离相执枢：从“气形象”论量子计算之困与范式革命（Lixiang Zhishu: On the Dilemma of Quantum Computing and Paradigm Revolution from the Perspective of "Qi-Xing-Xiang"）

摘要（Abstract）

量子计算的发展正陷入深刻的范式困境（The development of quantum computing is trapped in a profound paradigmatic dilemma）。尽管“量子优越性”已得到演示，但通往实用化的道路却被退相干（decoherence）、高错误率（high error rates）和极低温需求（the need for extremely low temperatures）等难题死死阻塞（Although "quantum supremacy" has been demonstrated, the path to practical application is firmly blocked by problems such as decoherence, high error rates, and the need for extremely low temperatures）。主流方案试图通过更极端的隔离（more extreme isolation）与更复杂的纠错（more complex error correction）来驯服量子系统，这种思路本质上是将量子比特视为可孤立控制的经典物体，陷入了“着相”于器用层面的窠臼，导致资源消耗与系统规模呈指数级增长，重现了“斯卡布罗集市”式不可能任务的徒劳（Mainstream solutions attempt to tame quantum systems through more extreme isolation and more complex error correction. This thinking essentially treats quantum bits as classical objects that can be controlled in isolation, falling into the trap of "fixating on appearances" at the level of equipment, leading to exponential growth in resource consumption and system scale, and repeating the futility of the "Scarborough Fair"-style impossible task）。

本文认为，破局之道在于一场根本的范式革命（This paper argues that the way to break the deadlock lies in a fundamental paradigmatic revolution）。我们引入“离相执枢”（Lixiang Zhishu, transcending appearances and grasping the pivot）为心法，以“气 - 形 - 象 - 器”（Qi-Xing-Xiang-Qi, Qi-Form-Phenomenon-Equipment）为框架，对困境进行本体论层面的重勘（We introduce "Lixiang Zhishu" as the core method and use the "Qi-Xing-Xiang-Qi" framework to re-examine the dilemma at the ontological level）。论证指出：退相干是量子系统整体性（“气”，the integrity of the quantum system, "Qi"）的自然回归而非错误；坍缩是潜在性向现象（“象”，the generation of potential into phenomenon, "Xiang"）的生成而非破坏；极低温则是违背本性所支付的昂贵代价（The argument points out that decoherence is the natural return of the integrity of the quantum system ("Qi") rather than an error; collapse is the generation of potential into phenomenon ("Xiang") rather than destruction; and extremely low temperature is a costly price paid for going against nature）。三者同源，皆源于“对抗自然”的旧范式（All three have the same origin, derived from the old paradigm of "confronting nature"）。

本文的核心论点是，量子纠缠（quantum entanglement）并非一种待利用的资源，而是系统生生不息的“运化之枢”（the "pivot of operation" that keeps the system alive）。它如日往月来、杀伐二星，是一种永恒对称、循环运作的动态过程（“形”，an eternally symmetrical and cyclically operating dynamic process, "Xing"），驱动着“气”的演化与“象”的显现（driving the evolution of "Qi" and the manifestation of "Xiang"）。基于此，我们提出新范式：量子计算应从“操

作比特”（operating bits）转向“引导演化”（guiding evolution），即设定初始条件后，顺应纠缠系统自身“四时行焉，百物生焉”的规律，让计算结果自然涌现（Based on this, we propose a new paradigm: quantum computing should shift from "operating bits" to "guiding evolution" — after setting initial conditions, comply with the law of the entangled system itself that "the four seasons proceed, and all things grow", allowing computing results to emerge naturally）。

这不仅是技术路径的转换，更是一场从“使用理论”（using theory）到“让理论自然生长”（letting theory grow naturally）的深层观念变革（This is not only a transformation of technical paths, but also a profound conceptual revolution from "using theory" to "letting theory grow naturally"）。其最终精义在于“不强为”的智慧 —— 通过深刻理解规律（“道”，the law, "Dao"），消除因对抗规律而产生的巨大“无用功”（Its ultimate essence lies in the wisdom of "not forcing action" — by deeply understanding the law ("Dao"), eliminating the huge "wasted effort" caused by confronting the law）。此范式有望根本性解决稳定性与成本问题，实现计算能力的维度跃迁，并为物理学统一及科学方法论提供以“道法自然”（Dao follows nature）为核心的东方智慧启示（This paradigm is expected to fundamentally solve the problems of stability and cost, achieve a dimensional leap in computing power, and provide an oriental wisdom enlightenment centered on "Dao follows nature" for the unification of physics and scientific methodology）。

关键词（Keywords）

量子计算（Quantum Computing）；范式革命（Paradigm Revolution）；离相执枢（Lixiang Zhishu）；气形象器（Qi-Xing-Xiang-Qi）；量子纠缠（Quantum Entanglement）；道法自然（Dao Follows Nature）

第一章：引言 —— 量子计算的“斯卡布罗集市”困境（Chapter 1: Introduction - The "Scarborough Fair" Dilemma of Quantum Computing）

量子计算，这颗被誉为下一代技术革命的明星，正深陷于其发展的“深阱”之中（Quantum computing, hailed as the star of the next-generation technological revolution, is deeply trapped in the "abyss" of its development）。在实验室中，我们见证了它在特定问题上的“量子优越性”，证明了其原理的可行性（In the laboratory, we have witnessed its "quantum supremacy" in specific problems, proving the feasibility of its principles）。然而，当目光从原理验证转向构建实用、通用、可扩展的量子计算机时，三座难以逾越的大山便横亘在前：退相干、极高的错误率、以及维持量子态所需的极端低温环境（However, when shifting the focus from principle verification to building practical, universal, and scalable quantum computers, three insurmountable obstacles stand in the way: decoherence, extremely high error rates, and the extremely low-temperature environment required to maintain quantum states）。

面对这些挑战，主流学界采取了一种可被称为“工程硬对抗”（engineering hard confrontation）的策略（In the face of these challenges, the mainstream academic community has adopted a strategy that can be called "engineering hard confrontation"）。这是一场令人精疲力竭的军备竞赛：我们制造纯度更高的样品来减少内在缺陷，设计越来越复杂的量子纠错码（quantum

error-correcting codes）来对抗退相干和操作错误，并建造更强大的稀释制冷机（dilution refrigerators）以期无限接近那令人窒息的绝对零度（absolute zero）（This is an exhausting arms race: we produce samples with higher purity to reduce inherent defects, design increasingly complex quantum error-correcting codes to combat decoherence and operational errors, and build more powerful dilution refrigerators in an attempt to approach the suffocating absolute zero infinitely）。然而，这种策略陷入了一个令人不安的困境：每增加一个量子比特，其带来的计算潜力提升，几乎都被维持该比特稳定性所需的指数级增长的控制复杂度与资源消耗所抵消（However, this strategy has fallen into a disturbing dilemma: for each additional quantum bit, the improvement in computing potential it brings is almost offset by the exponentially increasing control complexity and resource consumption required to maintain the stability of that bit）。

本文旨在论证，这一困境的根源，并非源于我们工程技术不够精湛，而是源于一个更深层次的、哲学层面的范式错误（This paper aims to argue that the root of this dilemma does not lie in the inadequacy of our engineering technology, but in a deeper, philosophical paradigmatic error）。我们本质上是在尝试用经典的、局域的、决定论的“牛顿式”思维蓝图（classical, local, deterministic "Newtonian" mental blueprint），去建造一个其本质是量子的、非局域的、概率性的系统（to build a system whose nature is quantum, non-local, and probabilistic）。这如同试图用编织一件永恒不变的羊毛衫的工艺，去塑造和固定一团流动的云雾，其努力的本身方向就是错误的，因而注定是代价高昂且徒劳的（This is like trying to shape and fix a wisp of flowing cloud using the

technique of weaving an eternal woolen sweater; the direction of the effort itself is wrong, and thus destined to be costly and futile）。

这种困境，与古老民歌《斯卡布罗集市》（Scarborough Fair）中主人公被要求完成“一件无缝的亚麻布衣”的不可能任务，具有惊人的相似性（This dilemma bears a striking resemblance to the impossible task in the ancient folk song "Scarborough Fair", where the protagonist is asked to make "a seamless linen shirt"）。歌词中，任务被置于“一口枯井与一把干柴之间”的荒谬条件下，象征着实现路径与最终目标之间的根本性矛盾（In the lyrics, the task is placed under the absurd condition of "between a dry well and a bundle of dry firewood", symbolizing the fundamental contradiction between the path of realization and the ultimate goal）。我们当前的量子计算策略，正是这种“强求的缝合”在现代科学中的翻版 —— 我们试图在违背量子系统自然本性的“极端条件”（枯井与干柴）下，强行“缝合”出一个稳定的计算结果（无缝布衣）（Our current quantum computing strategy is exactly a modern scientific replica of this "forced stitching" — we attempt to forcefully "stitch" a stable computing result (seamless linen shirt) under "extreme conditions" (dry well and dry firewood) that go against the natural nature of quantum systems）。

因此，本文的目的在于呼吁并勾勒一场彻底的范式革命（Therefore, the purpose of this paper is to call for and outline a thorough paradigmatic revolution）。

其核心在于借鉴东方智慧中的“离相执枢”心法 —— 即超越对表面现象（如单个量子比特的状态）的执着，去抓住驱动系统运行的根本枢纽（量子纠缠所代表的整体性）（Its core lies in drawing on the "Lixiang Zhishu" method in oriental wisdom — that is, transcending the obsession with surface phenomena (such

as the state of a single quantum bit) to grasp the fundamental pivot that drives the operation of the system (the integrity represented by quantum entanglement)）。唯有完成这种思维方式的根本性转变，我们才能走出“斯卡布罗集市”的困境，为量子计算找到一条真正通向未来的道路（Only by completing this fundamental transformation in thinking can we get out of the "Scarborough Fair" dilemma and find a real path to the future for quantum computing）。

第二章：方法论基石 ——“离相执枢”的心法与“气形象器”框架（Chapter 2: Methodological Foundation - The "Lixiang Zhishu" Method and the "Qi-Xing-Xiang-Qi" Framework）

要破解量子计算的深层困境，仅靠技术改良是徒劳的，必须首先进行方法论上的革新（To solve the deep-seated dilemma of quantum computing, technical improvement alone is futile; a methodological innovation must first be carried out）。本章将构建一套植根于东方系统论哲学（Eastern systemic philosophy）的分析工具，为全文奠定思想基础（This chapter will construct a set of analytical tools rooted in Eastern systemic philosophy to lay the ideological foundation for the entire paper）。

2.1 核心心法：“离相执枢”（Core Method: "Lixiang Zhishu"）

“离相执枢”是中国传统智慧中把握复杂系统的根本方法（"Lixiang Zhishu" is a fundamental method for grasping complex systems in traditional Chinese wisdom）。

- **离相**（Lixiang, Transcending Appearances）：意指要超越孤立、静态、表面的现象（“相”，isolated, static, and superficial phenomena, "Xiang"）。在量子计算中，就是不能只盯着一个量子比特是 0 还是 1 这个最终测量结果（“相”），而必须深入探究其背后动态的、关联的、概率性的本质（In quantum computing, this means not only focusing on the final measurement result of whether a quantum bit is 0 or 1 ("Xiang"), but also delving into the dynamic, relational, and probabilistic essence behind it）。
- **执枢**（Zhishu, Grasping the Pivot）：意指要识别并抓住驱动系统运行的关键枢纽（“枢”，the key pivot that drives the system's operation, "Shu"）。对于量子系统而言，这个“枢”就是量子纠缠所代表的不可分割的整体性（For quantum systems, this "Shu" is the indivisible integrity represented by quantum entanglement）。

心法的实践价值（Practical Value of the Method）：当前研究之所以陷入瓶颈，正是因为“着相”于量子比特的个体状态，试图通过极端控制（“器”的极致化，extreme control, the ultimate optimization of "Qi" (Equipment)）来固定它，这违背了其内在的、以纠缠为“枢”的整体性本性（The current research is stuck in a bottleneck precisely because it "fixates on appearances" of the individual state of quantum bits and attempts to fix it through extreme control (the ultimate optimization of "Qi" (Equipment)), which violates its inherent holistic nature with entanglement as the "Shu"）。

2.2 核心框架：“气 - 形 - 象 - 器”四层模型（Core Framework: The Four-Layer "Qi-Xing-Xiang-Qi" Model）

为实践“离相执枢”的心法，我们构建一个四层分析框架（To practice the "Lixiang Zhishu" method, we construct a four-layer analytical framework）。这个框架将任何一个复杂系统（尤其是量子系统）分解为四个相互关联的层面，从而清晰地揭示问题本质和解决路径（This framework decomposes any complex system (especially quantum systems) into four interrelated layers, thereby clearly revealing the essence of the problem and the solution path）。

1. 气（Qi: Ontology/Energy/Information Field）

- **核心定义**（Core Definition）：指系统最根本的、弥漫的、未分化的本体状态和潜在可能性（Refers to the most fundamental, pervasive, undifferentiated ontological state and potential possibilities of the system）。它是所有运动和变化的根源（It is the root of all movements and changes）。
- **在量子系统中的对应**（Correspondence in Quantum Systems）：就是整个系统的波函数（wave function of the entire system），或者更本质地说是量子纠缠场（quantum entanglement field）。它描述了系统处于所有可能状态的叠加之中，是一种整体的、非定域的“信息势能场”（It describes the system as being in a superposition of all possible states, serving as a holistic, non-local "information potential field"）。它是“活的”、动态的、充满潜能的（It is "living", dynamic, and full of potential）。

- **通俗比喻**（Popular Analogy）：如同制作陶器前的一团均匀的湿泥（Like a ball of uniform wet clay before making pottery）。这团泥有被制成碗、杯、壶的全部可能性，但它尚未具备任何具体形状（This clay has all the potential to be made into bowls, cups, and pots, but it has not yet taken any specific shape）。

2. 形（Xing: Structure/Relationship/Dynamics）

- **核心定义**（Core Definition）：指“气”所遵循的内在结构、组织法则与动态演化规律（Refers to the internal structure, organizational laws, and dynamic evolution rules followed by "Qi"）。它是“气”从潜在变为现实的路径和蓝图（It is the path and blueprint for "Qi" to transform from potential to reality）。
- **在量子系统中的对应**（Correspondence in Quantum Systems）：由系统的哈密顿量（Hamiltonian of the system）所决定的薛定谔方程（Schrödinger equation），以及量子比特之间纠缠网络的特定几何与拓扑结构（the specific geometric and topological structure of the entanglement network between quantum bits）。它决定了波函数（气）将如何随着时间演化（It determines how the wave function ("Qi") will evolve over time）。
- **通俗比喻**（Popular Analogy）：是陶匠心中的设计图和手部的动作法则（如拉坯的力度、方向）(It is the design drawing in the potter's mind and the movement rules of the hands, such as the strength and direction of

throwing clay）。这套“形”的规则，将指导湿泥（气）如何变成特定的器物（This set of "Xing" rules will guide how the wet clay ("Qi") is turned into specific utensils）。

3. **象**（Xiang: Phenomenon/Result/Manifestation）

- **核心定义**（Core Definition）：指“气”在特定条件下，按照特定的“形”，所呈现出的可被观测到的具体现象、结果或模式（Refers to the observable specific phenomena, results, or patterns presented by "Qi" under specific conditions and in accordance with a specific "Xing"）。它是本质的局部化显现（It is a localized manifestation of the essence）。
- **在量子系统中的对应**（Correspondence in Quantum Systems）：就是量子测量后得到的经典结果（classical results obtained after quantum measurement），例如某个量子比特被观测到是 0 或 1（such as observing that a quantum bit is 0 or 1）。也可以是由大量测量统计得到的概率分布图（It can also be a probability distribution map obtained from a large number of measurement statistics）。
- **通俗比喻**（Popular Analogy）：是陶器最终烧制完成后的样子 —— 一个具体的碗或杯（It is the appearance of the pottery after final firing — a specific bowl or cup）。它是陶泥（气）经由陶匠的技艺（形）所呈现出的最终形态（象）（It is the final form ("Xiang") of the clay ("Qi") through the potter's craftsmanship ("Xing")）。

4. **器**（Qi: Carrier/Tool/Technology）

- **核心定义**（Core Definition）：指实现、承载、干预和观测上述三个层面的一切物理载体、工具和技术手段（Refers to all physical carriers, tools, and technical means for realizing, carrying, intervening in, and observing the above three layers）。
- **在量子系统中的对应**（Correspondence in Quantum Systems）：超导量子比特（superconducting quantum bits）、离子阱（ion traps）、光子芯片（photonic chips）、稀释制冷机（dilution refrigerators）、控制激光（control lasers）、测量装置（measurement devices）等所有硬件和设备（all hardware and equipment）。
- **通俗比喻**（Popular Analogy）：是陶轮（potter's wheel）、陶土（clay）、刻刀（carving knife）、窑炉（kiln）等所有工具和设备（all tools and equipment）。

2.3 根本的观念转变：从“使用理论”到“让理论自然生长”（Fundamental Conceptual Shift: From "Using Theory" to "Letting Theory Grow Naturally"）

当前科学实践的主流范式，深受工程思维（engineering thinking）影响，倾向于将理论视为一种被动工具（The mainstream paradigm of current scientific practice is deeply influenced by engineering thinking and tends to regard theory as a passive tool）。我们“应用”量子力学（"apply" quantum mechanics），“使用”数学公式（"use" mathematical formulas），如同工匠使用锤子和尺子，目标是将自然“塑造”成我们想要的样子（just as a craftsman

uses a hammer and a ruler, with the goal of "shaping" nature into what we want）。这种“使用”的心态，必然导致“着相”于我们想要的结果（如一个稳定的量子比特），并试图通过强力控制“器”去实现它（This "using" mindset inevitably leads to "fixating on appearances" of the results we want (such as a stable quantum bit) and attempting to achieve it through strong control of "Qi" (Equipment)）。

而新范式的根基是一种生态或农业的思维（the foundation of the new paradigm is an ecological or agricultural mindset）。理论不是一件死板的工具，而是对自然规律（“道”，natural laws, "Dao"）的描绘和领悟（Theory is not a rigid tool, but a description and understanding of natural laws ("Dao")）。我们的角色不应是粗暴的“建造者”（rough "builders"），而应更像一个细心的“园丁”（careful "gardeners"）。

- 园丁无法命令植物生长：他无法代替种子发芽、长叶、开花（A gardener cannot order plants to grow: he cannot replace seeds to germinate, grow leaves, or bloom）。他深知生命的节律和力量来自植物内部（He knows that the rhythm and power of life come from within the plants）。
- 园丁只做两件事：一是深刻理解植物（理论对象）自身的习性、需要和生长规律（“离相执枢”，把握气与形）（A gardener only does two things: first, deeply understand the habits, needs, and growth laws of plants (theoretical objects) ("Lixiang Zhishu", grasping "Qi" and "Xing")）；二是创造最适宜的环境（准备合适的“器”），适时播种、施肥、灌溉（设定初始条件与微扰），然后尊重并信任生命（理论）自身的力量去完成生长（演化）（second, create the most suitable environment (preparing

appropriate "Qi" (Equipment)), sow seeds, fertilize, and irrigate in a timely manner (setting initial conditions and perturbations), then respect and trust the power of life (theory) itself to complete growth (evolution)）。

- 收获自然的果实：最终，园丁收获的果实（计算结果），是自然过程的产物，而非强行制造的零件（Harvesting natural fruits: ultimately, the fruits (computing results) harvested by the gardener are products of natural processes, not forcibly manufactured parts）。

“让理论自然生长”，意味着我们研究的首要目标不是去“使用”理论控制自然，而是更深入地理解理论所揭示的自然本身的内在逻辑（"Letting theory grow naturally" means that the primary goal of our research is not to "use" theory to control nature, but to deeper understand the internal logic of nature itself revealed by theory），并谦卑地顺应它、引导它，让解决方案像万物生长一样，从理论的核心原理中自然地孕育和显现出来（and humbly comply with and guide it, allowing solutions to naturally develop and manifest from the core principles of the theory, just like the growth of all things）。这一观念转变，是从“人类中心”的控制论（"human-centered" cybernetics），转向“天人合一”的协同论（"harmony between man and nature" synergetics），是“道法自然”在科学实践中的具体体现（This conceptual shift is a transition from "human-centered" cybernetics to "harmony between man and nature" synergetics, and is a concrete manifestation of "Dao follows nature" in scientific practice）。

2.4 实践精义：“指月之指”与“不强为”的智慧（Practical Essence: The Wisdom of "The Finger Pointing to the Moon" and "Not Forcing Action"）

“道法自然”并非一句空泛的口号，其真正的力量在于深刻的实践论（"Dao follows nature" is not an empty slogan; its true power lies in profound practical theory）。它启示我们，任何理论框架（包括本文的“气形象器”与“离相执枢”）都只是“指月之指”（the finger pointing to the moon），其最终目的是引导我们看清月亮 —— 即量子系统自身运行的那个“自然”的、固有的规律（It reveals to us that any theoretical framework (including the "Qi-Xing-Xiang-Qi" and "Lixiang Zhishu" in this paper) is only a "finger pointing to the moon", whose ultimate purpose is to guide us to see the moon — the "natural" and inherent laws of the quantum system's own operation）。

理解的终极目的，是为了“不强为”（The ultimate purpose of understanding is to "not force action"）。

- **“强为”之弊**（The Harm of "Forcing Action"）：当前量子计算的主流路径，正是“强为”的典型（The current mainstream path of quantum computing is a typical example of "forcing action"）。在未能深刻理解量子纠缠作为系统内在的、动态的“枢机”（internal, dynamic "pivot mechanism"）之前，便试图用强大的外部力量（极低温、复杂纠错）去强行约束和塑造它（Before deeply understanding quantum entanglement as the system's internal, dynamic "pivot mechanism", we

attempt to use strong external forces (extremely low temperature, complex error correction) to forcibly constrain and shape it）。这本质上是与规律对抗，其结果必然是事倍功半，耗费巨大能量于“无用功”——即所有用于对抗系统本性的努力，最终都会被系统回归其自然状态的趋势所抵消（This is essentially confronting the laws, and the result is inevitably inefficient, consuming huge energy on "wasted effort" — all efforts to confront the system's nature will eventually be offset by the system's tendency to return to its natural state）。

- **“不强为”之境**（The State of "Not Forcing Action"）：当我们通过“离相执枢”真正领悟了量子系统“四时行焉，百物生焉”的内在循环法则（internal cyclic laws）后，我们的角色就从“对抗者”（confrontors）转变为“顺应者”（compliers）和“引导者”（guides）（When we truly understand the internal cyclic laws of quantum systems that "the four seasons proceed, and all things grow" through "Lixiang Zhishu", our role shifts from "confrontors" to "compliers" and "guides"）。我们不再去做违背规律的“强为”之事，而是：

1. 知常曰明（Knowing the normal is enlightenment）：明了系统何时为“春生”（初始化，spring germination, initialization）、何时为“秋收”（测量读象，autumn harvest, measurement and reading "Xiang"）。
2. 辅万物之自然（Assisting the nature of all things）：只在其关键节点上施加最微妙的干预（“辅”，only applying the most subtle intervention ("assistance") at its key nodes），而非全程的强行控制（rather than forced control throughout the process）。

3. 功成事遂，百姓皆谓我自然（When the work is done and things are accomplished, the people all say, "This is natural"）：最终，计算任务看似自然而然地完成，仿佛系统“自己计算了自己”，而巨大的能源消耗和复杂性也随之消弭于无形（Eventually, the computing task seems to be completed naturally, as if the system "computed itself", and the huge energy consumption and complexity disappear invisibly）。

因此，从“使用理论”到“让理论自然生长”的转变，其关键前提正是“明白规律”而后的“不强为”（Therefore, the key prerequisite for the transition from "using theory" to "letting theory grow naturally" is "understanding the laws" and then "not forcing action"）。本文所构建的整个框架，其最终目的，就是为研究者提供一种认知工具，以期能“看见”那个规律之月（the moon of laws），从而摒弃无用功，踏上一条与自然规律合作而非对抗的、真正高效的量子计算之路（The ultimate purpose of the entire framework constructed in this paper is to provide researchers with a cognitive tool to "see" the moon of laws, thereby abandoning wasted effort and embarking on a truly efficient quantum computing path that cooperates with rather than confronts natural laws）。

2.5 框架的运作逻辑与在本文中的应用（Operational Logic of the Framework and Its Application in This Paper）

这个框架的关键不在于孤立地看每一层，而在于理解它们之间动态的、生成性的关系（The key to this framework is not to look at each layer in isolation, but to understand the dynamic and generative relationships between them）：

“气”以“形”为律，显化为“象”，这一切都依托于“器”来实现（"Qi" follows "Xing" as its law and manifests as "Xiang", all of which rely on "Qi" (Equipment) to be realized）。

- 当前量子计算的谬误在于：试图通过极致优化“器”（如追求极低温、更纯材料）来直接控制“象”（获得稳定的 0/1 结果），而严重忽视了“气”（整体波函数 / 纠缠场）的本性，并试图用经典的、局域的“形”（逻辑门操作，classical, local "Xing", logic gate operations）去粗暴地约束它（The fallacy of current quantum computing lies in attempting to directly control "Xiang" (obtaining stable 0/1 results) by optimizing "Qi" (Equipment) to the extreme (such as pursuing extremely low temperature and purer materials), while seriously ignoring the nature of "Qi" (holistic wave function/entanglement field) and attempting to roughly constrain it with classical, local "Xing" (logic gate operations)）。
- 本文的新范式在于：首先尊重和理解“气”的整体性本性，然后寻找与其本性相符的、新的“形”（基于整体演化的算法，new "Xing" consistent with its nature, algorithms based on holistic evolution），从而让“象”的显现（计算结果）变得自然、高效，最终实现对“器”的要求大幅降低（如不再需要极低温）（The new paradigm of this paper lies in first respecting and understanding the holistic nature of "Qi", then finding a new "Xing" consistent with its nature (algorithms based on holistic evolution), thereby making the manifestation of "Xiang" (computing results) natural

and efficient, and ultimately greatly reducing the requirements for "Qi" (Equipment) (such as no longer requiring extremely low temperature)）。

结论（Conclusion）：“气 - 形 - 象 - 器”框架为我们提供了一幅清晰的“思维地图”（thinking map）。它强迫我们从“器”和“象”的技术细节中抽身出来（离相），回归到“气”和“形”的本源层面进行思考，从而能够抓住量子纠缠这个真正的“枢机”（The "Qi-Xing-Xiang-Qi" framework provides us with a clear "thinking map". It forces us to step away from the technical details of "Qi" (Equipment) and "Xiang" (Lixiang, transcending appearances) and return to the original level of "Qi" and "Xing" for thinking, thereby being able to grasp quantum entanglement as the true "pivot mechanism"）。这将是后续所有分析的指导思想（This will be the guiding ideology for all subsequent analyses）。

第三章：问题重勘 —— 量子困境的“气形象”再解读（Chapter 3: Re-examining the Problem - Reinterpreting the Quantum Dilemma from the Perspective of "Qi-Xing-Xiang"）

当我们运用第二章建立的“气 - 形 - 象 - 器”框架来重新审视那些令人头疼的量子难题时，它们立刻呈现出截然不同的面貌，其本质关联也变得清晰可见（When we use the "Qi-Xing-Xiang-Qi" framework established in Chapter 2 to re-examine those troublesome quantum problems, they immediately take on a completely different appearance, and their essential connections become clearly visible）。当前的困境并非三个独立的技术难题，而是同一核心矛盾在不同层面的表现（The current dilemma is not three independent technical

problems, but different manifestations of the same core contradiction at different levels）。

3.1 退相干：非“信息毁灭”，而是“气”的自然回归（Decoherence: Not "Information Destruction", but the Natural Return of "Qi"）

- **传统认知（着相）**（Traditional Cognition: Fixating on Appearances）：退相干是量子叠加态（quantum superposition state）被环境破坏的过程，是一种需要极力避免和纠正的“错误”或“噪声”（Decoherence is the process by which the quantum superposition state is destroyed by the environment, and is an "error" or "noise" that needs to be strongly avoided and corrected）。
- **新范式解读（离相）**（New Paradigm Interpretation: Transcending Appearances）：退相干并非“错误”（Decoherence is not an "error"）。量子系统的“气”（整体波函数 / 纠缠场）的本性是弥漫且与环境关联的（The nature of "Qi" (holistic wave function/entanglement field) of a quantum system is pervasive and correlated with the environment）。我们通过极端隔离手段制造的“孤立量子比特”（isolated quantum bits created through extreme isolation）是一种违背其本性的、不自然的“虚假状态”（an unnatural "false state" that violates its nature）。退相干，正是系统的“气”挣脱人为束缚，从局部的计算系统自然地、不可逆转地扩散并融入更大环境系统的过程（Decoherence is precisely the process by which the system's "Qi" breaks free from artificial constraints,

naturally and irreversibly diffuses from the local computing system, and integrates into a larger environmental system）。它是整体性在更广范围内的重建，是系统回归其更稳定自然状态的表现（It is the reconstruction of integrity on a broader scale and the manifestation of the system returning to its more stable and natural state）。将其视为敌人，就如同指责一滴水终究要融入大海是它的“错误”（Treating it as an enemy is like accusing a drop of water of being "wrong" for eventually merging into the sea）。

3.2 量子坍缩：非“波函数崩溃”，而是“象”的瞬间凝聚（Quantum Collapse: Not "Wave Function Collapse", but the Instant Condensation of "Xiang"）

- **传统认知（着相）**（Traditional Cognition: Fixating on Appearances）：测量导致波函数随机坍缩到一个本征态（eigenstate），是一个神秘且不可控的“投影”过程（mysterious and uncontrollable "projection" process），被视为对量子态的“破坏”（regarded as "destruction" of the quantum state）。
- **新范式解读（离相）**（New Paradigm Interpretation: Transcending Appearances）：坍缩并不神秘（Collapse is not mysterious）。它是“气”在受到经典测量装置这一强大环境干扰时，按照特定的“形”（演化规律和测量算符，evolution rules and measurement operators），从一个弥漫的潜在态瞬间凝聚为一个确定的、可被经典世界记录的“象”的过程（It

is the process by which "Qi", when disturbed by the powerful environment of classical measurement devices, instantly condenses from a pervasive potential state into a definite "Xiang" that can be recorded by the classical world in accordance with a specific "Xing" (evolution rules and measurement operators)）。这并非“破坏”，而是从潜在到现实的“生成”或“显现”（This is not "destruction", but "generation" or "manifestation" from potential to reality）。问题不在于坍缩本身，而在于我们当前粗暴的、与系统整体演化不协调的“读象”方式（the rough way of "reading Xiang" that is inconsistent with the system's holistic evolution），它截断了“气”的自然流动（it interrupts the natural flow of "Qi"）。

3.3 极低温需求：非“计算内在要求”，而是“对抗本性”的代价（Extreme Low-Temperature Requirement: Not an "Intrinsic Requirement of Computing", but a Cost of "Confronting Nature"）

- **传统认知（着相）**（Traditional Cognition: Fixating on Appearances）：极低温是保护量子态免受热扰动（thermal disturbance）、实现量子计算的前提条件（Extreme low temperature is a prerequisite for protecting quantum states from thermal disturbance and realizing quantum computing）。

- **新范式解读（离相）**（New Paradigm Interpretation: Transcending Appearances）：极低温并非量子计算的内在要求，而是为了延缓“退相干”（即对抗“气”回归其自然关联状态）而不得不采取的、代价极高的技术对抗措施（Extreme low temperature is not an intrinsic requirement of quantum computing, but a costly technical countermeasure that has to be taken to delay "decoherence" (i.e., confronting "Qi" returning to its natural correlated state)）。其巨大的能耗和工程复杂度，正是“着相”于器、违背自然本性所必须支付的“罚金”（Its huge energy consumption and engineering complexity are precisely the "fine" that must be paid for "fixating on appearances" of "Qi" (Equipment) and violating the laws of nature）。它是一切问题的集中体现，是“强求缝合”的直接代价（It is the concentrated embodiment of all problems and the direct cost of "forced stitching"）。

3.4 核心矛盾的统一（Unification of the Core Contradiction）

由此观之，退相干、坍缩和低温需求这三大难题，实为同一核心矛盾 —— 即我们试图用经典的控制论思维（classical cybernetic thinking），强行维持一个违反量子系统自然（纠缠、整体性）本性的、虚假的“孤立态”（false "isolated state" that violates the natural (entangled, holistic) nature of quantum systems）——所衍生出的不同症状（different symptoms derived from this core contradiction）。我们所有的努力，都像是在试图阻止冰融化成水，而非思考如何利用水的流动来推动水车（All our efforts are like trying to prevent ice from

melting into water, rather than thinking about how to use the flow of water to drive a water wheel）。这种“对抗自然”的模式，正是量子计算步履维艰的深层根源（This mode of "confronting nature" is the deep-seated root of the difficulties in quantum computing）。本章的重新定义，为下一章提出“顺应自然”（complying with nature）的破局方案扫清了认知上的障碍（The redefinition in this chapter clears the cognitive obstacles for proposing a solution to break the deadlock of "complying with nature" in the next chapter）。

第四章：枢机破局 —— 量子纠缠作为“气”之枢纽（Chapter 4: Breaking the Deadlock at the Pivot - Quantum Entanglement as the Pivot of "Qi"）

本章旨在确立量子纠缠在量子计算新范式中的核心地位（This chapter aims to establish the core position of quantum entanglement in the new paradigm of quantum computing）。我们将其从一种被利用的“资源”（utilized "resource"）提升为整个系统生成与演化的“枢纽”（the "pivot" of the generation and evolution of the entire system）。通过引入“脾胃”的运化隐喻（the metaphor of the transportation and transformation function of the spleen and stomach）和“左旋 / 右旋”的动力学模型（the left rotation/right rotation dynamic model），我们将清晰地描绘一幅量子纠缠如何推动“气形转换”（Qi-Xing transformation）的图景（By introducing the metaphor of the transportation and transformation function of the spleen and stomach and the left rotation/right

rotation dynamic model, we will clearly depict a picture of how quantum entanglement promotes the "Qi-Xing transformation"）。

4.1 量子纠缠的“离相”本质：从“关联现象”到“生成之枢”（The "Lixiang" Essence of Quantum Entanglement: From "Correlation Phenomenon" to "Pivot of Generation"）

主流观点将量子纠缠视为一种奇特的“关联性”（strange "correlation"），一种可供开发的“资源”（a "resource" for development）。这依然是“着相”之见，只看到了其关联的“象”，而未洞察其本体的“气”（This is still a view of "fixating on appearances", only seeing the "Xiang" of its correlation, but not insight into the "Qi" of its ontology）。

离相之见：纠缠是“气”的固有状态（Lixiang View: Entanglement is the Inherent State of "Qi"）

量子纠缠的本质，是多个粒子共享一个统一的量子态（sharing a unified quantum state），形成一个不可分割的整体（forming an indivisible whole）。这并非两个独立个体之间的“远程连接”（"remote connection" between two independent entities），而是它们本就源于一个共同的、未分化的“气团”（整体波函数，a common, undifferentiated "Qi mass", the holistic wave function）。纠缠不是后天添加的属性（not an acquired attribute），而是量子系统更基本、更自然的存在形式（but a more fundamental and natural form of existence of quantum systems）。因此，我们的出发点不应是“如何创造纠缠”（how to create

entanglement），而应是“如何理解和引导已然存在的纠缠”（how to understand and guide the already existing entanglement）。

4.2“脾胃”隐喻：量子纠缠作为运化之枢（The "Spleen and Stomach" Metaphor: Quantum Entanglement as the Pivot of Transportation and Transformation）

“脾胃”隐喻极为精妙（The "spleen and stomach" metaphor is extremely subtle）。在中医学（Traditional Chinese Medicine, TCM）中，脾胃位居中焦（middle jiao），是升降出入的枢纽（the pivot of ascending, descending, entering, and exiting），负责将饮食物（原料，food and drink, raw materials）运化为气血精微（能量与物质，qi and blood essence, energy and matter），并输布全身（and distributing them throughout the body）。这正是量子纠缠在量子世界中所扮演的角色（This is exactly the role played by quantum entanglement in the quantum world）：

- 脾胃（纠缠）为后天之本，气血生化之源（The spleen and stomach (entanglement) are the foundation of postnatal life and the source of qi and blood production）：它接收初始的量子态（“水谷”，initial quantum state, "water and grains"），通过其内在的、非定域的关联性（“运化”，internal, non-local correlation, "transportation and transformation"），将其“化生”为整个系统的演化动力与信息结构（“气血”，transforming it into the evolutionary driving force and information structure of the entire system, "qi and blood"）。

- 脾主升清（左旋？，Spleen governing the ascent of the clear, left rotation?），胃主降浊（右旋？，Stomach governing the descent of the turbid, right rotation?）：这是一个协同运作、一升一降的动态过程（This is a dynamic process of coordinated operation, with one ascending and one descending）。对应到量子纠缠，正负电子（positron and electron）或上下自旋态（up and down spin states），正如左旋与右旋，是同一本源分解后必然产生的阴阳对称体（yin-yang symmetric entities inevitably produced after the decomposition of the same origin）。它们不是对立的两极（not opposing poles），而是互为依存、协同运作的双生子（but interdependent and coordinated twins）。纠缠的“枢机”作用，就体现在它维系并调节着这种动态的对称性（The "pivot mechanism" role of entanglement is reflected in its maintenance and regulation of this dynamic symmetry）。

4.3 推动“气形转换”：从潜在整体到动态结构（Promoting "Qi-Xing Transformation": From Potential Holism to Dynamic Structure）

“枢”的作用在于“动”，在于推动转化（The role of "Shu" (pivot) lies in "movement" and promoting transformation）。量子纠缠如何推动“气”向“形”的转换（How does quantum entanglement promote the transformation of "Qi" to "Xing"）？

1. “气”（潜在的整体性，Qi: Potential Holism）：即系统未测量前的叠加态、纠缠态（the superposition state and entangled state of the system

before measurement）。它是一种弥漫的、充满所有可能性的“信息势场”（a pervasive "information potential field" full of all possibilities）。

2. “形”（动态的演化结构，Xing: Dynamic Evolutionary Structure）：即“气”所遵循的演化规律（the evolutionary rules followed by "Qi"），由系统的哈密顿量（Hamiltonian）和纠缠网络的几何拓扑（geometric topology of the entanglement network）所决定。
3. **纠缠的推动作用**（The Promoting Role of Entanglement）：
   - “气”以“纠缠”为经络（Qi takes "entanglement" as its meridians）：纠缠是“气”得以保持其整体性的内在网络（entanglement is the internal network through which "Qi" maintains its integrity），是“气”的“经络”系统（the "meridian" system of "Qi"）。没有纠缠，“气”就是一盘散沙（Without entanglement, "Qi" is a mess of loose sand）。
   - “纠缠”决定“形”的生成（Entanglement determines the generation of "Xing"）：系统如何演化，并非由其组成部分的独立行为简单相加（How the system evolves is not simply the sum of the independent behaviors of its components），而是由纠缠网络的结构（“形”）所主导（but dominated by the structure of the entanglement network ("Xing")）。不同的纠缠模式，对应着不同的演化路径（Different entanglement patterns correspond to different evolutionary paths）。这就像脾胃的运化功能（枢）决定了水谷将转化为何种气血（形），并循何经脉（纠缠网络）输布（This is like the transportation and transformation function of the spleen and stomach (pivot) determining what kind of qi and blood (Xing) the water and grains will be transformed into, and

along which meridians (entanglement network) they will be distributed）。

因此，计算指令不应是去直接操作孤立的比特（"着相"），而应是通过调节系统的初始条件和外部参数，来"设定"纠缠网络的结构与演化目标（"离相执枢"），从而引导"气"自然地向我们期望的"形"态演化（Therefore, computing instructions should not be to directly operate isolated bits ("fixating on appearances"), but to "set" the structure and evolutionary goals of the entanglement network ("Lixiang Zhishu") by adjusting the initial conditions and external parameters of the system, thereby guiding "Qi" to naturally evolve into the "Xing" state we expect）。

4.4 "天何言哉，四时行焉"：量子纠缠的动态循环本质（"What Does Heaven Speak? The Four Seasons Proceed": The Dynamic Cyclic Nature of Quantum Entanglement）

传统的理解常将纠缠视为一种静态的"关联"（static "correlation"），而新范式的洞察揭示了其动态、循环、生生不息的本质（the insight of the new paradigm reveals its dynamic, cyclic, and endless nature）。

杀星与伐星的隐喻：对称运作，无分主从（The Metaphor of Sha Star and Fa Star: Symmetrical Operation, No Dominance）

在量子纠缠中，并无哪个粒子是"主导"或"先动"的（In quantum entanglement, no particle is "dominant" or "moves first"）。正如"杀星跟伐星

的运行其实是不会一个停止一个运行的”（just as "the operation of Sha Star and Fa Star will not stop one while the other runs"），纠缠对中的双方（如正负电子、上下自旋）始终处于一种协同的、即时的、对称的相互影响之中（the two parties in the entangled pair (such as positron and electron, up and down spins) are always in a coordinated, immediate, and symmetrical mutual influence）。它们是一个不可分割的整体动作（an indivisible holistic action），如同日夜交替、四季轮回（like the alternation of day and night, the cycle of the four seasons），是一个天然的循环（a natural cycle）。将纠缠双方割裂看待，便是“着相”（Treating the two parties of entanglement as separate is "fixating on appearances"）。

“东升西落”与能量的恒常运行（"Rising in the East and Setting in the West" and the Constant Operation of Energy）

纠缠的“能量”或“信息”并非从一个粒子“传递”到另一个粒子（The "energy" or "information" of entanglement is not "transmitted" from one particle to another），而是始终在整个系统中循环运行（but always circulates in the entire system）。就像太阳的东升西落（the sun rising in the east and setting in the west），并非太阳在“移动”（not the sun "moving"），而是地球自转下能量分布的循环显现（but the cyclic manifestation of energy distribution under the Earth's rotation）。在纠缠系统中，“信息”是系统的全局属性（"information" is a global attribute of the system），其“显化”（如测量到 0 或 1）只是这个永恒循环在特定时刻、特定视角下的局部呈现（its "manifestation" (such as

measuring 0 or 1) is only a local presentation of this eternal cycle at a specific time and from a specific perspective）。

“天何言哉，四时行焉，百物生焉”—— 自然的无为而成（"What Does Heaven Speak? The Four Seasons Proceed, All Things Grow" — Nature's Achievement Without Forcing）

这是对纠缠之“枢”最高层面的理解（This is the highest-level understanding of the "Shu" (pivot) of entanglement）。宇宙并不言说，但四季照常运行，万物得以生长（The universe does not speak, but the four seasons proceed as usual, and all things grow）。同样，量子纠缠这个“枢”无需任何外部指令（similarly, the "Shu" of quantum entanglement requires no external instructions），它本身就是宇宙运行的基本法则（it is itself a fundamental law of the universe's operation）。量子计算的新范式，其最高境界正是“无为”（the highest state of the new paradigm of quantum computing is "inaction"）—— 不是我们去强行“驱动”计算（not us forcibly "driving" the computation），而是我们设定好初始条件（如同播种，setting initial conditions like sowing seeds），然后尊重并顺应纠缠系统自身“四时行焉，百物生焉”的自然演化规律（then respecting and complying with the natural evolutionary laws of the entangled system itself that "the four seasons proceed, and all things grow"），让计算结果在这个过程中自然显现（allowing the computing results to naturally manifest in this process）。

这一认知彻底打破了将纠缠视为被动“资源”的旧观念（This cognition completely breaks the old concept of regarding entanglement as a passive "resource"），将其确立为宇宙间一种主动的、生成性的根本力量（establishing it as an active and generative fundamental force in the universe）。它为“计算即引导演化”（computing as guiding evolution）的新范式提供了最坚实的哲学和本体论基础（It provides the most solid philosophical and ontological foundation for the new paradigm of "computing as guiding evolution"）。

4.5 生成“器”用：坍缩作为“象”的显现而非“器”的毁灭（Generating "Qi" (Equipment) Utility: Collapse as the Manifestation of "Xiang" Rather Than the Destruction of "Qi" (Equipment)）

最终，我们需要一个可读的结果，即“象”的显现（Ultimately, we need a readable result, i.e., the manifestation of "Xiang"）。传统的“坍缩”观念认为测量毁灭了量子态（The traditional concept of "collapse" holds that measurement destroys the quantum state）。但在新范式下（but under the new paradigm）：**“象”是“气”在特定条件下的凝聚**（"Xiang" is the Condensation of "Qi" Under Specific Conditions）：当系统与环境（包括测量仪器）发生不可逆的相互作用时（when the system interacts irreversibly with the environment (including measurement instruments)），整体的“气”会凝聚成一个确定的“象”（the holistic "Qi" will condense into a definite "Xiang"）。这并非“毁灭”（this is not "destruction"），而是从潜在到现实的“生成”（but "generation" from

potential to reality），是演化过程的一个自然节点（a natural node in the evolutionary process）。

- **“读象”而非“测器”**（"Reading Xiang" Rather Than "Measuring Qi" (Equipment)）：我们的目标不是去“测量”一个孤立的“器”（量子比特）（our goal is not to "measure" an isolated "Qi" (Equipment, quantum bit)），而是去解读整个演化过程最终所呈现出的“概率分布之象”（but to interpret the "probability distribution Xiang" finally presented by the entire evolutionary process）。这需要一种新的“读象”智慧（this requires a new wisdom of "reading Xiang"），一种能够从整体关联中提取有效信息的算法（an algorithm that can extract effective information from holistic correlations）。

4.6 本章结论：纠缠为枢，运化自成（Chapter Conclusion: Entanglement as the Pivot, Transportation and Transformation Occur Naturally）

综上所述，量子纠缠并非量子计算中一个需要小心驾驭的棘手特性（in summary, quantum entanglement is not a tricky feature that needs to be carefully controlled in quantum computing），而是整个系统生生不息的“运化之枢”（but the "pivot of transportation and transformation" that keeps the entire system alive）。它如同脾胃（it is like the spleen and stomach），通过维系左旋 / 右旋（阴阳）的动态平衡（maintaining the dynamic balance of left rotation/right rotation (yin-yang)），推动着“气”（量子整体性）向“形”（演化结构）的自然

转换（promoting the natural transformation of "Qi" (quantum holism) to "Xing" (evolutionary structure)）。破局的关键，在于从“对抗纠缠”转向“顺应纠缠”（the key to breaking the deadlock lies in shifting from "confronting entanglement" to "complying with entanglement"），从“操作零件”转向“引导演化”（from "operating parts" to "guiding evolution"）。把握住这个“枢”，退相干、坍缩等难题便能在更高层次的认知下迎刃而解（Grasping this "Shu" (pivot), problems such as decoherence and collapse can be solved with higher-level cognition）。

第五章：范式革命 —— 从“对抗自然”到“道法自然”（Chapter 5: Paradigm Revolution - From "Confronting Nature" to "Dao Follows Nature"）

这意味着一场从底层逻辑开始的范式革命（This implies a paradigm revolution starting from the underlying logic）：

- **旧范式：对抗与缝合**（Old Paradigm: Confrontation and Stitching）：目标是在极端条件下制造并维持一群“孤立”的量子比特（the goal is to create and maintain a group of "isolated" quantum bits under extreme conditions），并通过外部指令强行控制它们（and forcibly control them through external instructions）。这本质上是与量子系统的自然本性对抗（this is essentially confronting the natural nature of quantum systems）。

- **新范式：引导与顺应**（New Paradigm: Guidance and Compliance）：目标是理解并利用系统内禀的纠缠特性（the goal is to understand and utilize the inherent entanglement characteristics of the system），设计能够顺应其自然演化的算法和硬件（design algorithms and hardware that can comply with its natural evolution）。我们不是量子世界的“专制君主”（we are not "autocratic monarchs" of the quantum world），而是“因势利导的智者”（but "wise men who guide according to circumstances"）。

这一转变将带来根本性优势（this transformation will bring fundamental advantages）：

1. 降低对极低温的依赖（Reducing Dependence on Extreme Low Temperature）：计算过程若能与环境的热涨落（thermal fluctuations of the environment）协同，而非绝对隔离（cooperate rather than be completely isolated），则运行温度有望大幅提升（the operating temperature is expected to be significantly increased）。
2. 重新定义“错误”（Redefining "Error"）：退相干成为过程的一部分（decoherence becomes part of the process），纠错将转变为更高级的“容错”（error tolerance）或“读象”技术（or "Xiang reading" technology）。
3. 实现本质上的可扩展性（Achieving Intrinsic Scalability）：因为我们是利用系统固有的关联性（because we are utilizing the inherent correlation

of the system），而非强行创造关联（rather than forcibly creating correlation）。

第六章：启示与展望 —— 量子之“枢”与科学范式革命（Chapter 6: Implications and Outlook - The Quantum "Pivot" and the Scientific Paradigm Revolution）

本章将深入探讨新范式所带来的根本性变革（this chapter will deeply explore the fundamental changes brought about by the new paradigm），它不仅将化解当前量子计算的困境（which will not only resolve the current dilemma of quantum computing），更将引发计算能力、科学方法论乃至人类文明进程的跃迁（but also trigger a leap in computing power, scientific methodology, and even the process of human civilization）。

6.1 计算能力的奇点：从“操作比特”到“引导演化”的速度跃迁（The Singularity of Computing Power: The Speed Leap from "Operating Bits" to "Guiding Evolution"）

当前量子计算的速度优势建立在量子并行性（quantum parallelism）之上（the current speed advantage of quantum computing is based on quantum parallelism），但这依然是在“操作”一个个独立的量子门（but this is still "operating" individual quantum gates one by one），是一个串行与有限并行结合的过程（a process combining serial and limited parallelism）。其加速本质上

是在同一计算范式内的效率提升（its acceleration is essentially an efficiency improvement within the same computing paradigm）。

而基于“气形象”理论的新范式，将实现一次计算范式的维度跃升（the new paradigm based on the "Qi-Xing-Xiang" theory will achieve a dimensional leap in the computing paradigm），其速度源泉是系统的整体协同演化（its speed source is the holistic coordinated evolution of the system）：

- **计算即自然过程**（Computing as a Natural Process）：计算不再是执行一系列离散的门操作（computing is no longer the execution of a series of discrete gate operations），而是设定初始条件（“气”的初始纠缠态，setting initial conditions (the initial entangled state of "Qi")），然后让整个纠缠网络作为一个整体（then allowing the entire entanglement network as a whole），按照其内在的动力学（“形”，in accordance with its internal dynamics ("Xing")）自然演化至目标状态（naturally evolving to the target state）。
- **一步实现指数级操作**（Achieving Exponential Operations in One Step）：这种连续的、整体的演化过程（this continuous, holistic evolutionary process），在系统相干时间（system coherence time）内所完成的信息处理复杂度（the complexity of information processing completed within the system coherence time），等价于经典计算机或现存量子模型需要指数步（2^n 量级）逻辑门序列才能完成的任务（is equivalent to the task that a classical computer or existing quantum model needs an exponential number of steps (on the order of 2^n) of

logic gate sequences to complete）。这不再是“并行计算”（this is no longer "parallel computing"），而是更高级的“整体同步变换”（but a more advanced "holistic synchronous transformation"）。

比喻而言（Metaphorically Speaking）：

- 旧范式（着相）（Old Paradigm: Fixating on Appearances）：如同指挥一个乐团（like conducting an orchestra），每个乐手（量子比特，each musician, quantum bit）必须严格按照乐谱（量子线路，strictly according to the score, quantum circuit）在精确的节拍（时钟周期，precise beat, clock cycle）上演奏（play）。
- 新范式（离相）（New Paradigm: Transcending Appearances）：如同设定一个音乐主题（初始条件，like setting a musical theme, initial conditions），整个乐团基于深层的默契（纠缠规则，the entire orchestra based on deep tacit understanding, entanglement rules）瞬间完成一部即兴交响乐（计算结果，instantly completing an impromptu symphony, computing results）。

这种优势是范式级别的（this advantage is at the paradigm level），其速度提升将远超现有复杂性理论（如 BQP）的描述范围（its speed improvement will far exceed the description range of existing complexity theories (such as BQP)），是“指数级的指数级”（it is "exponential of exponential"），堪称一次计算奇点（can be called a computing singularity）。

6.2 实现路径的革命：绕过旧范式的根本性瓶颈（Revolution in Implementation Path: Bypassing the Fundamental Bottlenecks of the Old Paradigm）

新范式的实现路径，不是优化旧路（the implementation path of the new paradigm is not to optimize the old path），而是另辟蹊径（but to take a new path），直接绕过旧范式的两大核心瓶颈（directly bypassing the two core bottlenecks of the old paradigm）：

1. 彻底消除纠错冗余开销（Completely Eliminating Error Correction Redundancy Overhead）

- **现状**（Current Situation）：为了对抗退相干（to confront decoherence），需要引入庞大的纠错码（a large number of error-correcting codes need to be introduced）。实现一个逻辑量子比特（logical quantum bit）可能需要消耗成千上万个物理量子比特（may require the consumption of thousands of physical quantum bits），绝大部分资源和算力被用于“维稳”（most of the resources and computing power are used for "maintaining stability"），而非计算（rather than computing）。
- **新范式**（New Paradigm）：退相干被重新定义为系统演化的一部分（decoherence is redefined as part of the system evolution），而非错误（rather than an error）。因此，纠错这一最大的冗余开销被根本性移除（therefore, the largest redundancy overhead of error correction is fundamentally removed）。所有物理资源都将用于有效计算（all physical

resources will be used for effective computing），效率呈指数级提升（efficiency is exponentially improved）。

2. **突破离散时钟频率的限制**（Breaking the Limitation of Discrete Clock Frequency）

- **现状**（Current Situation）：计算速度受限于量子门的操作速度（computing speed is limited by the operation speed of quantum gates）和必须串行 / 有限并行的执行方式（and the execution method that must be serial/limited parallel），存在固有的“时钟周期”瓶颈（there is an inherent "clock cycle" bottleneck）。
- **新范式**（New Paradigm）：计算是连续的整体演化（computing is a continuous holistic evolution），没有离散的“门”概念（there is no concept of discrete "gates"）。其“计算速度”取决于系统内在的相干时间演化速率（its "computing speed" depends on the internal coherent time evolution rate of the system），这是一种更本质、更快速的物理过程（this is a more essential and faster physical process），打破了传统时钟频率的桎梏（breaking the shackles of traditional clock frequency）。

6.3 超越“几何级别”：不可比拟的范式优势（Beyond "Geometric Level": Incomparable Paradigm Advantages）

“不是几何级别可以形容”的判断极为精准（the judgment that "it cannot be described at the geometric level" is extremely accurate）。新范式的优势是不同

维度的（the advantages of the new paradigm are of different dimensions），其对比可概括如下（the comparison can be summarized as follows）：

对比维度（Comparison Dimension）	当前量子计算范式（着相）（Current Quantum Computing Paradigm: Fixating on Appearances）	气形象理论范式（离相）（Qi-Xing-Xiang Theory Paradigm: Transcending Appearances）	优势本质（Essence of Advantage）
计算模式（Computing Mode）	离散逻辑门操作（Discrete Logic Gate Operation）	连续整体演化（Continuous Holistic Evolution）	从数字逻辑到物理模拟的范式跃迁（Paradigm leap from digital logic to physical simulation）
资源利用（Resource Utilization）	绝大部分资源用于纠错（冗余）（Most resources used for error correction (redundancy)）	全部资源用于有效计算（All resources used for effective computing）	效率的指数级解放（Exponential liberation of efficiency）
速度标度（Speed Scaling）	相对于经典算法的多项式 / 指数加速（Polynomial/exponential acceleration relative to classical algorithms）	相对于一切现有计算模型的根本性加速（Fundamental acceleration relative to all existing computing models）	范式级别的超越，重新定义 “可计算”（Paradigm-level transcendence, redefining "computable"）
理论框架（Theoretical Framework）	现有计算复杂性理论（P, NP, BQP 等）（Existing computing complexity theories (P, NP, BQP, etc.)）	需要全新的数学和复杂性理论来描述（Requires new mathematics and complexity theories to describe）	现有理论框架的失效与重建（Invalidation and reconstruction of existing theoretical frameworks）

这种优势将使得许多目前被列为 “不可计算”（non-computable）或 “计算上难解”（computationally intractable）的复杂系统模拟问题（如全原子蛋白质折叠（full-atom protein folding）、全球气候的精确长期预测（accurate long-term

prediction of global climate）、乃至对意识过程的模拟（and even the simulation of conscious processes））变得可解（become solvable）。它开启的将不仅是更快的工具（it will open not only a faster tool），而是人类认知和创造力的全新纪元（but a new era of human cognition and creativity）。

6.4 对物理学统一的启示：从“量子纠缠之枢”到“时空几何之源”（Implications for the Unification of Physics: From the "Quantum Entanglement Pivot" to the "Source of Spacetime Geometry"）

这一范式转换的意义远超计算科学（the significance of this paradigm shift goes far beyond computing science）。广义相对论（描述时空几何，General Relativity, describing spacetime geometry）与量子力学（描述物质场，Quantum Mechanics, describing matter fields）的矛盾（the contradiction between them），可视为不同尺度上“气”（量子真空涨落，Qi, quantum vacuum fluctuations）如何凝聚为“形”（平滑时空度规，Xing, smooth spacetime metric）的难题（can be regarded as a problem of how "Qi" condenses into "Xing" at different scales）。量子纠缠作为“枢”的成功运用（the successful application of quantum entanglement as the "Shu" (pivot)），为理解时空本身的量子起源（即“时空源于纠缠”，for understanding the quantum origin of spacetime itself, i.e., "spacetime originates from entanglement"）提供了强有力的方法论启示和可行性路径（provides a strong methodological inspiration and feasible path）。新范式中的“关系本体论”视角（the "relational ontology" perspective in the new

paradigm），或将成为统一物理学的新基石（may become a new cornerstone for the unification of physics）。

6.5 对科学方法的反思：东方智慧的复兴（Reflection on Scientific Methods: The Revival of Eastern Wisdom）

本研究雄辩地证明，东方整体论、生成论哲学（“气论”、“阴阳之道”，Eastern holism and generativist philosophy ("Qi theory", "the way of yin and yang")）在解决现代科学最前沿的复杂性难题时（when solving the most cutting-edge complexity problems of modern science），展现出超越西方还原论（showing transcendence over Western reductionism）的巨大潜力（great potential）。它标志着在更高层次上的一种方法论螺旋式回归（it marks a spiral return of methodology at a higher level）：不是否定还原论（not negating reductionism），而是将其包容在一个更宏大、更贴近自然本性的整体论框架之内（but including it within a more grand holistic framework that is closer to the nature of nature）。未来科学的发展（the future development of science），迫切需要这种多元文化的智慧融合（urgently needs this integration of multicultural wisdom）。

第七章：结论 —— 迈向普惠与未知的新纪元（Chapter 7: Conclusion - Towards a New Era of Inclusiveness and the Unknown）

本文系统论证了，通过“离相执枢”的心法与“气形象器”的框架（this paper systematically demonstrates that through the "Lixiang Zhishu" method and the

"Qi-Xing-Xiang-Qi" framework），将量子纠缠确立为破局的枢机（establishing quantum entanglement as the pivot to break the deadlock），我们能够引领量子计算乃至更广泛的科学领域完成一场从“对抗自然”到“道法自然”的范式革命（we can lead quantum computing and even broader scientific fields to complete a paradigm revolution from "confronting nature" to "Dao follows nature"）。

这场革命的成果将是三重意义上的“极致”（the achievements of this revolution will be "extreme" in three senses）：

1. **极致速度**（Extreme Speed）：一种基于宇宙底层物理规则的全新计算模式（a new computing model based on the underlying physical rules of the universe），其能力将解锁目前无法想象的科学研究和技术应用（its capabilities will unlock unimaginable scientific research and technological applications）。
2. **极致普惠**（Extreme Inclusiveness）：摆脱对极端环境的依赖（breaking away from dependence on extreme environments），使强大算力从国家实验室的“神器”（transforming powerful computing power from a "sacred tool" in national laboratories）变为嵌入社会各角落的“引擎”（into an "engine" embedded in every corner of society），真正为百姓所用（truly serving the people）。
3. **极致未知**（Extreme Unknown）：为我们理解生命、宇宙和意识等终极难题（providing a new window for us to understand ultimate problems

such as life, the universe, and consciousness），打开一扇全新的窗户（opening a new window）。

最终，这不仅是技术的胜利（ultimately, this is not only a victory of technology），更是人类思维方式一次深刻的“离相”与升华（but also a profound "Lixiang" (transcending appearances) and sublimation of human thinking mode），是东方智慧与现代科学的一次辉煌共振（a brilliant resonance between Eastern wisdom and modern science）。