To determine the ***quality*** of excitations we examine their eigenvalue equation for the angular momentum of the circle oscillator (3.167), which give rise to the two angular momentum vectors of (3.168), which sets two opposite orientations of a ***direction*** in something we call space.
The one $\vec{L}_3^+ = +\hbar\vec{n}$ into the future, the other opposite $\vec{L}_3^- = -\hbar\vec{n}$ back into the past, which constitutes each side of the circle oscillator plane. – See Figure 3.8 .
We remember from (3.168) that $|\vec{L}_3^{\pm}| = \hbar = 1$.

3.3.4.3. The *Qualitative* Unit of the Circle Oscillator *Entity*

To understand the ***quality*** of a circle oscillator we are looking for the unit of its fundamental ***quantity***. In addition, we introduce an autonomous normalization of the angular frequency, that is, we put $\omega = |\hat{\omega}| = 1$, where $\hat{\omega}$ stands for a unit of angular frequency as a norm for $\hat{\omega}$ itself, an autonomous norm. Furthermore, we set $\hbar{=}1,\ c^2{=}1$ in our intuition of the unit idea to concern it all, in the way that $|\vec{L}_3^+| = |\vec{L}_3^-| = 1$, and $\vec{L}_3^+ = -\vec{L}_3^-$.
We introduce a unit vector as the ***direction*** in some space out***wards*** from the active circular rotation

(3.171) $$\hat{\vec{\omega}} = \vec{L}_3^+ = \vec{n} = \vec{\mathbf{1}} \sim \hat{\vec{\mathbf{1}}} \sim \hat{L}_3 \sim \hat{\vec{\omega}},$$

where the unit norm for the angular frequency vector is written $|\hat{\vec{\omega}}| = |\hat{\omega}| \equiv 1$. <u>Thus, alleged</u>:
The ***direction*** vector $\hat{\vec{\omega}}$ for the rotation represents the ***quality*** of a circle oscillator.
Hence the ***quality direction*** is substantial to the concept of a transversal circular rotation.

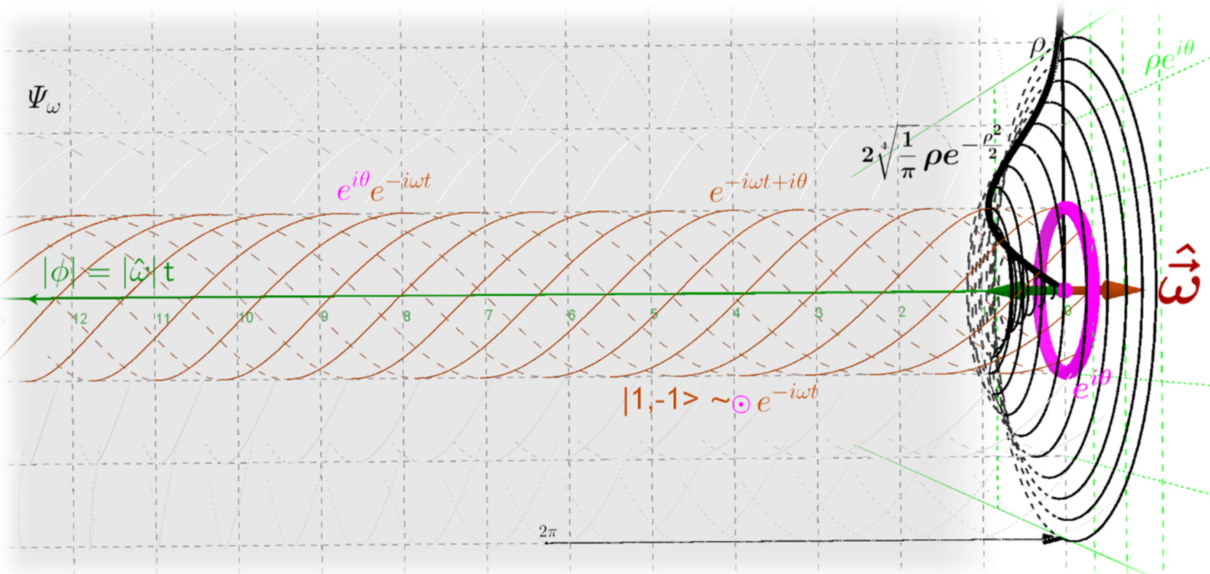

Figure 3.9 An intuition of the density distribution of the angular momentum for a retrograde excited circle oscillation.
The negative ***direction*** $\vec{L}_3^- = -\vec{n}$ for the retrograde rotation just points into the past from the transversal plane.
The transversal plane is represented by the polar coordinates (ρ,θ), which is equivalent to the complex number $\rho e^{i\theta}$.
The magenta circle ring represents the unitary rotational group $U(1)$, where $\odot = \{U_\theta{:}\,\theta{\to}e^{i\theta}{\in}U(1)\,|\,\forall\theta\in\mathbb{R}\}$.
This dictates that the radial distribution $2\frac{1}{\sqrt[4]{\pi}}\rho e^{-\frac{1}{2}\rho^2}$ of the excitation of the angular momentum must be rotation symmetric in the $\odot$ plane. We let the autonomous normed vector $\hat{\vec{\omega}}$ for the angular frequency determine the excitation with the creation operator $a^\dagger_{\pm\hat{\vec{\omega}}}$. The excited states (3.163) are $a^\dagger_{\pm\hat{\vec{\omega}}}|0,0\rangle = |1,\pm1\rangle_{\hat{\vec{\omega}}} = 2\frac{1}{\sqrt[4]{\pi}}\rho e^{-\frac{1}{2}\rho^2}\ \odot_{\hat{\vec{\omega}}}\ e^{\pm i\omega t}$.
The ***direction*** of the unitary rotational symmetry $\odot_{\hat{\vec{\omega}}}$ is given extern perpendicular to the ***direction*** $\hat{\vec{\omega}} = \vec{L}_3^+$.
Hence the transversal plane for $\odot_{\hat{\vec{\omega}}}$ has $\hat{\vec{\omega}}$ as normal vector $\hat{\vec{\omega}}\perp\odot$. $\hat{\vec{\omega}}$ is the ***direction*** *FORWARD* into the future.
Here, in this figure, the retrograde excitation $m = -1$ is illustrated as a unitary $(\rho{=}1)$ spiral cylinder $|1,-1\rangle_{\hat{\vec{\omega}}} \sim \odot e^{-i\omega t} = e^{i\theta}e^{-i\omega t} = e^{-i\omega t+i\theta}$, stretching out in the past, with a positive development parameter t, or phase $|\phi| = |\hat{\omega}|t$. This retrograde excitation is in line with the eigenvalue equation (3.114) $\vec{L}_3^-|1,-1\rangle_{\hat{\vec{\omega}}} \doteq -1|1,-1\rangle_{\hat{\vec{\omega}}}$.
The intuition in this figure assumes that all conditions are normalized $\left(1 \equiv |\hat{\omega}| = |\hat{\vec{\omega}}| = |\vec{L}_3^{\pm}| = \hbar = c^2 = 1\right)$.

Research on the a priori of Physics
Geometric Critique of Pure Mathematical Reasoning
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The plane of circle oscillators is transversal and those point out a ***direction*** $\hat{\vec{\omega}}$ for information development (a course to sail in space-time).
The sign of the ***direction*** orientation associated with angular momentum depends on the sign of the active rotation in the transversal plane following (3.167).
The positive ***direction*** for information development of the transversal plane in a circle oscillator $\vec{n}$ is given by the ***direction*** of $\vec{L}_3^+$. The positive *FORWARD* orientation of the ***direction*** into the future we use as an arrow vector ***direction*** for the angular frequency oscillation

(3.172) $$\hat{\vec{\omega}} = \vec{L}_3^+ = \vec{n}.$$

This is ***the primary quality*** of any development through a plane as given by an active creation of a circle rotation with a necessary energy ***quantity*** ω (the angular frequency). The active flow ***direction*** $\hat{\vec{\omega}}$ by the transversal plane into the future gives the positive orientation of rotation in the transversal plane. – (You may use the right-hand rule.)
The two possible orientations of rotation $m = \pm1$, are given by (3.167).
The retrograde angular momentum vector $\vec{L}_3^- = -\hat{\vec{\omega}}$ points into the past, and appoints thus the coordinate ***direction*** that represents the past,
'As a tail pulled by the circle oscillators momentum' shown in Figure 3.9.
We have two cases of rotation orientations $\vec{L}_3^{\pm} = \pm1{\cdot}\hat{\vec{\omega}}$

- The angular momentum $\vec{L}_3^{\pm}$ represents the active angular rotation in the transversal plane.
- The rotation axis ***direction*** $\hat{\vec{\omega}}$ represents the active progress through the transversal plane.

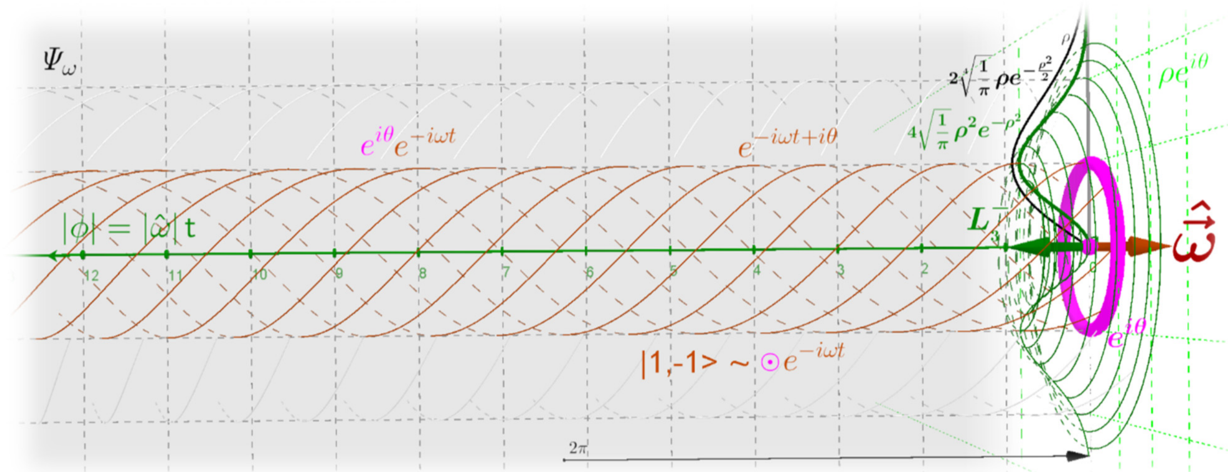

Figure 3.10 The intuition of expectation for the radial distribution of the active angular moment over the transversal plane for a retrograde $\vec{L}_3^- = -\hat{\vec{\omega}}$ excited circle oscillation. First the integrated contribution of the excited angular state throughout the transversal plane, we expect $\langle 1,-1|\vec{L}_3^-|1,-1\rangle_{\hat{\vec{\omega}}} = \langle 1,-1|1,-1\rangle_{\hat{\vec{\omega}}}\vec{L}_3^- = \vec{L}_3^-$. Then a detailed action contribution from a tiny circle ring $d\rho$ at radius ρ for the expectation of the angular momentum distribution
$\left|2\frac{1}{\sqrt[4]{\pi}}\rho e^{-\frac{1}{2}\rho^2}\right|^2\vec{L}_3^-\,d\rho = \frac{4}{\sqrt{\pi}}\rho^2 e^{-\rho^2}\vec{L}_3^-d\rho$, and by radial integration $\int_0^\infty\frac{4}{\sqrt{\pi}}\rho^2 e^{-\rho^2}\vec{L}_3^-d\rho = \vec{L}_3^-\int_0^\infty\frac{4}{\sqrt{\pi}}\rho^2 e^{-\rho^2}\,d\rho = 1\vec{L}_3^-$
Since the intuition in this figure assumes that all conditions are normalized $\left(1{=}\,|\vec{L}_3^{\pm}| = |\hat{\vec{\omega}}| = |\hat{\omega}| \equiv 1{=}\,\hbar = c^2\right)$ then we equivalent in the classical picture conclude that $m_\omega{=}1$ is an angular initial 'mass' in a circling ring at medium radius $r = \bar{\rho} = 1$ from (3.66) corresponds to a moment of inertia $I_{3,\omega} = m_\omega r^2 = |\vec{L}_3^-|/\omega = 1$. $(1{=}\,r = m_\omega = I_{3,\omega} = |\vec{L}_3^{\pm}|)$.
The illustrative idea with the classic image of the angular momentum viewed as a plane rotating disc or ring with an equivalent mass, giving a moment of inertia and kinetic energy (normed as = 1), around in the transversal plane. In the classic view, there is no action out from the plane. A contradiction to this, the created quantum circle oscillation produces a helix field through the passed displayed by a phase-parameter $|\phi| = |\hat{\omega}|t$. I would try to express the picture that the past press the transversal plane *FORWARD* in the ***direction*** $\hat{\vec{\omega}} = \vec{\mathbf{1}}$ and that the kinetic-energy~momentum~power~1; with the angular momentum $\vec{L}_3^{\pm}$ as a 'motor', internal autonomous norm $\left(|\hat{\vec{\omega}}| = |\vec{L}_3^{\pm}| = 1 = \hbar = c^2\right)$. – *This has the external **quantity***