A Theory of Complex Adaptive Learning and a Non-Localized Wave Equation in Quantum Mechanics

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Abstract: Complex adaptive learning is intelligent. It is adaptive, learns in feedback loops, and generates hidden patterns as many individuals, elements or particles interact in complex adaptive systems (CAS). CAS highlights adaptation in life and lifeless complex systems cutting across all traditional natural and social sciences disciplines. However, discovering a universal law in CAS and understanding the underlying mechanism of distribution formation, such as a non-Gauss distribution in complex quantum entanglement, remains highly challenging. Quantifying the uncertainty of CAS by probability waves, the authors explore the inherent logical relationship between Schrödinger's wave equation in quantum mechanics and Shi's trading volume-price wave equation in finance. Subsequently, the authors propose a non-localized wave equation in quantum mechanics if cumulative observable in a time interval represents momentum or momentum force in Skinner-Shi (reinforcement-frequency-interaction) coordinates. It supports the assumption that the invariance of interaction as a universal law exists in quantum mechanics and finance. The theory shows that quantum entanglement or adaptively interactive coherence is an interactively coherent state instead of a consequence of the superposition of coherent states. As a resource, quantum entanglement is non-separable, steerable, and energy-consumed. The entanglement state has opposite states subject to interaction conservation between the momentum and reversal forces.

Keywords: complex adaptive systems, complex adaptive learning, non-localized wave equation, interaction conservation, interactively coherent entanglement, adaptively interactive coherence

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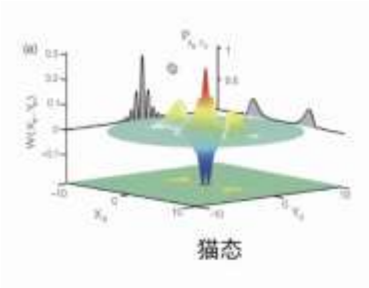
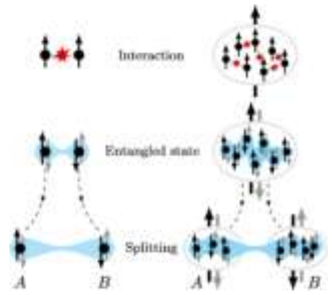
Background

- No consensus so far on the interpretation of quantum entanglement over the past 90 years [1];
- No satisfied theory justifying non-Gauss distribution in complex quantum entanglement, shown in Fig. 1 and 2 [2] [3];
- Experiments reveal the quantum violation of Bell inequality, confirming quantum non-locality;
- Stephen Hawking predicted, "I think the next century (the 21st century) will be the century of complexity";
- Complex systems such as complex quantum systems have commonalities and are driven by the exact underlying mechanism;
- A Chinese scientist discovered a trading volume-price probability wave equation in complex financial markets [4] [5].





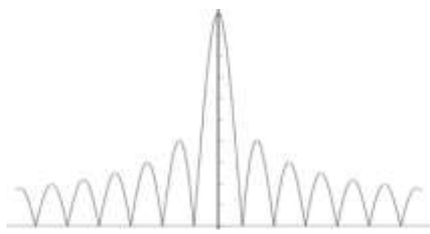


Fig 1 (left above): non-Gauss distribution in complex quantum entanglement [2]; Fig 2 (middle above): entanglement through interactions [3]; Fig 3 (right above): theoretical model or criterion for non-Gauss distribution in complex quantum entanglement [6].

Research Contents

- We find a non-localized wave equation (1) in quantum mechanics if cumulative observable m in a time interval t represents non-localized momentum $m_t = m/t$ or momentum force $m_{tt} = m_t/t = m/t^2$ and energy E is product of the momentum force m_{tt} and generalized coordinate q in reinforcement-frequency-interaction coordinates [6];

$$\frac{B^2}{M}\left(q\frac{d^2\psi}{dq^2}+\frac{d\psi}{dq}\right)+[E-U(q-q_0)]\psi=0, \tag{1}$$

- We have a unified framework for a non-localized quantum wave equation and Schrödinger's wave equation;
- We provide a testable interpretation of complex quantum entanglement on non-Gauss entanglement distribution (shown in Fig. 3) when we apply a law of interaction conservation written by equation (2);

$$\omega_n^2=\frac{m_{t,n,l}^2}{M}=\frac{m}{M}m_{tt,n,l}=m_{tt,n,l}-A_{tt,n,l}=const. \qquad (n=0,1,\cdots),(l=0,1,2\ldots) \tag{2}$$

Conclusion

Quantum entanglement is an interactively coherent state subject to interaction conservation between the momentum and reversal forces instead of a consequence of the superposition of coherent states. The opposite forces coexist and keep opposite states such as spin up and down non-separable in an entangled state.

References

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