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Information Soliton

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ABSTRACT

In this work, for understanding bio-information transmission through long distance a type of nonlinear master equation is studied. We found that the nonlinear power term can introduce a novel solution of the equation, in which a possible invariant structure as an information soliton can exist when time elapses long enough. This provides a sort of constructive channel for bio-information transmission for long distance.

Keywords: Quantum Information; Coherent State; Nonlinear Kinetic Equation

1. Introduction

Quantum information theory in treating interact transmission and processing of quantum states, entanglement of states for quantum computation, quantum cypotography or quantum teleportation has achieved great progresses nowadays [1-6]. However, until recently it is clear what is fundamental dynamical equation directly related to quantum information density (QID). In previous works [7,8] we have presented that the Liouville equation, the Schwinger-Tomonaga equation and the Einstein equation still hold for quantum information density (QID): $i\frac{\partial I[\rho]}{\partial t}=[H, I[\rho]]$. Here $I[\rho]$ corresponding to a sort of general QID, especially, $I[\rho]=\rho\ln\rho$ is defined as QID. In this way, the definition $I[\rho]=\rho$ can be considered as a minimum unit of QID [9-15]. Moreover, in the classical system, the similar Liouville equation for the information density can also be established, which means this information representation is universal both for quantum and classical systems [7]. All of these dynamic formulations reveal an essential information character of universe. Then a question is raised: how a subject builds an efficient information channel to communicate with any object or even universe by a long distance against decoherence or energy decaying?

The background of this interesting question is that quantum communication needs to develop more stable and low dissipative channel to transmit or receive quantum singles against decoherence. This is, of cause, an obviously application for our model, however, in this work, we stress a mechanism for understanding the transmission of bio-information through long distance in the Somatic experiments. This problem is important because started from 1987, the series of remote sensing thinking transmissions have been done by Shao Laisheng, Yu Huihua, Shen, J. Wang Boyang, Sheng Zujia, and Fang Lin Hu in Fudan University, China [16]. They made more than 3 years of experiments to find that the thinking sensing distance can reach more than 1000 km, and the sensing information can be numbers, text, graphics with colors. During 1987 to 1988, they had accomplished 37 times thinking sensing experiments, complete success was 14 times and partial success was 15 times, so the successful results were accounting for 41%. The sending information as random combination of 6 digital color pen written can be marked by the receiver as the number and color correctly. Close the time thinking, sensing in a few seconds to a few minutes. In 1990 they made remote sensing experiment of thinking between Beijing and Shanghai, sensing content of numbers and words, time difference from an hour to several hours or even more than ten hours. For the 15 experiments of Shanghai to Beijing in November 17-18, 1990, there existed succeed 8 times and 7 times of failures. In 1990 the experiments from Beijing to Shanghai, there were 8 times thinking sensing experiments, four of them were successful and four times were fail. Sensing successful contents were such as: Hua headmaster: Hello, spiced beans king, 98647, Spring in society. Time differences respectively were: about 8 hours, about 8 hours, about 7 minutes, about 18 minutes. The successful launching and received successful physiological signs were that the functional heads appeared “screen effect”, and the contents were written to the test paper. They found that there were quite a large amount of information, high resolution during the transmission while the receiving selective, transmission distance of the sensor had no significant effect on transmission. Furthermore this sort of transmission was almost not affected by the general electromagnetic shielding... Interference of telecommunications equipment could not influence the transmission. This seems to reveal that the information signal is a kind of invariant information solitons consisting of electromagnetic wave as we previously introduced [16]. However, since the experiments could not provide what was exact meaning of carrier in the transmission for long distance, therefore the experiments were subjected to a lot of suspicions and critics because the experiments discarded the classics and rebel against orthodoxy of well known physics, such as transmission of signal will decay in air [16].

So, along this clue, we firstly establish a sort of nonlinear master equation, then study the relevant solution to reveal a solitonic structure of information when time elapses long enough.

2. Nonlinear Kinetic Equation

Because QID is just the negative entropy density, the physical meaning of Liouville equation for QID allows us to consider logically introduce a micro-representation of the second law of thermodynamics by

$$\frac{\mathrm{d}\rho\ln\rho}{\mathrm{d}t} = \begin{cases} i\dfrac{\partial\rho\ln\rho}{\partial t} - \left[H,\rho\ln\rho\right] \\ i\dfrac{\partial\rho\ln\rho}{\partial t} - \left\{H,\rho\ln\rho\right\} \end{cases} = \begin{cases} 0, & \text{for equilibrium process} \\ >0, & \text{for non-equilibrium process, order increase} \\ <0, & \text{for non-equilibrium process, order decrease} \end{cases} \tag{1}$$

which gives naturally a general Liouville equation for the open system constructed by

$$i\frac{\partial\rho\ln\rho}{\partial t} = \begin{cases} \left\{H,\rho\ln\rho\right\} + V\left(\rho\ln\rho\right), & \text{for classical system} \\ \left[H,\rho\ln\rho\right] + V\left(\rho\ln\rho\right), & \text{for quantum system} \end{cases}, \tag{2}$$

where $V\left(\rho\ln\rho\right)$ is assumed to be introduced by the difference of QID between the system and environment. More generally, this difference is supposed to be introduced by a potential of information density, which drives the system to evolve along the direction described by the second law of thermodynamics.

In short, the above derived QID representation of Liouville equation coincides with the traditional Liouville equation, therefore it can not describe an irreversible process since its time evolution is symmetric by inheriting from the Liouville equation [17], however, from the point of view of thermodynamical second law we can introduce a difference (or gradient) of QID to allow

$$\frac{\mathrm{d}\rho\ln\rho}{\mathrm{d}t} = i\frac{\partial\rho\ln\rho}{\partial t} - \left[H,\rho\ln\rho\right] = V\left(\rho\right) \neq 0, \tag{3}$$

where $V\left(\rho\right)$ is assumed to be introduced by a difference (or gradient) of QID.

Because QID is just the negative entropy density, the above expression is like a microscopic representation of thermodynamical second law: when the QID in the two coupled systems are not equal to each other, then there exists a difference (or gradient) of QID, which will spontaneously drive the higher QID to transmit to the lower QID until the both arriving at equilibrium. Indeed for a quantum system, if one poses a non-equilibrium Liouville equation expressed as

$$\frac{\mathrm{d}\rho}{\mathrm{d}t} = i\frac{\partial\rho}{\partial t} - \left[H,\rho\right] = R\left(\rho\right), \tag{4}$$

then using the Baker-Hausdorf formula and applying the Magnus lemma [17] gives

$$\frac{\mathrm{d}}{\mathrm{d}t}\rho\ln\rho = R\left(\rho\right)\ln\rho + \left\{R\left(\rho\right), \frac{\ln\rho}{1-\rho}\right\} = V\left(\rho\right), \tag{5}$$

where $\left\{x, y^n\right\} = \overbrace{\left[\left[\cdots\left[x,y\right],y\right]\cdots,y\right]}^{n\text{ times}}$, so if $R\left(\rho\right)$ is chosen as an analytic function of ρ, then a nonlinear Liouville equation is achieved as

$$i\frac{\partial\rho}{\partial t} = \left[H,\rho\right] - R\left(\rho\right), \tag{6}$$

where $V\left(\rho\right) = R\left(\rho\right)\ln\rho$. For example, if $V\left(\rho\right) = \rho^n\ln\rho$, then

$$i\frac{\partial\rho}{\partial t} = \left[H,\rho\right] - \rho^n, \tag{7}$$

which specifies a nonlinear term. More concretely, if a system is open, then $\left[H,\rho\right]$ may transfer to type of terms relate to a master equation, consequently Equation (7) is changed to a type of nonlinear master equation (NME). This is a novel equation worthy of further study.

3. Information Solitons

For instance, in a quantum open system, a master equation for the amplitude damping model, after considering a nonlinear term ρ^4, can be established by

$$\frac{\mathrm{d}\rho}{\mathrm{d}t} = -\kappa\left(a^\dagger a\rho - a^\dagger\rho a - a\rho a^\dagger + \rho a a^\dagger\right) - \rho^4, \tag{8}$$

where κ is a damping number, a, $a\dagger$ is an annihilation or a creation operator, respectively. The nonlinear term ρ^4 can be considered as originating from nonlinear interaction between the system and environment as the Keer effect in the medium.

Then using the coherent and entangled state as a basis developed by Fan Hongyi [18], we can get

$$\begin{aligned}&\frac{\mathrm{d}\rho\left|I\right\rangle}{\mathrm{d}t}\\&=-\kappa\left(a^{\dagger}a\rho-a^{\dagger}\rho a-a\rho a^{\dagger}+\rho aa^{\dagger}\right)\left|I\right\rangle-\rho^{4}\left|I\right\rangle\\&=-\kappa\left(a^{\dagger}-\tilde{a}\right)\left(a-\tilde{a}^{\dagger}\right)\rho\left|I\right\rangle-\rho^{4}\left|I\right\rangle,\end{aligned}\tag{9}$$

where $\tilde{a}^{\dagger}$ and $\tilde{a}$ are defined as the creation or the annihilation operator acting to the thermostats such as $\left|\tilde{0}\right\rangle$ developed by Takahashi and Umezawa [19,20], and then $\left|I\right\rangle$ is given by

$$\left|I\right\rangle=\mathrm{e}^{a^{\dagger}\tilde{a}^{\dagger}}\left|0\tilde{0}\right\rangle,\tag{10}$$

consequently there are transformations $a\Leftrightarrow\tilde{a}^{\dagger}$, $a^{\dagger}\Leftrightarrow\tilde{a}$, and $a^{\dagger}a\Leftrightarrow\tilde{a}^{\dagger}\tilde{a}$ under state $\left|I\right\rangle$, which allows ρ to commute with right thermostats to arrive at the above Equation (9).

For solving this nonlinear Equation (9), let

$$f=\rho^{1-4},\tag{11}$$

then inserting $\left(-3\rho^{-4}\right)$ into the left of $\left|I\right\rangle$ for the both sides of the equation, one gets

$$\begin{aligned}\frac{\mathrm{d}\rho}{\mathrm{d}t}\left(-3\rho^{-4}\right)\left|I\right\rangle&=-\kappa\left(a^{\dagger}-\tilde{a}\right)\left(a-\tilde{a}^{\dagger}\right)\rho\left(-3\rho^{-4}\right)\left|I\right\rangle\\&\quad-\rho^{4}\left(-3\rho^{-4}\right)\left|I\right\rangle\end{aligned}\tag{12}$$

This enables one to arrive

$$\frac{\mathrm{d}\rho^{-3}}{\mathrm{d}t}\left|I\right\rangle=3\kappa\left(a^{\dagger}-\tilde{a}\right)\left(a-\tilde{a}^{\dagger}\right)\rho^{-3}\left|I\right\rangle+3\left|I\right\rangle,\tag{13}$$

so that

$$\frac{\mathrm{d}f\left|I\right\rangle}{\mathrm{d}t}=3\kappa\left(a^{\dagger}-\tilde{a}\right)\left(a-\tilde{a}^{\dagger}\right)f\left|I\right\rangle+3\left|I\right\rangle.\tag{14}$$

Thus the solution of this equation is considered as a form

$$f=\mathrm{e}^{3\kappa\left(a^{\dagger}-\tilde{a}\right)\left(a-\tilde{a}^{\dagger}\right)t}\left[\int3\mathrm{e}^{-3\kappa\left(a^{\dagger}-\tilde{a}\right)\left(a-\tilde{a}^{\dagger}\right)t}\mathrm{d}t+1\right]f_{0},\tag{15}$$

where f_0 corresponds to time $t=0$.

By left acting the coherent and entangled state $\left\langle\eta\right|$ to Equation (15) gives

$$\begin{aligned}&\left\langle\eta\right|f\left|I\right\rangle\\&=\left\langle\eta\right|\mathrm{e}^{3\kappa\left(a^{\dagger}-\tilde{a}\right)\left(a-\tilde{a}^{\dagger}\right)t}\left[\int3\mathrm{e}^{-3\kappa\left(a^{\dagger}-\tilde{a}\right)\left(a-\tilde{a}^{\dagger}\right)\tau}\mathrm{d}\tau+1\right]f_{0}\left|I\right\rangle\\&=\left\langle\eta\right|\left[\int3\mathrm{e}^{3\kappa\left(a^{\dagger}-\tilde{a}\right)\left(a-\tilde{a}^{\dagger}\right)(t-\tau)}\mathrm{d}\tau+\mathrm{e}^{3\kappa\left(a^{\dagger}-\tilde{a}\right)\left(a-\tilde{a}^{\dagger}\right)t}\right]f_{0}\left|I\right\rangle\\&=\left[\int3\mathrm{e}^{3\kappa|\eta|^{2}(t-\tau)}\mathrm{d}\tau+\mathrm{e}^{3\kappa|\eta|^{2}t}\right]\left\langle\eta\right|f_{0}\left|I\right\rangle,\end{aligned}\tag{16}$$

therefore one gets an integral form of the normal product as

$$\begin{aligned}\left|f\right\rangle=\left|\rho^{-3}\right\rangle&=\int\frac{\mathrm{d}^{2}\eta}{\pi}\left[\int3\mathrm{e}^{3\kappa|\eta|^{2}(t-\tau)}\mathrm{d}\tau+\mathrm{e}^{3\kappa|\eta|^{2}t}\right]\left|\eta\right\rangle\left\langle\eta\right|f_{0}\left|I\right\rangle\\&=\int\frac{\mathrm{d}^{2}\eta}{\pi}:\left[\int3\mathrm{e}^{3\kappa|\eta|^{2}(t-\tau)}\mathrm{d}\tau+\mathrm{e}^{3\kappa|\eta|^{2}t}\right]\\&\quad\cdot\mathrm{e}^{-|\eta|^{2}+\eta\left(\alpha^{\dagger}-\tilde{a}\right)+\eta^{*}\left(a-\tilde{a}^{\dagger}\right)+a^{\dagger}\tilde{a}^{\dagger}+\tilde{a}a-a^{\dagger}a-\tilde{a}^{\dagger}\tilde{a}}:f_{0}\left|I\right\rangle.\end{aligned}\tag{17}$$

Hence one gains

$$\begin{aligned}\left|f\right\rangle&=\int\frac{\mathrm{d}^{2}\eta}{\pi}:\left[\int3\mathrm{e}^{3\kappa|\eta|^{2}(t-\tau)}\mathrm{d}\tau+\mathrm{e}^{3\kappa|\eta|^{2}t}\right]\mathrm{e}^{\left(-|\eta|^{2}+\eta\left(\alpha^{\dagger}-\tilde{a}\right)+\eta^{*}\left(a-\tilde{a}^{\dagger}\right)+a^{\dagger}\tilde{a}^{\dagger}+\tilde{a}a-a^{\dagger}a-\tilde{a}^{\dagger}\tilde{a}\right)}:f_{0}\left|I\right\rangle\\&=:\left[-\int\left(\frac{1}{3\kappa\left(t-\tau\right)-1}\mathrm{e}^{-\frac{\left(\alpha^{\dagger}-\tilde{a}\right)\left(a-\tilde{a}^{\dagger}\right)}{3\kappa(t-\tau)-1}}\right)\mathrm{d}\tau-\frac{1}{3\kappa t-1}\mathrm{e}^{-\frac{\left(\alpha^{\dagger}-\tilde{a}\right)\left(a-\tilde{a}^{\dagger}\right)}{3\kappa t-1}}\right]\mathrm{e}^{a^{\dagger}\tilde{a}^{\dagger}+\tilde{a}a-a^{\dagger}a-\tilde{a}^{\dagger}\tilde{a}}:f_{0}\left|I\right\rangle\\&=:\left[-\int\left(\frac{1}{3\kappa\left(t-\tau\right)-1}\mathrm{e}^{-\frac{3\kappa(t-\tau)\left(a^{\dagger}\tilde{a}^{\dagger}+\tilde{a}a-a^{\dagger}a-\tilde{a}^{\dagger}\tilde{a}\right)}{3\kappa(t-\tau)-1}}\right)\mathrm{d}\tau-\frac{1}{3\kappa t-1}\mathrm{e}^{-\frac{3\kappa t\left(a^{\dagger}\tilde{a}^{\dagger}+\tilde{a}a-a^{\dagger}a-\tilde{a}^{\dagger}\tilde{a}\right)}{3\kappa t-1}}\right]:f_{0}\left|I\right\rangle\\&=:\frac{\left(\frac{1}{1-3\kappa\left(t-\tau\right)}-1\right)}{a^{\dagger}\tilde{a}^{\dagger}+\tilde{a}a-a^{\dagger}a-\tilde{a}^{\dagger}\tilde{a}}\mathrm{e}^{\left(\frac{1}{1-3\kappa(t-\tau)}+1\right)\left(a^{\dagger}\tilde{a}^{\dagger}+\tilde{a}a-a^{\dagger}a-\tilde{a}^{\dagger}\tilde{a}\right)}\Bigg|_{\tau=0}^{\tau=t}+\frac{1}{1-3\kappa t}\mathrm{e}^{-\frac{3\kappa t\left(a^{\dagger}\tilde{a}^{\dagger}+\tilde{a}a-a^{\dagger}a-\tilde{a}^{\dagger}\tilde{a}\right)}{3\kappa t-1}}:f_{0}\left|I\right\rangle\\&=:\frac{\left(\frac{1}{1-3\kappa t}-1\right)}{a^{\dagger}\tilde{a}^{\dagger}+\tilde{a}a-a^{\dagger}a-\tilde{a}^{\dagger}\tilde{a}}\mathrm{e}^{\left(\frac{1}{1-3\kappa t}+1\right)\left(a^{\dagger}\tilde{a}^{\dagger}+\tilde{a}a-a^{\dagger}a-\tilde{a}^{\dagger}\tilde{a}\right)}+\frac{1}{1-3\kappa t}\mathrm{e}^{-\frac{3\kappa t\left(a^{\dagger}\tilde{a}^{\dagger}+\tilde{a}a-a^{\dagger}a-\tilde{a}^{\dagger}\tilde{a}\right)}{3\kappa t-1}}:f_{0}\left|I\right\rangle.\end{aligned}\tag{18}$$

This allows one to arrive at

$$
\begin{aligned}
|f\rangle &= \left[\frac{\left(\frac{1}{1-3\kappa t}-1\right)}{a^\dagger\tilde{a}^\dagger+\tilde{a}a-a^\dagger a-\tilde{a}^\dagger\tilde{a}}\mathrm{e}^{\left(\frac{1}{1-3\kappa t}+1\right)a^\dagger\tilde{a}^\dagger}\left(\frac{\left(\frac{1}{1-3\kappa t}-1\right)}{a^\dagger\tilde{a}^\dagger+\tilde{a}a-a^\dagger a-\tilde{a}^\dagger\tilde{a}}\right)^{a^\dagger a+\tilde{a}^\dagger\tilde{a}}\mathrm{e}^{\left(\frac{1}{1-3\kappa t}+1\right)a\tilde{a}}\right. \\
&\quad \left.+\frac{1}{1-3\kappa t}\mathrm{e}^{\frac{3\kappa t}{1-3\kappa t}a^\dagger\tilde{a}^\dagger}\left(\frac{1}{1-3\kappa t}\right)^{a^\dagger a+\tilde{a}^\dagger\tilde{a}}\mathrm{e}^{\frac{3\kappa t}{1-3\kappa t}a\tilde{a}}\right]f_0|I\rangle \qquad (19) \\
&= \left[\frac{\left(\frac{1}{1-3\kappa t}-1\right)}{\left(a^\dagger-a\right)^2}\mathrm{e}^{\left(\frac{1}{1-3\kappa t}+1\right)a^{\dagger 2}}\left(\frac{\left(\frac{1}{1-3\kappa t}-1\right)}{\left(a^\dagger-a\right)^2}\right)^{2a^\dagger a}\mathrm{e}^{\left(\frac{1}{1-3\kappa t}+1\right)a^2}+\frac{1}{1-3\kappa t}\mathrm{e}^{\frac{3\kappa t}{1-3\kappa t}a^{\dagger 2}}\left(\frac{1}{1-3\kappa t}\right)^{2a^\dagger a}\mathrm{e}^{\frac{3\kappa t}{1-3\kappa t}a^2}\right]f_0|I\rangle.
\end{aligned}
$$

Thus, one obtains

$$
\rho=\left[\mathrm{e}^{\left(\frac{1}{1-3\kappa t}+1\right)a^{\dagger 2}}\left(\frac{\left(\frac{1}{1-3\kappa t}-1\right)}{\left(a^\dagger-a\right)^2}\right)^{2a^\dagger a+1}\mathrm{e}^{\left(\frac{1}{1-3\kappa t}+1\right)a^2}\rho_0+\mathrm{e}^{\frac{3\kappa t}{1-3\kappa t}a^{\dagger 2}}\left(\frac{1}{1-3\kappa t}\right)^{2a^\dagger a+1}\mathrm{e}^{\frac{3\kappa t}{1-3\kappa t}a^2}\rho_0\right]^{-\frac{1}{3}}. \qquad (20)
$$

The approximation of ρ when $t\to\infty$ is

$$
\lim_{t\to\infty}\rho=\left[\mathrm{e}^{a^{\dagger 2}}\left(\frac{(-1)}{\left(a^\dagger-a\right)^2}\right)^{2a^\dagger a+1}\mathrm{e}^{a^2}\rho_0\right]^{-\frac{1}{3}}=-\mathrm{e}^{a^{\dagger\frac{-2}{3}}}\left(a^\dagger-a\right)^{\frac{4a^\dagger a+2}{3}}\mathrm{e}^{a^{\frac{-2}{3}}}\rho_0^{-\frac{1}{3}}, \qquad (21)
$$

where if suppose ρ_0 is a pure state, such as a coherent state or a soliton state, then one gets an invariant density operator as

$$
\lim_{t\to\infty}\rho=-\mathrm{e}^{a^{\dagger\frac{-2}{3}}}\left(a^\dagger-a\right)^{\frac{4a^\dagger a+2}{3}}\mathrm{e}^{a^{\frac{-2}{3}}}\rho_0. \qquad (22)
$$

We can define this invariant structure as a sort of information soliton in the sense it is a invariant structure locally when time elapses long enough, and this structure exists in open system which may be not in equilibrium states.

Generally speaking, for any nonlinear master equation (NME) expressed by

$$
\frac{\mathrm{d}\rho}{\mathrm{d}t}=\mathcal{L}\left(a^\dagger,a\right)\rho-\rho^n, \qquad (23)
$$

where $\mathcal{L}\left(a^\dagger,a\right)$ is defined as certain functional of the operator $a^\dagger,a$ to act to ρ, if defining

$$
f=\rho^{1-n}, \qquad (24)
$$

one can get

$$
\frac{\partial f}{\partial t}=\mathcal{L}\left(a^\dagger,a\right)f-(1-n)f. \qquad (25)
$$

This allows one to obtain a formal solution as

$$
\begin{aligned}
f &= \mathrm{e}^{\mathcal{L}\left(a^\dagger,a\right)t}\left[\int(1-n)\mathrm{e}^{-\mathcal{L}\left(a^\dagger,a\right)\tau}\mathrm{d}\tau+1\right]f_0 \\
&= \left\{\frac{(1-n)}{\mathcal{L}\left(a^\dagger,a\right)}\mathrm{e}^{A\left(a^\dagger,a\right)(t-\tau)}\Big|_0^t+\mathrm{e}^{\mathcal{L}\left(a^\dagger,a\right)t}\right\}f_0 \qquad (26) \\
&= \left\{\frac{(1-n)}{\mathcal{L}\left(a^\dagger,a\right)}\left(1-\mathrm{e}^{\mathcal{L}\left(a^\dagger,a\right)t}\right)+\mathrm{e}^{\mathcal{L}\left(a^\dagger,a\right)t}\right\}f_0.
\end{aligned}
$$

If the evolution operator described by the master equation $\frac{\partial\rho}{\partial t}=\mathcal{L}\left(a^\dagger,a\right)\rho$ is declined when $t\to\infty$, *i.e.*

$$
\lim_{t\to\infty}\mathrm{e}^{\mathcal{L}\left(a^\dagger,a\right)t}=0, \qquad (27)
$$

then an invariant state exists

$$\lim_{t\to\infty} f = \frac{(1-n)}{\mathcal{L}\left(a^\dagger, a\right)} f_0, \tag{28}$$

which permits a solution of NME as

$$\lim_{t\to\infty} \rho = \left(\frac{1-n}{\mathcal{L}\left(a^\dagger, a\right)}\rho_0\right)^{-\frac{1}{1-n}}, \tag{29}$$

where it is the nonlinear power term that introduces an approximated solution, while the power *n* may introduce the squeezing intensity change. This proves that the existence of the information soliton for NME is generally true.

On this line, a master equation of the amplitude damping model, after considering a nonlinear term ρ^6, can be given by

$$\frac{\mathrm{d}\rho}{\mathrm{d}t} = \kappa\left(2a\rho a^\dagger - a^\dagger a\rho - \rho a^\dagger a\right) - \rho^6, \tag{30}$$

where κ is a damping number, a, $a\dagger$ is a creation or an annihilation operator, respectively. Then use the same approach as the above and let

$$f = \rho^{1-6}, \tag{31}$$

we get

$$\frac{\mathrm{d}f\left|I\right\rangle}{\mathrm{d}t} = -5\kappa\left(2a\tilde{a} - a^\dagger a - \tilde{a}^\dagger\tilde{a}\right) f\left|I\right\rangle + 5\left|I\right\rangle. \tag{32}$$

Thus the solution of this equation is considered as a form

$$f = \mathrm{e}^{-5\kappa\left(2a\tilde{a}-a^\dagger a-\tilde{a}^\dagger\tilde{a}\right)t}\left[\int 5\mathrm{e}^{5\kappa\left(2a\tilde{a}-a^\dagger a-\tilde{a}^\dagger\tilde{a}\right)t}\mathrm{d}t + 1\right] f_0, \tag{33}$$

where f_0 corresponds to time $t = 0$.

By left acting a coherent and entangled state $\langle\eta|$ to Equation (15), it becomes

$$\langle\eta|\, f\rangle = \left[\int 5\mathrm{e}^{+\left(a^*\eta - a\eta^*\right)\left(\mathrm{e}^{-5\kappa\tau} - \mathrm{e}^{-5\kappa t}\right)}\mathrm{d}\tau + \mathrm{e}^{-\frac{|\eta|^2}{2} - \left(a^*\eta - a\eta^*\right)\mathrm{e}^{-5\kappa t}}\right] \cdot\langle\eta|\, f_0\,|I\rangle, \tag{34}$$

therefore one gets an integral form of the normal product as

$$\begin{aligned} f &= \int\frac{\mathrm{d}^2\eta}{\pi} : \langle\eta|\, f\,|I\rangle \mathrm{e}^{-\frac{|\eta|^2}{2} + \eta a^\dagger - \eta^* a} \\ &:= 10\int \mathrm{d}t' \left|\sqrt{2}\left(\mathrm{e}^{-5\kappa t} - \mathrm{e}^{-5\kappa t'}\right)\alpha\right\rangle\left\langle\sqrt{2}\left(\mathrm{e}^{-5\kappa t} - \mathrm{e}^{-5\kappa t'}\right)\alpha\right| \\ &\quad + \left|\mathrm{e}^{-5\kappa t}\alpha\right\rangle\left\langle\mathrm{e}^{-5\kappa t}\alpha\right| \end{aligned} \tag{35}$$

Then an invariant solution of Equation (30) can be considered when time tends to long enough,

$$\begin{aligned} &\lim_{t\to\infty} 10\int \mathrm{d}t' \left|\sqrt{2}\left(\mathrm{e}^{-5\kappa t} - \mathrm{e}^{-5\kappa t'}\right)\alpha\right\rangle\left\langle\sqrt{2}\left(\mathrm{e}^{-5\kappa t} - \mathrm{e}^{-5\kappa t'}\right)\alpha\right| \\ &+ \left|\mathrm{e}^{-5\kappa t}\alpha\right\rangle\left\langle\mathrm{e}^{-5\kappa t}\alpha\right| \\ &\sim 0\left|\frac{\sqrt{2}}{5\kappa}\alpha\right\rangle\left\langle\frac{\sqrt{2}}{5\kappa}\alpha\right|, \end{aligned} \tag{36}$$

which gives

$$\lim_{t\to\infty} \rho \sim 10^{-\frac{1}{5}}\left(\left|\frac{\sqrt{2}}{5\kappa}\alpha\right\rangle\left\langle\frac{\sqrt{2}}{5\kappa}\alpha\right|\right)^{-\frac{1}{5}} \tag{37}$$

in which the compressure of the input ensemble encoded state can be adjusted by the power of ρ in the non-linear term through NME. One can finds that the power increases with the compressure increase, *i.e*. if the power 6 for ρ in the nonlinear term is changed to n, then one can obtain the compressed intensity of state is increased as

$$\lim_{t\to\infty} \rho \sim \left(2(n-1)\left|\frac{\sqrt{2}}{(n-1)\kappa}\alpha\right\rangle\left\langle\frac{\sqrt{2}}{(n-1)\kappa}\alpha\right|\right)^{-\frac{1}{n-1}}. \tag{38}$$

All of these are processed in the open system through an interaction between system and environment. Therefore the above information soliton in the open system can be used in quantum information for long time and far distance channel to carry information. The characteristics of transmission states in this constructed channel is stable without decay even considering interaction from the environment.

As previously mentioned, this possibly provides a channel to support the phenomena of long distance transmission of bio-information in the somatic sciences. In this sense, the above proposed squeezing coherent state described by NME may provide an efficient information channel for the long distance transmission of sensing thinking without decoherence or decaying. As comparing we give following several corresponding between assumption and facts from the relevant experiments in refs. [16]:

1) The experiments demonstrate that there are various color lights and electromagnetic waves existed in the processes. This is coincided to our model that the coherent states are a sort of electromagnetic waves.

2) The experiments show that this sort of bio-information can transmit over 100 km long distance without decay. This can be carried by the information solitons as a channel described by our model because of the invariant structure when time past long enough.

3) This sort of "information solitons" possesses macro-quantum tunneling ability to tunnel many obstacle, such as through the metal mesh shield, which discussed

in refs. [7] and [21] as a kind of the macro-quantum tunneling. This is coincided with the phenomena in the experiment that the emote sensing thinking wave crossing through the metal mesh shield allow the receiver to get the information.

For further proving our points, below we propose a mechanism of ideal experiment for a long distance to disturb the electric equipment (TV, or computer) by remote bio-sensing thinking transmission.

The key concept of mathematical physics here is that the bio-information density, which is composed of the squeezing coherent states coming from the subject, can nonlinearly interact with the information density which come from the object. This can be described by the following equation:

$$\frac{\mathrm{d}\rho_o}{\mathrm{d}t} = -\kappa\left(a^\dagger a\rho_o - a^\dagger\rho_o a - a\rho_o a^\dagger + \rho_o a a^\dagger\right) + \chi\rho_o\rho, \tag{39}$$

where ρ_o represents a density operator of an object system described by NME and ρ represents a bio-information density operator from the subject, and χ is a coupling number to introduce a nonlinear term, $\chi\rho_o\rho$. This nonlinear interaction can be adjusted by the subject field ρ, so that ρ is proportional to ρ_o through a sort of resonance between the coherence states ρ and ρ_o:

$$\rho = \chi\rho_o,$$

then the approximation of solution ρ_o for the object is transferred to have an invariant structure as an information soliton from original decaying structure, which is described by

$$\rho_o \to \lim_{t\to\infty}\rho_o = \left[\mathrm{e}^{a^{\dagger 2}}\left(\frac{-1}{\left(a^\dagger - a\right)^2}\right)^{2a^\dagger a+1}\mathrm{e}^{a^2}\rho_0\right]^{-1} = -\mathrm{e}^{a^{\dagger -2}}\left(a^\dagger - a\right)^{4a^\dagger a+2}\mathrm{e}^{a^{-2}}\rho_0. \tag{40}$$

This changes the original states ρ_o in the object system so that the wave function of the object is disturbed by the bio-information soliton from the subject. Thus the object (electricity equipment) function states can be agitated by the bio-information from the remote subject.

The above ideal assumption is supported by the evidences, although the further experiments are necessary:

1) The human body could broadcast complicated electromagnetic wave, coherent states should be not problem for certain people who have special function abilities, for example, since 1992, Sheng Jingchuang and Sun Chuling have successfully developed an ordinary photographic film method in functional state of consciousness field information clearly recorded on film, large reflect the characteristics of information consciousness field RS images were obtained, with high resolution and rich information content. Moreover, this sort of radiation from Sun Chuling acupuncture points, can penetrate through black paper and tin box to make a photographic sensitization even far from distance, which means the broadcast electromagnetic wave by Sun Chuling are quit complicated. Furthermore, Sun Chuling seems to show ability to disturb the computer screen from long distance [22]. Not only Sun Chuling but also Zhang Baosheng had measured the complicated spectrum of electromagnetic wave by Song Kongzhi when he performed some experiments [23].

2) In fact, there had been many electrical interference phenomena often occur around Zhang Baosheng. At that time, when Song Kongzhi went to Zhang Baosheng in the bedroom, he often shew him to interfere with television function. He blew his television in the doorway to enable the color to become black and white, and he could also make the image disappeared all of a sudden. However, because this is in his room, Song Kongzhi was unable to determine its true nature. Until one day he came to Song Kongzhi home, when he entered a door to see a TV is open he blew, the color became to black and white, then he blew again, the images in the TV disapeared, finally he gave another blow again, the color and pictures in TV returned. The TV set at least 4 - 5 metres away from him. Moreover, the TV was placed near the window in the house corner, while he was standing in the doorway. Another time, Song Kongzhi had a minicomputer connnected with a printer produced by America Texas. Song edited a program to print sine wave, Zhang Baosheng was once to change a sine wave to flat wave. In addition, as often saw a situation, when people made call, he was blowing from far away, then the call was disconnected [23].

4. Conclusion

A type of nonlinear kinetic equation is introduced. The nonlinear term ρ^n enables the squeezing coherent state to tend to be invariant without decaying when time elapses enough long. While the power n can be used to control compressed intensity of coherent state. These two characteristics provide a constructive channel for the quantum information transmission in the practical system against decoherence or damping, which possibly provides a wave carrier to allow long distance transmission of bio-information from the human body shown in the relevant experiments of the somatic science.

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