This double excitation of ±***subtons*** $\omega_+ = -\omega_-$ is equivalent to

$$ {}^{AB}\Psi^{\vec{2}}_{\omega} = {}^{AB}\Psi^{\text{linear}}_{\omega} = {}^{AB}\Psi_{+\omega} + {}^{AB}\Psi_{-\omega} = $$

(3.244) $$ {}^{AB}\Psi^{\vec{2}}_{\omega} \sim \left|\psi^{\vec{2}}_{\odot_{\theta'}\perp\mathbf{e}_3}(t)\right\rangle = 2\tilde{r}(\rho)\cos(\omega t+\theta')_{\perp\mathbf{e}_3}, \text{ for } \forall\rho\geq 0, \quad \phi=\omega t+\theta' \in\mathbb{R}, \ \forall\theta'\in[0,2\pi[\ . $$

$\vec{\omega}$ as the object of intuition is an ontological concept referring to Figure 3.13 as an illustration of the two ±***subtons*** ${}^{AB}\Psi_{\pm\widehat{\vec{\omega}}}$ simultaneously created in A with the phase angle difference θ', and after that both annihilated in B at the same time with the preserved angular phase difference θ'. This intuition is viewed as an information transfer of a real scalar ***quantity*** θ' of a transversal angular ***quality*** transferred in that ***direction*** $\widehat{\vec{\omega}} \| \overrightarrow{AB}$.

We call ${}^{AB}\Psi^{\vec{2}}_{\omega}$ for a ***double±subton***. I suggest that we also call it a *double-photon*, in that its quantum energy $\hbar 2\omega$ is a linear combination (superposition) into a linear polarized state, that is also a solution for the *linear* harmonic oscillator.

The autonomous ***quantum*** $2 = 2|\widehat{\vec{\omega}}|$ represents also power and momentum $\vec{\mathbf{2}} = 2\widehat{\vec{\omega}}$ while the resulting angular momentum is $\widehat{\vec{\omega}} - \widehat{\vec{\omega}} = \vec{L}_3^+ + \vec{L}_3^- = 0$.

The ***double±subton*** ${}^{AB}\Psi^{\vec{2}}_{\omega}$ endowed by creation in A one state-mode energy $\hbar 2\omega$ and handing back this energy in the annihilation B. The same applies to its momentum, where the recoil $-\frac{\hbar}{c}2\omega_2\mathbf{e}_3$ in A creates a momentum $\frac{\hbar}{c}2\omega_2\mathbf{e}_3$ which is delivered in B.

It is important here to note that $\hbar 2\omega$ is the frequency energy of the state-mode, not a portable energy (external mass=0 of photons\subtons). The state-mode *energy transfer* corresponding to the transfer of a *momentum* which results in an effect. This *flow of energy* (power) is expressed with the autonomous time-frequency reference $|\widehat{\vec{\omega}}| \equiv 1$ [radian]

(3.245) $$ \vec{\omega}_{2\text{superposition}}/|\widehat{\vec{\omega}}| = \frac{2\widehat{\vec{\omega}}}{|\widehat{\vec{\omega}}|} = 2\widehat{\vec{\omega}} = \vec{\mathbf{2}} $$

and the *flow of energy* expressed relative to an **external** time-frequency reference $|\widehat{\omega}|=1\ [\widehat{\omega}]$

(3.246) $$ \hbar\omega_2\mathbf{e}_3/|\widehat{\omega}| = \hbar 2\omega\widehat{\omega}\mathbf{e}_3/|\widehat{\omega}| = \hbar 2\omega\mathbf{e}_3\ [\widehat{\omega}], \qquad \text{where} \quad |\mathbf{e}_3| = 1[\widehat{\omega}^{-1}]. $$

for the ***subton±pair*** ${}^{AB}\Psi^{\vec{2}}_{\omega} \sim {}^{AB}\Psi_{+\omega} + {}^{AB}\Psi_{-\omega}$ is one linearly polarized ***quantum*** $\hbar 2\omega$.

In addition to this, it is the real ***quantity*** the *phase angle relationship* of the ***subton±pair*** $\theta' = \sphericalangle({}^{AB}\Psi_{+\omega}, {}^{AB}\Psi_{-\omega})$, which carries the angular information from A to B.

3.4.5.2. One *double±subton* Interpreted as a Progressive Wave

For the ***double±subton*** applies $N_+=1$ and $N_-=1$. We formulated now as in (3.238) alternative super-positions of the difference between creations $a^\dagger_{\odot+\omega}$ and $a^\dagger_{\odot-\omega}$

(3.247) $$ |\psi_{\Sigma^2\pm\odot\perp\vec{\omega}}(t)\rangle = \pm\tfrac{1}{2}\left(a^\dagger_{\odot+\omega} - a^\dagger_{\odot-\omega}\right)_{\perp\widehat{\vec{\omega}}}|0,0\rangle = \pm\odot\tilde{r}(\rho)\left(e^{+i\phi} - e^{-i\phi}\right)_{\perp\widehat{\vec{\omega}}} $$
$$ = \pm\odot\tilde{r}(\rho)\left(e^{+i(\omega t+\theta')} - e^{-i(\omega t+\theta')}\right)_{\perp\widehat{\vec{\omega}}} = \pm i\odot 2\tilde{r}(\rho)\sin(\omega t+\theta')_{\perp\widehat{\vec{\omega}}}, $$

for $\forall\rho\geq 0$, and $\phi=\omega t+\theta'$.

From here we now write the progressive extension on the form as in (3.223) and (3.238)

(3.248) $$ |\psi_{\Sigma^2\pm\odot\perp\widehat{\vec{\omega}}}(t)\rangle \leftrightarrow \begin{pmatrix} \pm\tilde{r}(\rho)\left(e^{+i(\omega t+\theta'+\theta)} - e^{-i(\omega t+\theta'-\theta)}\right) \\ -|\omega t| \end{pmatrix}_{\widehat{\vec{\omega}}} = \begin{pmatrix} \pm i\,\tilde{r}(\rho)\,2\sin(\phi+\theta'+\theta) \\ -|\phi| \end{pmatrix}_{\widehat{\vec{\omega}}} $$
$$ \leftrightarrow \begin{pmatrix} {}^{\frac{\pi}{2}}\odot\,\tilde{r}(\rho)\,2\sin(\phi\pm\frac{\pi}{2}+\theta') \\ -|\phi\pm\frac{\pi}{2}| \end{pmatrix}_{\widehat{\vec{\omega}}} \leftrightarrow \begin{pmatrix} {}_0\odot\,\tilde{r}(\rho)\,2\cos(\phi+\theta') \\ -|\phi| \end{pmatrix}_{\widehat{\vec{\omega}}}, \quad \text{for } \forall\rho\geq 0 $$

Research on the a priori of Physics
Geometric Critique of Pure Mathematical Reasoning
Jens Erfurt Andresen
Edition 2, © 2020-22

We see that different combinations of $\pm\psi_+, \pm\psi_-$ in the ***double±subton*** superposition only provide $\odot$ a symmetry invariant $\frac{\pi}{2}$ displacement along the helicity, that is, both in A and B, and therefore do no change to the information contained in $|\psi_{\Sigma^2\pm\odot\perp\widehat{\vec{\omega}}}(t)\rangle$.

Therefore, we count (3.238)→(3.244) as a sufficient description of the ***double±subton***.[123]

3.4.5.3. Superposition of Linear Polarized *double±subtons*

We write the superposition of $N=N_+=N_-$ ***double±subtons*** states (3.238) $|\psi_{\Sigma^2\pm\odot\perp\widehat{\vec{\omega}}}(t)\rangle$ created simultaneously with N pairs of angular phases $\theta_n = \theta_{n^+} - \theta_{n^-}$, with $n=1,\ldots N$, where the desire is that $n = n^+ = n^-$; and created from a single angular frequency $\omega[\widehat{\omega}] = \omega_+ = -\omega_-$ equal for all $a^\dagger_{\odot+\omega}$ and all $a^\dagger_{\odot-\omega}$ as well as all combinations $a^\dagger_{\odot+\omega}+a^\dagger_{\odot-\omega}$

(3.249) $$ \left|\psi^{\vec{2}}_{\Sigma^N\pm\odot\perp\omega\mathbf{e}_3}(t)\right\rangle = AN\left(a^\dagger_{\odot+\omega} + a^\dagger_{\odot-\omega}\right)_{\perp\mathbf{e}_3}|0,0\rangle = A2\tilde{r}(\rho)\odot\left(\textstyle\sum_{n=1}^{N}\left(e^{+i(\omega t+\theta_n)}+e^{-i(\omega t+\theta_n)}\right)\right)_{\perp\mathbf{e}_3} $$
$$ = A2\tilde{r}(\rho)\odot\left(\textstyle\sum_{n=1}^{N} 2\cos(\omega t+\theta_n)\right)_{\perp\mathbf{e}_3}, \text{ for } \forall\rho\geq 0, \qquad \phi_n = \omega t+\theta_n, $$

We try approaching this as a coded signal containing information, in between each ***subton±pair***. The impossibility here by reading at the annihilation B is that all the single simultaneous excited N_+ ***subtons+*** respectively N_- ***subtons−*** are *identically indistinguishable*, with individual ***subton*** phase angles θ_{n^+} respectively θ_{n^-}, may be combined in any $N!$ manner $\theta_{n^+n^-} = \theta_{n^+} - \theta_{n^-}$, where $n^+ = 1,\ldots N_+$, and $n^- = 1,\ldots N_-$.

The idea of simultaneous useful modulation of ***double±subtons*** in a monochromatic transversal plane wave (in one ***direction*** $\mathbf{e}_3$)[124] is thus **an illusion**. All phases are mutually indecipherable. Only if we can separate the individual ***double±subton***$_n$ e.g. at different frequency energies ω_k, or by a causal angular displacement of the phases $\phi_m = \omega t_m$, in which the development parameter has a sequential order of $t_m \gtrsim t_{m-1} + 2\pi/|\omega|$ with $\phi_{m-1}+2\pi \lesssim \phi_m$, a transmission with a sequential subsequence reception of the individual phase angle signals $\theta_{m,k}\in[0,2\pi[$ from each ***double±subton***$_{m,k}$ that can be individually read in B. More about t_m modulation below.

Thus, only single ***double±subtons*** which can be modulated with their own quantum mechanical angular phase θ' of (3.238) to be read individually. The idea linear polarization produces relative angular information in the creation of a ***double±subton*** of event A, which is then transferred to the annihilation of the ***double±subton*** in event B.

I would like to point out, if we can modulate one single ***double±subton*** couple with a phase angle difference θ' and read them again without being disturbed by thermal noise, we can phase modulate the transversal plane of a monochromatic plane wave at one single frequency ω_k.[125]

The problem is, that the modulation is quantised to a single ***entity double±subton*** ${}^{AB}\Psi^{\vec{2}}_{\omega_k}$.

We ask, is this an indivisible elementary particle or merely a composite particle? For optical photons, room temperature is so low that single ***double±subtons*** pair can be detected.

The ensemble (3.249) cannot be ***quantum coded*** because of simultaneous individual phase detection confusion in the permutation between the identical individualities of respectively + and − rotation orientations. All these individual phases are mutually indecipherable.

Superposition of the linearly polarized ***double±subtons*** has relevance to the concept of linearly polarized light, as it is an equal number of ***subtons*** of positive and negative helicity.

---

[123] The reader, that will investigate this further can study Hilbert couples and transformation. (I do not have the strength.)

[124] This view with a transversal plane wave through one ***direction*** is also called a *transmission channel*.

[125] One single ***double±subton*** is by definition given at one frequency. Opposite this, by ordinary radio technique (which for many years has been my livelihood) we used to say that phase modulation is synonymous with frequency modulation in contrast to the monochromatic idea. But by radio modulation and communications, the temperatures are so high that single photons cannot be registered individually and the phase of the ***double±subton*** cannot be read. ($\hbar\omega \ll kT$). So, in traditional radio wave communication neither this nor the monochromatic idea has relevance. Opposite for light double±photons $\hbar\omega > kT$.