

QUANTUM SPIN STATES IN WATER: ORTHO-PARA TRANSITION THEORY AND ITS IMPACT ON ENVIRONMENTAL AND INDUSTRIAL TECHNOLOGIES

Let him who seeks continue seeking until he finds. When he finds, he will become troubled. When he becomes troubled, he will be astonished, and he will rule over the All.”

—Gospel of Thomas (2:1–4)

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Abstract: *Recent discoveries reveal that light-induced water evaporation—the “photomolecular effect”—is governed by quantum spin isomerism in H₂O. This study unifies ortho-para transitions, Djanibekov-like rotational instabilities, and Vernadsky’s noosphere concept to explain how spin-state dynamics influence atmospheric, oceanic, and industrial systems. Polarized light (532 nm) drives para→ortho conversion via resonance with rotational energy levels, while π -turn flips of ortho-H₂O enhance interfacial processes. These phenomena challenge classical fluid dynamics, offering pathways for climate regulation, sustainable desalination, and pollution control. By framing water’s quantum behavior within the noosphere—a biosphere shaped by human intellect—we propose novel solutions for global environmental challenges.*

INTRODUCTION

Water, often regarded as a simple molecule, exhibits complex quantum behaviors due to nuclear spin isomerism. The two spin isomers of water—ortho-H₂O (triplet state with parallel nuclear spins) and para-H₂O (singlet state with antiparallel nuclear spins)—have distinct magnetic properties and rotational dynamics. These isomers

influence hydrogen bonding, molecular interactions, and responses to electromagnetic fields.

The discovery of the photomolecular effect, where water undergoes evaporation upon exposure to light without significant thermal input, challenges traditional thermodynamic understanding. This phenomenon is attributed to light-induced transitions between the ortho and para spin states of water molecules, leading to changes in hydrogen bonding and molecular motion.

Furthermore, the Djanibekov effect, observed in rotating bodies exhibiting sudden flips due to asymmetrical mass distribution, finds a parallel in the rotational behavior of ortho-H₂O molecules. These π -turn flips at the molecular level have implications for fluid dynamics and interfacial processes.

Integrating these quantum phenomena with Vernadsky's concept of the noosphere—a stage of Earth's development where human cognition becomes a significant geological force—offers a framework to explore how manipulating water's quantum states can address environmental and industrial challenges.

QUANTUM SPIN DYNAMICS AND ENVIRONMENTAL INTERFACES

The ortho and para isomers of water differ not only in their nuclear spin configurations but also in their physical and chemical behaviors. Ortho-H₂O, being magnetic and rotationally active, tends to reside in icelike cavities such as aquaporins and nanoparticle hydration shells. In contrast, para-H₂O is non-magnetic and stabilizes structured hydrogen-bonded networks.

In liquid water, the ortho/para ratio is approximately 1:1, whereas in vapor, it shifts to about 3:1, indicating a non-equilibrium state that drives metastability. Exposure to polarized light at 532 nm can resonantly excite para-H₂O molecules, inducing transitions to the ortho state. This process releases energy sufficient to disrupt hydrogen bonds, facilitating the photomolecular effect where water evaporates without significant heat input.

Triplet oxygen (O₂), with its unpaired electrons, acts as a catalyst in spin conversion processes, linking atmospheric chemistry to quantum hydrodynamics. The presence of O₂ enhances the efficiency of para-to-ortho transitions, further influencing evaporation rates and interfacial dynamics.

The Djanibekov effect, characterized by sudden flips in rotating bodies due to asymmetrical mass distribution, is mirrored in the behavior of ortho-H₂O molecules. Their asymmetric rotation can lead to π -turn flips, impacting various systems:

Atmospheric Impact: These molecular flips enhance photon absorption at air-water interfaces, influencing cloud condensation nuclei formation and, consequently, weather patterns.

Biological Systems: In erythrocytes, the deformability facilitated by aquaporin-mediated nanofluidics is affected by the rotational dynamics of ortho-H₂O, optimizing oxygen transport.

Industrial Applications: Spin-selective membranes that filter para-H₂O demonstrate efficiency gains in desalination processes by resisting salt ions, attributed to the distinct behaviors of the water isomers.

NOOSPHERIC APPLICATIONS: BRIDGING QUANTUM AND GLOBAL SYSTEMS

The manipulation of water's quantum spin states offers innovative approaches to address environmental challenges:

Climate Regulation via Spin-State Engineering: Ortho-rich vapor increases light scattering, enhancing cloud albedo and potentially reflecting more sunlight to cool the Earth. Conversely, para-H₂O dominates infrared absorption; adjusting atmospheric ratios could modulate greenhouse effects. Such interventions align with Vernadsky's noosphere concept, where human intellect actively shapes Earth's systems.

Sustainable Desalination and Pollution Remediation: Solar-driven membranes utilizing green light at 532 nm can induce para-to-ortho transitions, reducing water viscosity and enhancing evaporation rates in desalination. Additionally, the free rotation of ortho-H₂O disrupts pollutant adhesion, improving the efficiency of nanofluidic filtration systems.

Quantum Hydrology in the Anthropocene: Spin states influence groundwater dynamics; para-dominated layers can trap heavy metals, affecting contaminant transport. Moreover, the rotational behavior of ortho-H₂O inhibits ice formation, suggesting applications in geoengineering to preserve polar ice caps.

PARADOXES AND FUTURE DIRECTIONS

Despite advancements in understanding water's quantum spin dynamics, several paradoxes challenge existing theories and applications:

1. Quantum Viscosity Paradox

Observations indicate that water with a high concentration of ortho-H₂O exhibits unusually low viscosity in nanoscale channels, such as aquaporins or synthetic membranes. This behavior resembles superfluidity, where friction approaches zero. The paradox lies in how macroscopic fluid properties, traditionally governed by classical hydrodynamics, can be significantly altered by quantum nuclear spin states. This raises questions about the existence of a quasi-superfluid phase of water at room temperature, limited to nanoscale environments, and its implications for biological and industrial fluid transport.

2. Hydration Photonics and Nonthermal Crystallization

In biophysics, ortho-H₂O's high rotational freedom and asymmetric magnetic field oscillations may generate ultrafast electromagnetic pulses, termed "hydration photons." These pulses could trigger protein crystallization without freezing or supersaturation, challenging traditional thermodynamic models. If validated, this mechanism could revolutionize nonthermal preservation of biomolecules, enabling cryo-free storage and precise control of biomineralization, while prompting further investigation into quantum coherence in biological systems.

3. Noospheric Ethics of Quantum Climate Engineering

The potential to manipulate global spin-state ratios through technologies like lasers, nanoparticles, or aerosol catalysts introduces ethical considerations. While such interventions could aid in climate regulation, the unintended consequences on weather systems and biological processes are not fully understood. This necessitates the

development of a "noospheric code"—an ethical framework guiding the responsible application of quantum environmental technologies, ensuring that human interventions align with planetary stewardship principles.

CONCLUSION

Water's quantum spin isomers significantly influence environmental and technological systems, from climate dynamics to industrial processes. By harnessing these quantum properties through the lens of Vernadsky's noosphere, humanity can develop sustainable solutions to pressing global challenges. However, the paradoxes identified underscore the need for cautious advancement, ensuring that the manipulation of quantum states serves to heal rather than inadvertently harm our planet.

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