We can use the angular frequency of the background radiation as the clock, but all other radio frequencies can be used. Anyway, there will always be a soup (a so-called field[397]) of low frequency subtons with the relative speed of information around each free electron.
Some of these will be Compton bounced in interaction with the electron.
These causal ***outwards*** propagating subtons will carry information about the charge and spin, from this electron into the future with the speed of light.
We can for our intuition display this as line rays starting in the presumed locality intersection center point of electron ***entity*** $\Psi_{½}$. Such Faraday-like field lines are only an illustration of straight past *null line* trajectories[398] of subtons displayed in the local frame of one electron by Figure 6.25.

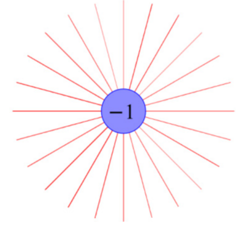

Figure 6.25 *null lines* of an information field from a charged electron. As a 2D projection from a 4-dimensional idea.

6.7. Multiple Numbers of Spin½ Fermions

We will not go into the emergence of a classical force field in this volume.

6.7.1. External Qualities of Charged Fermions

We will not treat nuclear particles in this Chapter, but only uses atom nucleus as orbital centres.

6.7.1.1. Identical Charged Fermions

We know from the classical idea of charge, that two bodies with the same sign of charge repel each other. All experience indicates that two identical charged fermions repel too.

6.7.1.2. Opposite Charge Fermions

Oppositely charged bodies attract each other. The same for an electron and a positron attraction. There is nothing in our experience that tells us, that they avoid each other. We have the idea that they annihilate in a gamma burst.

6.7.1.3. The Bohr-Rutherford Atomic Model

The atom-model idea with a central massive nucleus of an integer-numbered positive charge attracting the same number of electrons (orbiting around). For Hydrogen we have just one positive charge attracting one electron. But the nucleus (proton) has a property that the electron avoids, possibly in some similar way as the electron avoids its identical siblings. The ***category*** of fermions demands the ability to distinguish the different ***entities*** whether they are identical or not § 6.6.3.

6.7.2. Mutual Exclusive Extension of Fermions

We have seen that fermions possess locality in $\mathfrak{Z}$-space. Identical fermions have to be differentiated by space extension. This exclusion idea has been essential since Leibniz.[399] It has been widely discussed, that different extended solids cannot possess the same locality in space. The local radial extension of a fermion is the magnitude of its unitary versor wavefunction that by definition is $|\Psi_{½}|=1$ in its autonomous norm $|\omega|=1$.
In traditional external lab system norm, we *estimate* the radius of a fermion from the internal frequency energy $\omega_{½}$ expressed as an external mass relative to a frequency standard e.g. $[s^{-1}]$ as

(6.524) $$r_{½} = \frac{c}{\omega_{½}} \sim \frac{2\hbar c}{mc^2} \sim \frac{2\hbar}{mc}, \qquad \text{for the electron: } r_e \sim 0.77 \cdot 10^{-12} \text{ meter } \sim \tfrac{1}{68} \text{ Bohr-radius.}$$

This estimate shows that there is sufficient extensive space for the electron to stay in its own exclusive autonomous right in the orbitals of an atom.

6.7.2.2. The Pauli Exclusion Principle

The classical exclusion principle was reformulated by Pauli in 1925 to the exclusion principle for the electron states, which also included the two spin½ states of the electrons. E.g., the spin *up*

[397] Avoid the classical field, where all clocks have stopped in an eternal GOD's eye view. Thomas Aquinas's eternal-time ⇐GOD.
[398] Trajectories as a projection of null lines from an abstract Minkowski $\mathcal{B}$-plane orthogonal to $\mathfrak{Z}$ space, see section 5.7.
[399] Two equal-sized solid stones cannot be merged to fill the same space of just one stone. The same for two water drops.

and *down* stats of two electrons in a He*lium* atom, etc. for orbital electrons in atoms, and exclusions for valence electrons and further to conduction electrons in solid state physic.

6.7.3. Orbital Angular Momentum

For the fundamental fermion category, we have presumed the first excited state of $\mathfrak{Z}$-space with quantum number $\boxed{j = \frac{1}{2}}$ in the treatment of the concept of all ***entities*** $\Psi_{½}$
The exclusion principle seems to avoid further excitations to new indivisible ***entities*** $\Psi_{j>½}$.
From this, we conclude a judgment that higher values $\boxed{j = 1, \frac{3}{2}, 2, \frac{5}{2}, \ldots}$ represent multiple spin½ fermion ***entities*** $\Psi_{½}$ in external interactions mutually excluding each other.

6.7.3.1. The Squared Perpendicular Part of Orbital Integer Quantum Number Excitation

For $j = 1$ we have three states $m = -1, 0, +1$, and $\lambda = 2$, continued from (6.361)-(6.364)

(6.525) $$\langle \lambda,m | J^2 - J_3^2 | \lambda,m\rangle = \langle 2,\pm1 | J_\perp^2 | 2,\pm1\rangle \sim \hbar^2\lambda - \hbar^2 m^2 = \hbar^2 2 - \hbar^2(\pm1)^2 = \hbar^2 1, \quad \times\text{two states,}$$

(6.526) $$\langle \lambda,m | J^2 - J_3^2 | \lambda,m\rangle = \langle 2,0 | J_\perp^2 | 2,0\rangle \sim \hbar^2\lambda - \hbar^2 m^2 = \hbar^2 2 - \hbar^2(\pm0)^2 = \hbar^2 2, \quad \times\text{two states.}$$

This last (6.526) is e.g. the case for the first shell with *principal* ***quantum*** number n=1 of a He*lium* atom with two electrons $\Psi_{½,1}$ and $\Psi_{½,2}$ in the subshell *orbital* angular momentum ***quantum*** number $\ell_1 = \ell_2 = 0$, each $j_1 = j_2 = ½$ with *spin* $m_{½,1} = \pm½$ and $m_{½,2} = \mp½$, making up the total angular momentum $j = j_1 + j_2 = |\ell_1 \pm ½| + |\ell_2 \mp ½| = 1$, and for He*lium* the total spin is

(6.527) $$m_{½,1} + m_{½,2} = 0 \;\Rightarrow\; \langle 2,0 | J_3 | 2,0\rangle = \mathbf{L}_3^{\mathrm{He}} = 0, \quad \text{with two indistinguishable states } 1,2 \leftrightarrow 2,1.$$

The situation is completely different for the first case (6.525), the two spins of the ***entities*** $\Psi_{½,1}$ and $\Psi_{½,2}$ are parallel aligned $m_\pm = m_1 + m_2 = \pm1$.
My best guess for an example is an electron-positron annihilation to a gamma burst of two subtons $\gamma_+ + \gamma_-$ of opposite helicities of spin ±1, for the opposite 1-vector propagation ***directions***, containing the total frequency energy equal balance to the two internal oscillations, that external is perceived as masses for the two ***entities*** $\Psi_{½,1}$ and $\Psi_{½,2}$. The two propagating *spins* $m_+ = +1$ and $m_- = -1$ with opposite orientated ***direction*** is then given

(6.528) $$m_+ + m_- = 0 \;\Rightarrow\; \langle 2,\pm1 | \mathbf{j}_3 | 2,\pm1\rangle = \pm\mathbf{j}_3^\gamma = \pm\hbar 1\boldsymbol{\sigma}_3 = \pm\hbar\vec{L}_3^\pm$$

The new thing is that the propagating development into the future result in two opposite helicity orientations of a 1-vector ***direction*** into the extension of $\mathfrak{Z}$-space by two subtons Ψ_{+1}, Ψ_{-1}.
(vice versa, possibly creating a pair from two gamma rays interacting in a forceful field).

6.7.3.2. The Orbital Angular Momentum of Multiple Spin *entities* $\Psi_{½}$

The Rutherford model of the atom with a small central instance (nucleus) separated from the surrounding electrons. The first approach was an atom nucleus with electrons orbiting around as point satellites in an electrical force field with a conserved orbiting angular momentum just as Kepler's second law for planets. The classical approach was that the positive electric charged nucleus attracts the negatively charged electron, with an *eternal forcefield* $\vec{F}=m\vec{a}$ accelerating an electron mass inwards orbiting around the nucleus in the atom. It was a problem that the accelerated point electron will continuously radiate electromagnetic energy so that the orbiting angular development should decay. But Niels Bohr realised from Balmer series and Rydberg's spectrum formulas for the H*ydrogen* atom has distinct ***quantised*** energy levels ordered after n^{-2}, and proposed that the H*ydrogen* electron state in an angular revolving (kind of orbital) resonance around the nucleus numbered after natural numbers $n \in \mathbb{N}$. This we instrumentalise as states of the preserved magnitude of *orbital angular* momentum $|\mathbf{L}| = \hbar n$, that in principle is not observable.
The square of this is a commutating scalar $|\boldsymbol{L}|^2 = \hbar^2 n^2$ that has an observable ***quantity***.
The interchange between these levels stays in proportion to the frequency energy of subtons in interaction. We write this as $\hbar\omega \propto (n_2^2 - n_2^2)/(n_2^2 n_2^2)$.

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