Possible temporal-eigenwert resonances on a timelike worldline by multi-oscillations of itself quantized Super-Schroedinger-equation for multiple oscillation spectra

Abstract:

Discussed is the possibility to overlap several temporal structures of events with time-difference on a timelike wordline or bundles/bunches of familar worldlines through a form of resonance process, which identifies the events on an eigenwert-scale with one another. This overlapping-effect of different timelike incidents on the same worldline or worldbundle will cause a form of "time travel" with several consequences. These consequences are discussed. May be, that by this process a form of information transport can occur over timelike distance-intervalls on the same global timelike wordline through a sort of identification folding resp. approximation of eigenvalue alignments of incidents without energy transport. Mathematically used for this description is a Super-Schroedinger-equation, which solutions are Schroedinger-equations for single and multiple resonance-states.

Key-words: time-resonance; temporal overlapping; temporal identification; temporal eigenwert-alignment; worldline; event-straightening; associating events; time-travel; coupled causal conditions; eigenfunction; super-Schroedinger-equation; SSE.

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1. Introduction:

1.1. Starting point: timelike events on a worldline.

In SRT/GRT there is a wordline the series of timelike events of a system e.g. a quasi-inertalsystem of SRT [1.]. Usually there is defined: Every incident is located in a clear and unambiguous way over its eigen-timeparameter τ. No two different events on the same timelike worldline can overlap. The supposing in this consideration breaks this law not by a classical contradiction (e.g. not by closed circled worldlines: CTCs) but by a resonance-effect of eigentime-structure.

1.2. Interpretation of „Eigenvalue-resonance" of eigentime:

The imagination is the changing in paradigm of eigentime from a continous parameter to a (possible discret) spectral structure over eigenvalues:

$$\tau \to \tau_N \qquad (1.)$$

The assumption for conditions is:
1. Every τ_N is a temporal eigenstate,
2. Incidents or events are not pointlike but have a timelike structure of modes,
3. A resonance then means that two or more than two incidents project themselves onto the same eigentime-modus.
4. They stay causally distinguishable but are coherent in their temporal characteristics, a kind of shaking effect that aligns them .

1.3. How could this congruent overlapping now look like? There is a model:

1. Wavepicture of time. Every event owns a timelike amplitude along the wordline. Only at special eigentimes τ_N there is a form of constructive interference,
2. Overlapping means: several timelike incidents have the same phase position in their eigentime,
3. This is not coincidence but an identy in their modi,
4. The events are not the same event,
5. They are resonant in a timelike form – similiar to two places in space, which can share the same modi of a standing wave.

1.4. Quantizing:

A finite but increasing number of resonances with a possible principle like:

$$N_\tau \sim \lfloor \frac{\tau}{\tau_0} \rfloor, \qquad (2.)$$

where τ_0 fundamental eigentime-scale and only discrete functions of resonance are allowed:

$N=1;2;3;\ldots$

1. At every time there is only a finite number of overlappings,
2. With increasing eigentime the number of accesible resonance modi increases,
3. No infinite self-overlapping causes stability.

1.5. Hypothetical physical consequences:
There may be a sort of memory along the worldline: earlier incidence-modi might still be faintly present in higher resonance orders: no backcoupling in a classical way but a sort of structural correlation. A system could be have a form of self-similiarity by acting at later eigentimes resonant to earlier states without a classsical time-travel and no breaking of causality. The entropy stays monoton. Resonance is no turning back of time. Resonance triggers and increases the intern structure not the order. In the case of a quantized proper time, there is liked to introduce a discrete proper time (τ_N) instead of a continuous time variable (t) where $\tau_N = N \cdot \tau_0 ; n \in \mathbb{N}$ and τ_0 is a fundamental time scale.

2. Methods/ Calculation:

2.1. The eigentime could act as an operator: $\hat{\tau}$, the incidents as states: $\langle 0|E\rangle$ with the condition of resonance:

$$\langle |E_i|\hat{\tau}|E_j\rangle = \tau_N \qquad (3.)$$

Only discret τ_N are allowed, this leads to a description of quantizing [2.]. There is a sort of an intuitive metapher: a world line is not a line, but a string in time. Events are impacts.
Resonance only occurs at certain natural frequencies. With increasing string length, more overtones become possible. This description is not a part of classical RT or QT but is consistent as a non-classical structure of time similar to the theories of quantizing eigentime, two-time-formalism or history-interference resp. consistent history theory.

2.2. Mathematical formulation of temporal resonance:
Since the eigentime τ is interpreted as an operator , not only as a parameter like in classical RT, it acts only on finite quantized modi not in a continuum. Instead of interpreting this eigentime-term as continuos parameter but as an operator:

$$[\hat{\tau}] \tag{4a.}$$

with its eigenwertproblem of:

$$\langle 0|\hat{\tau}|N\rangle = \langle |0|t_N|N\rangle, \tag{4b.}$$

where $\langle 0|N\rangle$--- timelike eigenmodi,
(τ_N)--- discrete eigentimes
Quantizing of a form:

$$\tau_{N\in\mathbb{N}};\tau_N = N\cdot\tau_0 \tag{4c.}$$

The worldline then is not a single course, but a state within the space of these modi.

2.3. Events as states with temporal/timelike amplitude:

A timelike incidence (I) is not pointlike but

$$\langle 0|I\rangle = \left\langle |0|\sum_N (c_N)\middle|N\right\rangle \ , \tag{5.}$$

where

c_N--- amplitude, that the incidence I is realized in the timemodus N. Classical time arises as an expected value

$$\langle\hat{\tau}\rangle_I = \sum_N c_N^2\cdot\tau_N. \tag{6.}$$

2.4. Condition of resonance between two events:

The eigenwert-modi are described over $N=(2n+1);n\in\mathbb{N}$ because they come from a gravitonlike oscillator with spin $s=2$ (four-spacetime). Nevertheless here only a coupling of two modi is explained, to make thoughts clearer although the first excited eigenmode is an overlap of three events for $n=1$.
Definition: Two events (I_i, I_j) are temporal resonant, if:

$$\exists N, c_N^{(i)} \neq 0 \wedge c_N^{(j)} \neq 0 \qquad (7a.)$$

or stronger:

$$\langle I_i | \pi_N | I_j \rangle \neq 0 \qquad (7b.)$$

with

$$\pi_N = |N>0<N| \qquad (7c.)$$

--- projector on a temporal modus,
Then a congruent overlapping comes by:
Different events share the same temporal eigenstate,
not the same spacetime point.

<u>2.5. Finite but increasing number of overlappings through spectral-modi:</u>
The accessible modes are limited by the proper time accumulated so far:

$$N_{max} \tau = \lfloor \frac{\tau}{\tau_0} \rfloor \Leftrightarrow max \{ N \in \mathbb{N} | N \cdot \tau_o \leqslant \tau \} \qquad (8.)$$

Then there is:
1. At every timepoint there are only a finite number of resonances,
2. With increasing length of the worldline new resonance arrangements are being unlocked,
3. No divergence, no timelike explosion.

How would one recognize such a resonance-response? Important is the reason that there is no real time-travel with CTCs or energy transport or doubling of an event but the physical sign is a timelike correlation without an interaction.
One would expect:
1. Correlations between $((2n+1); n \in \mathbb{N})$ states of a system,
2. without causal coupling in a classical sense,
3. But only at determined distances of eigentime,
4. A sort of timelike inerference patterns.

<u>2.6. Windows of resonance instead of continuous dynamics</u>.
Observable/measurable would be:
Transitions or reactions occur preferentially at discrete times. Between: suppressed probability. Formal:

$$P(transition|\tau) \propto \sum_N \delta(\tau - \tau_N) \qquad (9.)$$

Physically broadened, of course, not true delta functions.

<u>2.7. Memoryeffects without storage:</u>

A system could react phase-sensitive at earlier states without a storage of information. In experiment this scenario would look like unexplained reappearance patterns but only at certain determined time-intervalls. No violation of causality, because: no energywearing information is transmitted backwards. Only a using of intern phase-structure happens.

2.8. Effects of entropy stay correct:

An important test: The system's entropy continues to grow monotonically. Resonances increase structure, not order. This clearly distinguishes the model from: time-cycles, block-universal repetitions (in original: Parmenides) and retrocausality.

2.9. A short summary:
A worldline is not a thread, but a temporal resonator.
Events are mode superpositions. Only discrete proper times are stable. With increasing lifetime, more resonances become possible.

Now the classical idea of pathintegral is coupled to the concept of quantized eigentime.

2.10. Pathintegral in classical quantum mechanics:

In quantum mechanics, the pathintegral of Feynman describes a method, in which all possible paths or worldlines of a particle are taken into account, to calculate the probability of a certain result of an event or incidence. Ergo the classical ansatz is:

Examinated is a particle in classical QM, which is moving through space and time. For every possible path $x(t)$ of the particle, moving from one point to another, there is a transition of two states $\langle 0|x_a, t_a\rangle \rightarrow \langle 0|x_b, t_b\rangle$ and contribution to complete amplitude:

$$K(x_b, t_b; x_a, t_a) = \int (x(t_a) = x_a \wedge x(t_b) = x_b) D \cdot x(t) \cdot \exp^{\frac{i}{\hbar} S[x(t)]}$$
(10.)

--- $D(x,t)$ is the pathintegral over all possible trajectories x(t)

--- $S[x(t)]$ is the action-integral for a path $x(t)$, following the classical laws of energy and movement moment. The amplitude for the transition of a particle from an initial state (x_a, t_a) to a final state (x_b, t_b) is the sum resp. the integral of all possible paths, weighted with the wave-function of the system.

2.11. The concept of quantized eigentime in pathintegrals and its modified structure:

If the eigentime should be quantized, then the continous worldline of the particle is substituted by discret time-modi. Thereby the eigentime-parameter τ isn't anymore interpreted as a continous term but as an operator with discret eigenvalues τ_N . This means, that the worldline of the particle not only is a continous trajectory in spacetime but an overlapping of resonant states. This situation leads to a form of time-quantization and therefore to a new structure in description via path-integral. We can represent the path integral as the sum of the discrete modes, where the proper time can only take on certain discrete values τ_N . The idea is that the particle no longer has a continuous time evolution, but oscillates in discrete proper time modes. The path integral becomes a sum over the possible time modes:

Suppose that the eigentime τ of the particle is quantized $\tau \rightarrow \tau_N$ and contains from discret eigenvalues, where $\tau_N = N \cdot \tau_0 ; N \in \mathbb{N}$. Then the pathintegral over all possible worldlines x(t) and the quantized eigentime t_N looks like:

$$K(x_b, \tau_b; x_a \tau_a) = \sum_N \int Dx(t) D\tau_N e^{\frac{i}{\hbar} \sum_N S[x(t), \tau_N]} \qquad (11.)$$

Thereby:

--- $D\tau_N$ is the summation of pathintegral over all eigentime-modi,

--- $D(x(t))$ Integration over all possible worldlines /trajectories,

--- $[S(x(t)), \tau_N]$ is integral of action, which considers the movement of the particle as well as the resonances of or between the discrete eigentime-modi. The worldline isn’t a continous function anymore but an overlapping of discrete resonance-modi.

2.12. Conditions of resonance and interference in pathintegral-formalism:

The ideas of resonance inside a pathintegral could lead to an interference of time-modi, whereby only these modes, which interfere in a constructive way play an important role within the complete path.This situation would lead to a temporal pattern of interference, where only determined, particular differences of time, namely the τ_N have a measurable effect.

Proper Time and Interference of Modes

Discrete Proper Times as states:The proper time τ_N can be viewed as an operator $(\Delta \tau)$ acting on the state $\langle 0|N \rangle$:

$$[\langle \Delta \tau | N \rangle = \langle \tau_N | N \rangle]$$

The state of a particle is now described as a superposition of eigenmodi that reflect the quantized proper time:

$$E \in \mathbb{R} ; \langle 0|E \rangle \in H ; \langle 0|E \rangle = \sum_N c_N \langle 0|N \rangle ; N \in \mathbb{N}$$

where (c_N) Amplitude for the state $\langle 0|N \rangle$ associated with the proper time τ_N .

The probability that the particle is observed in a state $\langle 0|E \rangle$ with proper time τ_N is given by

$$P(E, \tau_N) = |c_N|^2$$

This means that the proper times of the two events must coincide in order to create a resonance. This resonance leads to a constructive interference between the two events.

2.13. Modification of the action -integral:

The action-integral wich is used for the path integral has to be adjusted to take into account the discrete proper time modes. For a system with quantized eigentime-modi there is:

$$[S(x(t)),\tau_N]=\int d\,\tau\left(\frac{1}{2}m\cdot x^2-V(x)\right):\tau=N\cdot\tau_0\,;N\in\mathbb{N}$$

Since the eigentime/propertime is discret, the integral over τ has to be substituted by a sum:

$$S(x(t),\tau_N)=\sum_N\left(\frac{1}{2}m\cdot x_N^2-V(x_N)\right)\tau_0$$

This means, that the action-integral now is formulated as a sum over discret eigentimes τ_N .

2.14. Influence of the eigentime at the path integral:

The changing of the action-integral through the quantized eigentime leads to a weighted influenve of eigentime at the path integral. The eigentime-mode generate a weighted sum of possible worldlines, where the influence of the certain modi deepends from the c_N - amplitudes. This means, the pathintegral for the transition between two states $(x_a,\tau_a),(x_b,\tau_b)$ is modified by the sum of all contributions of all resonance modi. Addition of the different modi then is the result of the interference of the several eigentime-modi, which influence the wordline of the “particle“ (means, the event). Only those modi, which are resonant, which correspond with the discret structure of eigentime-modi, contribute significantly to the overall amplitude.

Interfering time-modi:

If in example two events (three real at least in the first stimulated eigenmodus) E_i and E_j overlap along their worldline, then the probability, that both incidents occur at the same time, is given by the interference of their resonance-modi:

$$P(E_i,E_j)\sim\sum_{m.n}\langle E_i|\tau_m\rangle\langle E_j|\tau_n\rangle e^{\frac{i}{\hbar}(S_m+S_n)} \quad , \tag{12.}$$

whereby: $\langle E_i|\tau_m\rangle$, $\langle E_j|\tau_n\rangle$ are the amplitudes, that the incident E_i is realized in modus of eigentime τ_m and the incident E_j is realized in the modus of eigentime τ_n ,

--- S_m,S_n are the actions, which result from the time-dependence of the worldline under consideration of the quantizing of the eigentime-term τ_N .

2.15. Coherence and interference-effects:

Coherence between incidences:

If two (three!) events $\left(E_i, E_j\right)$ appear along the worldline of a “particle“, then their resonance leads to a form of constructive inerference. This situation means that the probability for the situation that both events occurred simultaneously, depends from the relationship of phases between the eigentime-modi. This relationship of phases can lead to coherent correlations between the events, which could be measurable experimentally.

Interfering timemodi:

The interference between two time-modi occurs, when two modes $\tau_N ; \tau_M$ carries the same phase factor. The result is:

$$\langle E_i | \hat{\tau} | E_j \rangle \sim \sum_{M,N} c_N^i c_M^j e^{\frac{i}{\hbar}(S_N + S_M)}$$

From this interference there follows, that only certain time-modi intefere in a constructive way and contribute to the overall amplitude. There are non-classical correlationsents between events generated, which only are visible at certain specific distances of eigentimes.

In an experiment based on this structure, one would expect discrete time-interval probabilities, i.e.:

Recurrence of events only at specific time intervals. Interference effects between events, which are amplified or suppressed at certain times. The times at which this interference occurs would be determined by the discrete proper-time modes $\left(\tau_N\right)$. The experimental signature could also consist of regular, quantized patterns corresponding to the proper-time modes.

Short summary of the matematical details:
The path- integral is changed by quantizimg of eigentime/propertime, whereby the time is parted into different time-modi τ_N .

2.16. Coherence and correlations:

Caused by the quantized eigentime-term and the pattern of interference in pathintegrals, there arise coherent correlations between different worldlines, which normally are not causal connected. The events are temporal coherent without being connected in a classical sense.

2.17. Observations as examples:

If an experiment is executed, where the wordline of a particle passes through several different resonance-modi, there can be detected, that certain differences of time, namely the eigentime-modes τ_N have a special probability. These modes are resonant and they lead to a reappearing of events without an explanation through classical causality or transfer of energy coupled information.

This means:

1. Resonance-modi: certain eigentimes are determined in a preference,

2. Correlations: between the incidents there are patterns of interference, which show coherent but not causal coupled connections between different events.

2.18. Experimental signature of a quantized eigentime in path-integral-mechanism:

An experimentally demonstrable, detectable proof of such a structure could be occur in form of non-classical interferences or correlated events, which only are measurable or detectable at certain time-intervals.

A hypothetical measurement:

in a system, that works with such quantized eigentimes, there could be detected, that the probabilities for transitions or determined states at exactly discret time-intervals are significant higher, increased. Such a system would indicate effects of reappearings, repetitions or returns, where events appear in regular intervals without a possible description or explanation of the cycle by classical causality.

Experimental Signature:

In an experiment based on this structure, one would expect discrete time-interval probabilities, i.e.:
Recurrence of events only at specific time intervals.
Interference effects between events, which are amplified or suppressed at certain times.
The times at which this interference occurs would be determined by the discrete proper-time modes τ_N . The experimental signature could therefore consist of regular, quantized patterns that correspond to the proper-time modes.

2.19. Summary:

1. The quantized eigentime τ_N is integrated in mechanism of pathintegral.

2. Events no longer are described by classical worldlines but over a superposition of discret eigentime-modi,

3. Resonant overlapping of the incidents would cause patterns of interference and leads to a coherent but non-causal behaviour of the worldline,

4. In experiments this structure would determine its existence through appearing of discret time-intervals in probability of energy-transitions or events (may be in bounded spectral states).

5. Modified Structure of the Path Integral:
Now the path integral is formulated under the assumption of a quantized proper time. If the proper time (τ) is quantized, the path integral changes in a way that there must additionally introduced the sum over the proper time modes.

The path integral can represent the sum of the discrete modes, where the proper time can only take on certain discrete values τ_N . The idea is that the particle no longer has a continuous time evolution, but oscillates in discrete proper time modes.
The path integral becomes a sum over the possible time modes:

Summary of the mathematical details:The path integral is modified by quantizing proper time, dividing time into discrete modes τ_N . Resonance between events occurs when their proper time modes coincide. The action integral is summed for discrete proper times, generating interference effects. This structure leads to coherent correlations between events, which could be experimentally verified by discrete time interval probabilities.

3. Special coupling of resonance:

With taking into account the physical properties of the underlying spacetime, whose field-theoretical particle parameters must at least satisfy the conditions of weak or linearized GRT, e.g. spin s=2.Then this condition leads to a special form of resonance-coupling, where the eigentime-modi occur in a form of a symmetric spectrum. This structure must be like the conditions of an (an-) harmonic oscillator for gravitons, namely $N(\psi_n)=(2n+1)$ because description of wordlines underlies their physical interaction. These numbers of the spectrum indicate and describe the number of possible overlaps. Then the first state for $n=0$ is groundstate with the central, single original incident ψ_0 and $N(\psi_0)=1$. There is no overlap because the system is a "classical" one with a "normal", not excited state. As mentioned above, the first excited state with $n=1$ consists of three events: $N(\pi_1)=3$. This is the first situation of an overlapping of incidences. The description above is made for only two states to clearly present and clarify the processes that could occur in a fundamental way.

3.1. Polynomial structure of resonance-description:

Like in classical quantum mechanics [3.],[4.] the overlapping resonance structure can be described by a special form of polynomial system. Half of the overlapping is a projection into past, the other half into future. This configuration can be interpreted as a model of retarded and advanced waves like in the absorber theory wave model of R. Fevnman [5.], where future-directed advanced waves are "absorbed" by destructive interferences. May be, that the future overlaps disappear because they overlap destructively but the past overlaps are constructively and in this case they are accessible to measurement and thus to empirical verification.

Possible form of the eigenfunction polynomial for eigenwert-overlapping of ψ_n could be:

$$P(n)=t_0\cdot x\cdot\prod_{n=1}^{N}\left(x^2-n^{(2n-2)}\right) \tag{13.}$$

and $P(0)=x$.

--- t_0 is a weighting constant of time and all zeros of the polynomial provide possibilities for resonance overlap. The term of t_0 must be determined experimentally, but could perhaps also be set at will, because it is not yet known or really clear whether it depends on an external calibration or not.

3.2. Quantitative example given for $n=3;t_0=62{,}5\,y$ (arbitrarily invented numbers):

This conditions lead to the polynomial-eigenfunction of

$P(3)=62{,}5\,y\cdot x\cdot(x^2-1^0)\cdot(x^2-2^2)(x^2-3^4)$. The solutions of this polynomial are the proper eigenwert-resonances of eigentime along the worldline:

$t_0=0; t_1=\pm 62{,}5\, y; t_2=\pm 125\, y; t_3=562{,}5\, y$.

3.3. The spectrum of eigentime-modi:

If it is assumed, that the spectrum of eigentime-modi only accepts the discret values of $N=(2n+1)$ for τ_n , then this situation means, that eigentime is quantized in a symmetrical way. There are positive and negative eigentime-modi and a central null-modus of τ_0 , which represents the ground-state of all spectral-states which could be called the “temporal vacuum-state”.

Suppose now, these eigentime-modi τ_n are organized in a symmetric form like:

$$\tau_N=N\cdot\tau_0; N\in\mathbb{N}; S=-(N);-(N-1);\ldots;(N-1);(N) \quad (14.)$$

This could be an analogy to angular momentum quantum numbers of atoms in magnetic splitting states. There the number of eigentime-modi S is finite but is increasing with N increasing, where the complete number of the modi is $N=(2n+1)$ including the zerovalue of “temporal vacuum“-state of the central incident.

3.4. Interpretation of symmetry in the spectrum:

The central zeromode τ_0 could be interpreted as a form of „resting time“ or resting-state where no overlap takes place, because no outer resonances or interactions occur.

Positive and negative modes: These represent oscillating states that are symmetrically distributed around the resting state. For example, (τ_1) could represent in addition to its temporal resonance also a specific frequency, while (τ_{-1}) reflects the same frequency in the opposite direction. The proper-time modes are thus constructively and destructively coupled, leading to an interaction between different frequencies. In this way it could be possible, that future-like incidence overlaps are deleted. Thus the eigentime-modi are coupled in a form of constructive and destructive possibilities. This could lead to an interaction between different frequencies, where the first are called “events” and the last are called “exents”. This definition means: an “exent” is a destructive overlapping of two time-modi with disappearing inner probability.

3.5. Coupling of resonance and interference:

1. The condition of resonance:

The resonance-condition explains, that events along the same wordline of a system are only then temporal coherent, if their eigentime-modi have a certain connection to one another. This means, that the two states $(E_i),(E_j)$, which are described by the discret eigentime-modi, only then are coupled with one another, iff their eigentime-modi match. For the number of $N=(2n+1); n\in\mathbb{N}$ of discret eigentime-modi the coupling of two incidents with the eigenmodi $(\tau_m),(\tau_n)$ can be considered. A coupling of resonances appears, iff $\tau_m=\pm\tau_m$ or iff both modi have the same value.

2. Constructive coupling: If two events share the same eigentime-modus or their eigentime-modi are symmetric like $\tau_1\wedge\tau_{-1}$ they reinforce each other and contribute in this way to complete amplitude.

3. Destructive coupling: If the modi oscillate in opposite directions and through this the phases cancel each other out, this situation leads to a suppression of probability ➔ exents.

The coupling between the modi is not only dependent on a simple interference of phases but follows a symmetric structure. There are positive as well as negative resonances which lead to a broader and more complex interaction.

3.6. Mathematical description of coupling:

The condition of interference can be written as:

$$\langle E_i|\hat{\tau}_N|E_j\rangle = \sum_{n=-N}^{N} c_N^i c_N^j \cdot \tau_N$$

where E_i and E_j are the two coupled incidents and c_m, c_n are their amplitudes for the eigentime-modi. If the modi corresponds, there is a constructive, resonant coupling of the incidences. The complete amplitude for a system with resonant coupling then can be written as:

$$A \sim \sum_{-N}^{N} c_N^i c_M^j e^{i \cdot S_N \cdot \tau_N}$$

whereby S_N is the action-integral for the relevant corresponding eigentime-modus.

A possible physical scenario:

Multiple coupling in a discret spectrum of resonance:

If there are several different events or processes along the worldline, these modi can be coupled by multiple modi of resonance. This situation means, that incidents not only are coupled by their direct eigentime-modi but also are influenced at the same time by multiple modi.

Example given:

An event could interact with the lowest resonance-modus of τ_0 , which leads to a central effect. Another incident could interact at the same time with other higher modi of say τ_1 or negative modi of form τ_{-1} which generates multiplicated and symmetric interferences.

Dynamics and spectral structure:

With existence of a symmetric spectrum there are several dynamics possible:

1. The time-development, the evolution of a system can look like a pattern of interference of several resonance-states, where the modi with increasing number and higher symmetries get stronger or weaker.

2. The system then shows a sort of quantized time-dynamics, where every incidence or event is characterized by a discrete frequency of resonance, but the possibility occurs, that several modi get over a cooperation together in resonance, which may lead to a more complex but very structured interaction.

3.7. Mathematical consequences of the modus of structure in a $N=(2n+1)$ time-dynamics:

The discret spectrum and the limitation of states:

The number of assecible eigentime-modi is limited, because there are only $N=(2n+1)$ mpdi. This situation leads to a finite but increasing system of spectral values, which get more complex, when the number of state N increases. The lowest eigenstate, groundstate τ_0, has the values of quanrum numbers of $(n=0;N=1)$. For the lowest excited eigenvalue-niveau $(n=1;N=3)$ which is the second level, the spectrum looks like: $[\tau_{-1}|\leftarrow|\tau_0|\rightarrow|\tau_1]$. At the third level further resonance-modi are added: $[\tau_{-2}|\leftarrow|\tau_{-1}|\leftarrow|\tau_0|\rightarrow|\tau_1|\rightarrow|\tau_2]$. In this case the spectrum of eigenmodi is increasing and every state is coupled by symmetry of his history-interference modi.

3.8 Energy- and timescale:

The $(N=(2n+1))$ structure influences the energy- and time-scales of the system, because energy in the modi of the system is quantized. A changing of numbers of modi N leads to a changing of the frequencies of temporal developements of the system. The states, which the system accepts therefore are limited but increases with increasing N, which leads also to an increasing of the possible resonances and interferences.

3.9. Summary and physical implications:

1. A symmetric spectrum with $(N=(2n+1))$ eigentime-modi generates a form of complex eigenvalues, which are coupled in couplings of resonance between the events along a bundle of worldlines or along a single one,

2. The constructive and destructive interferences between the modi lead to a nonlinear but limited system, which numbers of resonant states increases with increasing quantum number of N.

3. The multiple coupling between the modi could lead to multidimensonal pattern of interference, which could be detected experimentally.

4. In closer physical examination this situation means, that time could be considered as a quantized system, where several events along the same worldline are coupled one with another over resonances in a symmetrical way.

4. The Super-Schroedinger-equation (SSE):

Every eigentime-modus can be described over the SSE, which itself is quantized and which solutions are Schroedinger-equations for a spectrum of oscillators. The SSE functions here as a generating system for a spectrum of Schroedinger-equations. The groundstate describes the moving of a free particle and the first exciting state is the equation for classical harmonic oscillator. Then the following states lead to nonlinear oscillator-descriptions, their eigenfunctions and inner eigenvalues. The SSE can be written as:

$$E_N\,\psi_N(x)=\frac{-\hbar^2}{2m}\frac{d^2}{dx^2}\,\psi_N(x)+\prod_{k=1}^{N}(x^2-k^{2k})\,\psi_N(x)\,e^{\frac{-x^2}{2}} \qquad (15.)$$

For every $k \in \mathbb{N}$ there results a special Schroedinger-equation with its inner solutions. The outer solutions form the spectrum of temporal eigenfunctions with its eigenvalues, which describe the resonance-effects of eigentime-modi.

4.1 The recursive form of eigenvalues:

To find a recursive formula for the eigenvalues of this equation, there must be examined the influence of the additional potential terms $(x^2 - k^{2k})$ to the eigenvalues of E_N. For $N=0$ there is only a state of a free, not bounded "particle". Then the system is interpreted as a groundstate, wich is identified with a single, eigentime-state, which is not in a timelike resonance with other incidents. Then there the potential is:

$$V(x)=0 \qquad (16a.)$$

and the eigenfunction and its eigenwert is:

$$\psi_0(x)=A_0 e^{ikx} \wedge E_0=\frac{\hbar^2 k^2}{2m} \qquad (16b.)$$

For $N=1$ the potential is:

$$V(x)=(x^2-1) \quad . \qquad (16c.)$$

The Schroediner-equation for $(N=1)$ is:

$$\frac{\hbar^2}{2m}\frac{d^2}{dx^2}\psi_1(x)+(x^2-1)\psi_1(x)=E_1\psi_1(x) \qquad (16d.)$$

This equation correspondens to the Schroedinger-equation for the harmonic oscillator and the eigenvalues are well-known:

$$E_1=(n+\frac{1}{2})\hbar \qquad (16e.)$$

For $(N=2)$ the potential is:

$$V(x)=(x^2-1)(x^2-4) \qquad (16f.)$$

which leads to a Schroedinger-equation for $N=2$ of:

$$\frac{-\hbar^2}{2m}\frac{d^2}{dx^2}\psi_2(x)+(x^2-1)(x^2-4)\psi_2(x)=E_2\psi_2(x) \qquad (16g.)$$

Here obtains a nonlinear quantization of the energy, since the potential has more interactions. The eigenvalues for (N = 2) are more complex than for the harmonic oscillator, and the quantization is determined by the product potential.

To formulate a recursive formula, consider the difference between two eigenvalues for two folloing N -values:

$$E_{N+1}=E_N+\Delta E_N \tag{17.}$$

Here, (ΔE_N) is the change in the eigenvalue due to the additional interaction of the potential. For larger (N), this change becomes increasingly nonlinear due to the new quadratic terms (x^2-k^{2k}).

<u>4.2. Numerical Calculation of the Eigenvalues:</u>
To calculate the eigenvalues numerically, there is used a finite difference method or a direct solution of the Schrödinger equation. Formulated is the Schrödinger equation as a linear system and calculated are the eigenvalues by matrix diagonalization.
Steps of the numerical calculation:
1. Discretization of the Schrödinger equation:

discretization of the second derivative $\frac{d^2}{dx^2}$ on a grid of points (x_i) with step size Δx :

$$\frac{d^2}{dx^2}\approx\frac{\psi(x_{i+1})-2\,\psi(x_i)+\psi(x_{i-1})}{\Delta x_i^2} \tag{18.}$$

2. Matrix formulation of the Schrödinger equation:

The Schrödinger equation for the potential $(V(x))$ is transformed into a matrix form:

$$\frac{-\hbar^2}{2m}H(\psi)=E(\psi) \tag{19.}$$

where H is the Hamiltonian matrix, which is based on the discrete lattice representation.
The Hamiltonian matrix contains the kinetic energy (diagonal terms) and the potential (off-diagonal terms).

3. Calculation of the eigenvalues:

Calculated are the eigenvalues (E_N) of the Hamiltonian matrix (H) by eigenvalue decomposition (e.g., using the QR algorithm or the Jacobi method).

4. Outlook on higher (N) Values:

For higher (N) values, there is simply needed to adjust the potential accordingly and apply the same procedure. The difference lies in the fact that the potential becomes more complex, but the numerical method remains essentially the same. For (N = 2) and higher, the potential is determined by the product of additional quadratic terms (x^2-k^{2k}). The matrix representation for the potential must therefore be extended accordingly, but the basic approach remains unchanged.

5. Summary of calculation:

Recursive form of eigenvalues: The eigenvalues for each (N) can be calculated recursively by considering the interactions of the potential with the previous eigenvalues [6.]. The eigenvalue for (N) depends on the quantization of the energy and the interaction of the quadratic terms.

Numerical calculation: The Schrödinger equation can be solved numerically by formulating it as a linear system and calculating the eigenvalues of the Hamiltonian matrix [7.]. Matrix methods (e.g. eigenvalue decomposition) allow for efficient calculation of the eigenvalues and eigenfunctions.

5. Summary:

With help of a Super-Schroedinger-equation there can be calculated the several advancing Schroedinger-equations, which are needed to describe a time overlapping of incidences per resonance-effect on the same (bundle of) wordline(s). This resonance-effect transports no energy in time backwards or forward. In this case, it cannot interpreted as a classical time-travel because a resonance of eigenvalues generates no CTC.

6. Conclusion:

In principle there are merasurements possible, to reject this theory or to take its description into account. Some quantum mechanical experiments (may be with time-crystals) could make to verify or to neglect this description. In a way, the new SSE and its new product- polynom-class can be used to further research on this theme.

7. Discussion:

If this theory would prove to be consistent, then further investigations on this theme can be made. It may even be possible to establish temporal communication between three time planes or more if they are subject to the same eigentime- modus of natural oscillation

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9. Nonscientific Comment:

"As time goes by" and "tempora mutantur nos et mutamur in illis".

Dedicated to my "Oxian felawe in Old England".

10. Verification:

This paper definitely is written without support from an AI, LLM or chatbot like Grok or Chat GPT 4 or other artificial tools. It is fully, purely human work in every universe.

2026, January.