conceptual world of information the modulation will have to be dependent on the evolution of the concept of time.
This is intuited as a modulation function $m(t_m)$, which depends on the modulation development parameter $t_m$; by which the angular frequency ***spectrum*** $\tilde{m}(t_m,\omega)$ as a function of $\omega$ also will depend on this development.
What does this look like in a conceptual world of ***subtons***?
We look at a ***spectrum*** of angular frequencies $\omega$ and thus at ***subtons*** with different eigen-frequency energies $\hbar\omega$ and as a consequence of this different phase angles $\phi = \omega t \in \mathbb{R}$.
These ***quantities***, which for us define a ***spectrum*** of a full ensemble of ***subtons***, are external to each of the individual ***subtons***.

Here, the eigen frequency for each ***subton*** has its own autonomy internal reference $\widehat{\widehat{\omega}}$.
We remember that the ***subton*** auto-norm is $|\widehat{\widehat{\omega}}| \equiv 1$ [radian], so the quantum phase angle performs the inner development parameter $\phi = |\widehat{\widehat{\omega}}|t_a = t_a = |\widehat{\widehat{\omega}}|\phi = \phi$. But -.

In the modulation of the external ***spectrum***, the intuition of the concept permits $\omega \in \mathbb{R}$ as a variable ***quantity***. Relative to this variable input frequency $\omega$ we introduce the idea of an *external constant carrier frequency* $\omega_c$ as a reference for $\forall\omega \in \mathbb{R}$ in the ***spectrum***.
The *external reference* for this *carrier is* the external reference clock $[\widehat{\omega}]$, where $|\widehat{\omega}| \equiv 1$.
To take the ***spectrum*** as a self-consistent ensemble ***entity*** $\Psi$ we have to take all the given ***subton*** frequencies as *internal conserved* in their existence $\forall\,\Psi_\omega \in \Psi$ relative to the carrier.
A constant relative measure $\omega/\omega_c$ in this ***spectrum*** $\Psi$.

### 3.5.2. The Carrier

Are there physical ***entities*** that possess a ***quality*** concerning a constant ***quantity*** that could serve as a reference measuring information in a spectrum? As an everlasting constant internal reference of a signal, we introduce the idea of a carrier of angular frequency $\omega_c \in \mathbb{R}$, in which real ***quantity*** $\omega_c[\widehat{\omega}]$ is given relative to the external reference $|\widehat{\omega}| \equiv 1[\widehat{\omega}]$.
For this carrier $\omega_c$ we also assign the idea of a development parameter $t_c$ for the carrier.
The idea is, an ideal eternal carrier wave $\vec{c^\infty}$ is formed by an external intuition of a transversal plane wave as shown in Figure 3.13, with a constant internal carrier frequency $\omega_c$ relative to an externally referenced $|\widehat{\omega}| \equiv 1[\widehat{\omega}]$, and preferred in one ***direction*** $\forall\widehat{\widehat{\omega}} \| \mathbf{e}_3$ for all carrier ***subtons*** with the transversal circle of rotation $\odot\perp\mathbf{e}_3$ of the angular frequency vector






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