Backed By Bismuth

OFFICIAL WHITEPAPER

2025

PREPARED FOR
$BISM TOKEN HOLDERS

Date: June 22, 2025
Network: Solana Program Library (SPL)
Token: $BISM
Total Supply: 1 Billion

BACKEDBYBISMUTH.COM

DISCLAIMER

The $BISM token is a decentralized digital asset. It is not intended to be an investment and does not confer any ownership, equity, or rights to profits in any company or entity. The $BISM token is not a security and has not been registered with the U.S. Securities and Exchange Commission (SEC) or any other regulatory authority. This token does not represent an offer to buy or sell securities and should not be interpreted as such.

Participation in the $BISM token ecosystem is purely for utility purposes, and holders should not expect profits derived from the efforts of any individual or centralized entity. The $BISM token is not marketed as an investment opportunity, and its value is subject to market forces beyond the control of the issuer.

By purchasing or using $BISM tokens, participants acknowledge that they have reviewed applicable laws and regulations in their jurisdiction and that they are responsible for ensuring compliance. The issuer makes no guarantees regarding regulatory status, legal classification, or potential future changes in the legal landscape.

DISCLAIMER

This Official Whitepaper is for informational purposes only and does not constitute an offer to sell or a solicitation to buy $BISM tokens. Participation in the $BISM presale and ecosystem involves risks, including market volatility, regulatory uncertainty, and technical challenges. $BISM is a digital asset designed to reflect the project's intention to accumulate and maintain physical bismuth reserves. Our goal is to connect digital innovation with tangible metals by using bismuth as a transparent benchmark for the token's economic alignment.

At this time, $BISM is an asset-referenced digital utility token designed to reflect the project's internal bismuth reserve model. While $BISM is inspired by real-world assets, it does not currently grant redemption rights, or any direct legal claim to physical bismuth. The token is not marketed as a security or investment, and its value may fluctuate independently of reserve activity. As the project evolves, additional features may be introduced in compliance with applicable regulations. Please review the Token Terms of Sale, Risk Disclosures, and Privacy Policy at www.backedbybismuth.com when available prior to engaging with $BISM or the Backed By Bismuth platform.

The Backed By Bismuth Vault and it's partial backing does not guarantee $BISM's market value, which remains driven by supply, demand, and ecosystem utility. We aim to expand the reserve with ecosystem growth, reinforcing $BISM's unique position in the crypto landscape

INTRODUCTION

Backed By Bismuth ($BISM) is an innovative SPL cryptocurrency that combines real-world asset backing with crypto market potential. Launched in mid-2025 via the Pump.fun platform (a fair-launch token incubator), $BISM is the first crypto token partially pegged to bismuth metal. Out of a total supply of 1,000,000,000 tokens, a percentage are backed by physical bismuth reserves, providing a partial peg that imparts stability while preserving speculative growth upside. Unlike 1:1 stablecoins pegged fully to assets or fiat, $BISM's model offers a unique hybrid of asset support and free-market pricing. The project's mission is to leverage bismuth's untapped value in emerging technologies (like quantum computing) to create a token that appeals to both retail and institutional investors as a store of value, medium of exchange, and investment in the future of technology metals. Crucially, $BISM is being developed without pursuing formal regulatory compliance at this stage, aiming for broad global accessibility and rapid innovation in the crypto space.

HOW IT STARTED . . .

While studying for his geology class at Carnegie Mellon, Chad saw bismuth for the first time.

Its distinct appearance captured his attention with its vibrant pink hue and elegant structure. He studied the metal and discovered Bismuth's supernatural properties and emerging role in quantum computing hardware.

By chance, he had just given a talk at campus about quantum technology's anticipated effect on society. His analysis featured crypto's obligation to evolve and remain secure in a quantum world.

That's when it became apparent to him: this relatively unknown metal is a hidden gem, far-advanced for its time! It will no longer be limited as artifact of geologic study- it will be the foundation of the quantum revolution.

The paradigm shift from the linear to the non-linear, from bits to qubits, from newtonian mechanics to quantum mechanics: Bismuth is the underlying source.

That's how Backed by Bismuth was born.

We're not just launching a token. We're building a movement grounded in substance and future-readiness. We're inspired by the potential of quantum technology, Inspired by the utility of real-world assets, and the opportunity to create something sustainable and forward-looking in the crypto space.

We're here to build something real - not just ride hype.

This is just the beginning of the Quantum Era. Are you ready to take part?

THE BACKED BY BISMUTH VISION

Backed By Bismuth's vision is to pioneer a new class of crypto assets that blend commodity backing with crypto-native growth. Traditional asset-backed tokens (for example, gold- or silver-backed stablecoins) trade strictly at the value of their underlying asset, with little room for price appreciation. In contrast, $BISM introduces a partially pegged model: a portion of the token's value is anchored by real bismuth reserves (providing a price floor and intrinsic worth), while the majority of its supply floats freely, driven by market demand. This model is distinct from 1:1 stablecoins – $BISM is not pegged to a fixed fiat or metal price, but rather a portion of its supply is collateralized by bismuth metal, giving it a measure of stability without capping its upside.

HEDGED SPECULATIVE ASSET

$BISM's value can rise with crypto market dynamics and growing demand, yet investors have the reassurance that a slice of its supply is backed by a tangible, valuable commodity. This hybrid approach positions $BISM as a hedged speculative asset – one with an inherent safety net and exposure to a potentially booming raw material.

DEMOCRACY

Furthermore, by launching through Pump.fun's fair-launch process, $BISM ensured a democratic distribution with no early-access insiders. Pump.fun's platform allowed anyone to buy in from the moment of creation, meaning "everyone has equal access to buy and sell when the coin is first created". This fair launch ethos aligns with the project's goal of building an engaged, community-driven token from day one.

THE BACKED BY BISMUTH VISION

RWA + SPECULATION

Backed By Bismuth's unique value proposition lies in marrying the trustworthiness of real-world asset backing with the high-growth nature of crypto markets – an approach that could redefine how investors view commodity-pegged cryptocurrencies.

PRIVATE VAULT

Backed By Bismuth has secured a private, state-of-the-art vault at it's headquarters to store bismuth metal reserves that back the token. The presence of an actual commodity reserve provides holders with added confidence. Top holders are even offered private tours to view the bismuth vault, underscoring the team's commitment to transparency and community trust.

PARTIALLY COLLATERALIZED PEG

$BISM's peg is partial and not intended as a direct redemption at all times. Instead, the bismuth reserve acts as a financial backstop and value driver. Importantly, maintaining only a fractional peg frees the majority of $BISM's valuation to be determined by market forces, thus avoiding the rigidity of a full peg. The result is a token that can trade above the implied commodity value (reflecting crypto market sentiment and project growth), while still retaining a baseline intrinsic value linked to bismuth.

WHY BISMUTH?

Bismuth (atomic weight 208.98) is an element often overlooked in mainstream commodities, yet it has unique properties with rising strategic importance. Bismuth's electromagnetic characteristics – including its ability to become highly magnetic under certain conditions – make it attractive for cutting-edge applications in quantum computing and spintronics.

THE BACKED BY BISMUTH VISION

BISMUTH SPECIAL PROPERTIES

Researchers have noted that bismuth can support special electronic states (e.g. conducting on surfaces while insulating in bulk) and plays a role in the next generation of quantum electronic devices. In essence, bismuth is a “hidden gem” – its demand is poised to grow as quantum hardware development accelerates.

BULLISH ON BISMUTH

The Backed By Bismuth team holds a bullish stance on bismuth’s future value, expecting that as the world recognizes bismuth’s role in advanced technology (such as quantum computing chips, topological insulators, and specialized alloys), the price of bismuth will rise. By pegging $BISM partly to bismuth, early adopters of the token are indirectly investing in this bullish commodity thesis.

FLOOR APPRECIATION

Should bismuth prices increase over time, the asset-backed portion of $BISM’s value will also appreciate, further boosting the token’s floor value. This contrasts with stablecoins backed by traditional assets (like USD or gold) which have relatively stable or slow-moving values.

QUANTUM TECH

Bismuth’s real-world utility and scarcity add a strategic dimension to $BISM: holders are not only betting on the crypto project’s success but also on the growing importance of bismuth in the quantum tech economy.

THE $BISM TOKEN

- NETWORK: SOLANA PROGRAM LIBRARY (SPL)
- TICKER: $BISM
- TOTAL SUPPLY: 1 BILLION $BISM
- ICO FAIR LAUNCH VIA PUMP.FUN

TOKEN LOCK

Our allocation strategy balances growth, community engagement, and long-term sustainability:

- 50% of Token supply is locked via streamflow contracts
- The lock is spread amongst 3 wallets comprising 40%, 6%, and 4%
- The Lock is for 18 months and on a biweekly vesting period
- Future lock’s will be promulgated via the telegram and X forums

TECHNICAL ARCITECTURE

TRADING MECHANICS

- Bonding Curve Model: The token uses a linear bonding curve for price discovery, meaning each purchase slightly increases the token price.
- Auto Market Maker: pump.fun uses an internal AMM to facilitate swaps, similar to Uniswap but custom-tailored to Solana’s low-fee environment.
- No Team Allocation: Tokens are distributed entirely through market activity—no tokens are reserved for the project team, which aligns with fair-launch principles.
- Contract Visibility: Verified and available for audit on Solana explorers like Solscan.

INTEROPERABILITY AND INFRASTRUCTURE

- Wallet Support: Compatible with Phantom, Solflare, Backpack, and other Solana-based wallets.
- DEX Integration: The token can be traded on Jupiter, Raydium, and Orca after launch.
- Bridging: Future bridging plans to EVM chains or cross-chain swaps can be implemented via Wormhole or LayerZero.

BISMUTH RESEARCH STUDY

Bismuth (element 83) is emerging as a uniquely valuable element for quantum computing hardware due to its remarkable physical, electronic, and quantum properties. As one of the heaviest stable elements, bismuth exhibits exceptionally strong spin–orbit coupling (SOC), a trait that underlies its involvement in topological quantum materials (science.org) Unlike most heavy metals, bismuth is also environmentally benign – it is the heaviest non-toxic heavy metal (thermofisher.com) – making it attractive for scalable quantum devices. Researchers have long suspected that bismuth belongs to a class of "quantum-ready" materials ideally suited for qubits and spintronics (phys.org). Indeed, ongoing studies are uncovering how bismuth's electronic structure, surface behavior, and spin properties can be harnessed in a range of quantum computing platforms. In this report, we survey bismuth's unique advantages – from its large SOC and topological surface states to its long-lived spin qubits – and examine its roles in superconducting qubits, spin qubits, topological qubits, and other emerging quantum architectures. We blend recent peer-reviewed findings with forward-looking insights, concluding with a perspective on bismuth's strategic importance as a "quantum-era" critical material.

BISMUTH RESEARCH STUDY

Bismuth's fundamental properties set it apart as a quantum material. Its high atomic number confers a strong spin–orbit coupling, which profoundly influences electron band structure. Thanks to this large SOC, bismuth is a key ingredient in several topological phases of matter – for example, the first realized 3D topological insulator was the bismuth–antimony alloy ($Bi_{1-x}Sb_x$) (science.org). Strong SOC causes bismuth-based crystals to support spin-polarized electronic states that are robust against scattering. Notably, bismuth and its compounds can host conductive surface states with Dirac-like dispersion, similar to topological insulators. These surface electrons travel without back-scattering, dissipating minimal heat (news.northeastern.edu). Such behavior makes bismuth-rich materials ideal for low-power, coherence-preserving interconnects in quantum circuits. In fact, theoretical models predict that pure bismuth itself has "hallmark signatures" of a topological insulator – it efficiently conducts electrons on its edges with much less scattering (and heating) than ordinary metals (news.northeastern.edu). Recent work has resolved a long-standing debate about elemental bismuth's topology: the surface of bismuth exhibits topologically conductive behavior that is "masked" over a bulk semimetal that is actually topologically trivial (phys.org). This arises from a spontaneous relaxation of bismuth's rhombohedral crystal structure near the surface, which breaks the usual bulk–surface correspondence (phys.org). Figure 1 illustrates a bismuth crystal; such surface structural effects can induce robust conductive states on the crystal facets despite the non-topological bulk character (phys.org).

BISMUTH RESEARCH STUDY

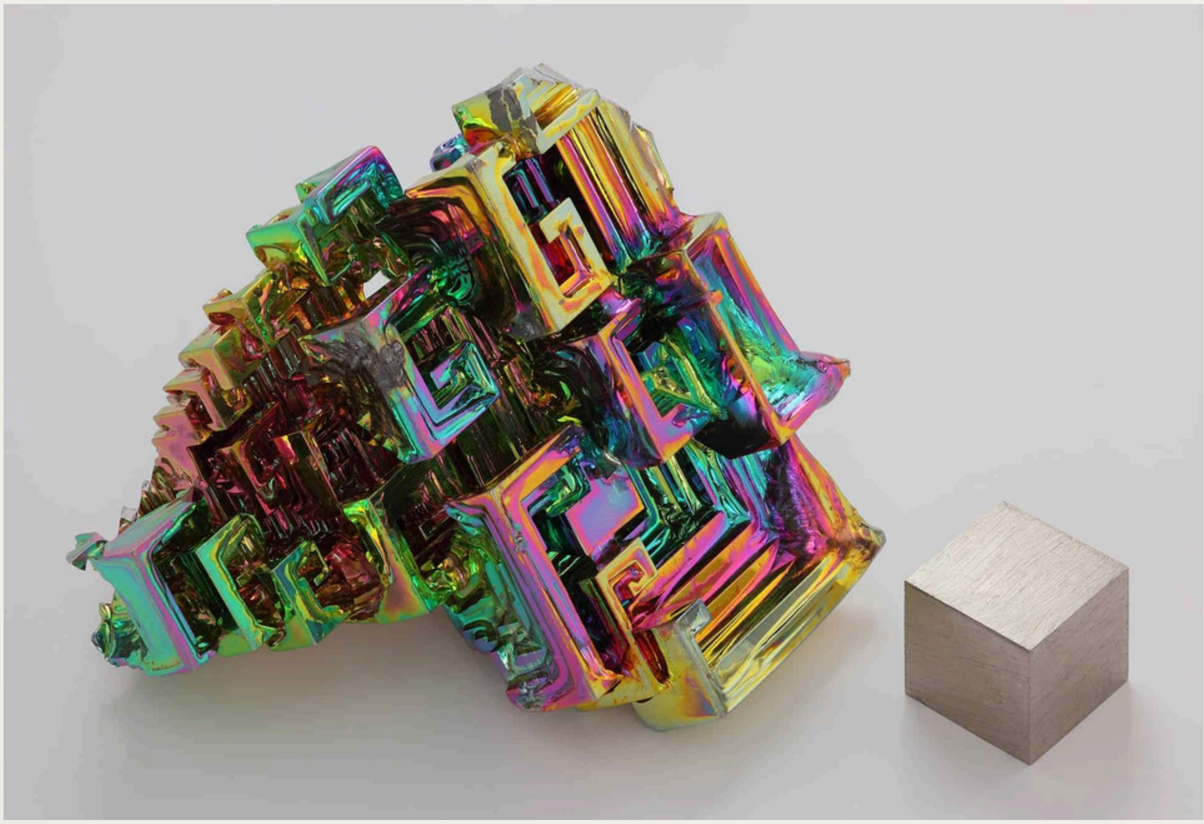

Figure 1

BISMUTH RESEARCH STUDY

Figure 1: Lab-grown bismuth crystal showing its stepped, hopper-like crystal structure. Bismuth's heavy atomic mass and rhombohedral lattice give it extraordinarily large spin–orbit coupling, underpinning exotic surface states. Calculations show that bismuth's surface atomic relaxation can "trick" the material into appearing topologically conductive at the surface while the bulk remains non-topological (phys.org). These robust surface electrons experience minimal back-scattering, a desirable trait for quantum devices (news.northeastern.edu).

Another intrinsic advantage of bismuth is its benign chemistry and low toxicity. Bismuth is often called a "green" metal because it can replace toxic heavy metals like lead in technological applications (thermofisher.comthermofisher.com). It is, in fact, the heaviest element that is not highly toxic (thermofisher.com). This means bismuth-based components can be developed and manufactured with fewer health and environmental concerns compared to materials based on mercury, lead, or arsenic. The push to eliminate lead from electronics has already expanded the market for bismuth as a safe substitute (thermofisher.com). In the context of quantum hardware, bismuth's non-toxicity and compatibility with existing semiconductor processes (e.g. bismuth can be introduced via ion implantation or thin-film growth) make it favorable for large-scale deployment. Additionally, bismuth has only one stable isotope (^209Bi) with a nuclear spin of 9/2, meaning that bismuth impurities in a crystal provide a uniform nuclear spin environment without the complication of multiple isotopes – a useful feature for reproducible qubit behavior.

BISMUTH RESEARCH STUDY

Finally, bismuth displays intriguing quantum magnetism and coherence properties. It is highly diamagnetic and has a very small carrier density as a semimetal, leading to long electron de Broglie wavelengths and quantum oscillations observable even at modest fields and nanoscales (ccam.uci.edu). Bismuth dopant atoms in silicon possess a large hyperfine interaction (≈1.475 GHz) and multiple spin states, which as we discuss later, can be leveraged for long-lived quantum bits. In summary, bismuth's combination of strong SOC, topologically enabled surface conduction, single-isotope nuclear spin, and chemical benignity provide a rare confluence of attributes ideal for quantum technology.

BISMUTH RESEARCH STUDY

Superconducting qubits – such as the transmons and flux qubits used by IBM, Google and others – form the backbone of today's quantum computers. These qubits rely on superconductors (often aluminum or niobium circuits) operating at millikelvin temperatures. Although elemental bismuth is not a superconductor at ambient conditions, it plays important roles in superconducting quantum hardware through its presence in superconducting compounds and in hybrid designs. A prime example is the family of bismuth-based high-temperature superconductors. Bismuth strontium calcium copper oxide (BSCCO) is a cuprate superconductor that contains bismuth and can carry lossless currents up to ~90 K. While high-T_c cuprates are not yet used as qubit materials (due to noise and integration challenges), they offer tantalizing possibilities for future quantum hardware that operates at higher temperatures. In a landmark 2013 experiment, researchers interfaced the topological insulator bismuth selenide (Bi_2Se_3) with a BSCCO high-T_c superconductor and induced superconductivity in Bi_2Se_3's surface states up to the high transition temperature of BSCCO (phys.org) (phys.org). This created a superconducting topological surface with a large energy gap, opening the door to achieving Majorana zero modes – exotic quasiparticles that could serve as qubits immune to decoherence (phys.org)(phys.org). Inducing superconductivity on a bismuth-based topological layer at elevated temperatures was an important step towards fault-tolerant quantum computing, since Majorana-based qubits require superconductivity but would ideally operate above millikelvin temperatures (phys.org) (phys.org). Thus, bismuth's presence in high-T_c superconductors and topological insulators has enabled hybrid platforms (e.g. Bi_2Se_3/BSCCO heterostructures) where robust superconducting qubits might function with greater thermal headroom. While still experimental, these bismuth-linked heterostructures suggest a path to topologically protected superconducting qubits that can work at relatively higher temperatures (phys.org).

BISMUTH RESEARCH STUDY

Bismuth also features in intrinsic superconductors that are of interest for quantum computing. A notable case is β-bismuth palladium (β-Bi_2Pd), a binary superconductor (T_c ≈ 5.4 K) discovered in the 1950s. Decades later, β-Bi_2Pd was found to harbor topologically non-trivial surface bands coexisting with s-wave superconductivity (phys.org). In 2017, Qi-Kun Xue and colleagues grew epitaxial films of β-Bi_2Pd and found compelling evidence of topological superconductivity in this material (phys.org). Tunneling spectra showed two superconducting gaps (one from the bulk and an larger one from the surface states), and most strikingly, scanning tunneling microscopy detected zero-bias peaks at the centers of magnetic vortices – a hallmark of Majorana zero modes bound in the vortex cores (phys.org) (phys.org). These results establish β-Bi_2Pd (a bismuth-containing superconductor) as a promising topological superconductor hosting Majorana quasiparticles (phys.org) (phys.org). Majorana modes in such a system obey non-Abelian statistics and could be braided to encode qubits with built-in fault tolerance (phys.org). From a hardware perspective, a β-Bi_2Pd thin film could function as a superconducting qubit element (for example, as a Josephson junction electrode or a qubit island) where the quantum information is stored non-locally in Majorana pairs, making it inherently robust to local noise. The advantage of bismuth here is two-fold: its heavy atoms provide the SOC needed for topological states, and its inclusion in a stable superconducting compound like Bi_2Pd yields a material that, by itself, realizes the coveted Majorana-carrying phase (phys.org) (phys.org). Looking ahead, continued materials engineering of bismuth-based superconductors (including ternary compounds like $PdBi_2Te_4$ (nature.com) may produce superconducting qubit networks that operate via topologically protected currents. Such systems could drastically reduce error rates by encoding qubits in the exotic quasiparticles that bismuth's electronic structure helps to generate.

BISMUTH RESEARCH STUDY

Beyond materials science, bismuth contributes to superconducting qubit architectures through hybrid quantum circuits. One innovative approach uses bismuth donor spins as auxiliary quantum memories that interface with superconducting qubits. Superconducting qubits are fast and controllable, but they suffer from relatively short coherence times (typically microseconds to milliseconds). In contrast, certain impurity spins in solids can retain quantum information for seconds. Bismuth donors in silicon are a prime example – these spins have demonstrated exceptionally long coherence, storing quantum states for over one second under the right conditions (physics.aps.org). However, single spins are hard to couple and manipulate in a circuit. To bridge this gap, researchers have successfully coupled bismuth donor spins to superconducting devices. In a recent demonstration, a single bismuth donor in silicon was coherently linked to a superconducting flux qubit acting as a "quantum bus" (arxiv.org). The flux qubit's superconducting loop could transfer quantum information to and from the bismuth spin, effectively entangling the spin with the circuit (arxiv.org). This allowed distant Bi donor qubits to be connected on-demand via the superconducting mediator, all while the donor's long-lived coherence was preserved (arxiv.org).

BISMUTH RESEARCH STUDY

Such hybrid architectures marry the best of both worlds: the long memory of bismuth spin qubits and the fast logic of superconducting qubits (arxiv.org). Another team built a prototype quantum random-access memory (qRAM) device by embedding an ensemble of bismuth atoms in a superconducting microwave resonator (physics.aps.org). They showed that weak microwave pulses (representing quantum bits of information) could be absorbed by the Bi spins and later retrieved with minimal degradation (physics.aps.org). The bismuth spin ensemble served as a multi-mode quantum storage element, capable of storing multiple qubit states simultaneously in its many spin degrees of freedom (physics.aps.org) (physics.aps.org). This experiment achieved the essential features of a quantum RAM – the ability to write and read quantum states in arbitrary order – with bismuth-based memory nodes (physics.aps.org). These examples underscore bismuth's versatility in superconducting qubit systems: it can act as a quantum memory medium that interfaces naturally with the microwave photons used in superconducting quantum processors. The low toxicity and solid-state compatibility of bismuth donors make it feasible to integrate them into chip fabrication. In summary, whether through enabling high-T_c Majorana platforms or hybrid quantum memories, bismuth is proving to be an invaluable asset in advancing superconducting qubit technology.

BISMUTH RESEARCH STUDY

Among solid-state spin qubits, bismuth has achieved distinction by enabling some of the longest-lived qubits ever demonstrated. In particular, bismuth donor atoms in silicon form highly coherent two-level systems that are being actively explored as qubits and quantum memories. When a bismuth atom substitutes for a silicon atom in a crystal, it brings an extra electron that can serve as an electron-spin qubit (phys.org). The bismuth nucleus itself (with spin $I=9/2$) provides a second, coupled qubit – a nuclear spin that is magnetically connected to the electron spin via a strong hyperfine interaction (phys.org). Dr. Gavin Morley and colleagues demonstrated in 2012 that these electron and nuclear spins of Bi in silicon can be “hybridized” and controlled together as a pair of dance partners (phys.org) (phys.org). At certain magnetic fields, the electron and nucleus become entangled into mixed spin states, such that applying a microwave pulse flips both spins in unison (phys.org). This hybrid electron-nuclear qubit is easier to control than a lone nuclear spin (which responds only to slower radio-frequency pulses) yet retains the nucleus’s robustness against decoherence (phys.org) (phys.org). Essentially, the bismuth donor hosts an integrated two-qubit register: a fast but short-lived electron spin qubit directly coupled to a slow but long-lived nuclear spin qubit (phys.org) (phys.org). By flipping the two spins synchronously or swapping states between them, researchers can leverage the best attributes of each – using the electron spin for rapid operations and the nuclear spin as a stable memory. This strategy was validated in a Nature Materials experiment, where microwave pulses cleanly manipulated the Bi electron+nucleus system, significantly simplifying quantum control in a silicon qubit device (phys.org). The bismuth donor thus acts as a high-performance “dual qubit”: one physical dopant provides multiple logical qubits or a qubit with built-in error protection via its nuclear spin.

BISMUTH RESEARCH STUDY

Beyond this two-qubit capability, bismuth donors in Si are remarkable for their exceptional coherence times. In isotopically purified ^{28}Si (with no background nuclear spins), the Bi donor electron spin can maintain quantum superposition for on the order of a second, and the nuclear spin for minutes, when using magnetic fields that exploit so-called “clock transitions” (physics.aps.org). Even at millikelvin temperatures in natural silicon, coherence times T_2 > 1 second have been observed for Bi donor spins (physics.aps.org). These coherence times are five to six orders of magnitude longer than those of typical superconducting qubits, highlighting the quantum memory potential of Bi-based spins (physics.aps.org). The long-lived nature of bismuth qubits stems from several factors: the nuclear spin is relatively isolated from environmental noise, the large hyperfine splitting allows working at field-frequency sweet spots that are insensitive to fluctuations, and the absence of nearby magnetic isotopes in purified silicon removes the main decoherence mechanism. As a result, a Bi dopant in silicon can serve as a quasi-permanent storage of quantum information – a true solid-state quantum memory that can be written and read by coupling it (via magnetic resonance techniques or via a superconducting resonator) to the rest of a quantum computer (physics.aps.org) (physics.aps.org). Recent experiments have capitalized on this by integrating Bi donor ensembles with superconducting microwave circuits, demonstrating on-demand writing and retrieval of multiple qubit states from the spin ensemble memory (physics.aps.org) (physics.aps.org). In effect, a small crystal enriched with bismuth dopants can function analogously to a multi-qubit RAM module, storing quantum bits in the collective spin excitations of the Bi atoms (physics.aps.org).

BISMUTH RESEARCH STUDY

Another attractive feature of bismuth spin qubits is their interface-ability and readout. Because bismuth donors have a huge hyperfine splitting (~7.5 GHz between the electron spin states in zero field), their electron spin transitions can be tuned into the microwave frequency range used by superconducting qubit circuits (phys.org) (phys.org). This means bismuth spin flips can be directly driven by microwave photons and can exchange energy with superconducting resonators or qubits at resonance. Indeed, the strong coupling regime between an individual Bi spin and a superconducting cavity has been reached, fulfilling the criteria for coherent information transfer (arxiv.org). For readout, one can use dispersive coupling to a resonator or capitalize on the electron's interaction with nearby charge sensors. The large magnetic moment of the Bi electron spin (being a bound electron) means it can also be detected via electron spin resonance techniques with high single-spin sensitivity. Meanwhile, the nuclear spin of bismuth can be read out by swapping its state onto the electron (a process made easier by the hybridization tricks mentioned above) and then detecting the electron. These capabilities point toward using bismuth dopants as quantum nodes in a network: they can store quantum states for long durations, interface with superconducting photon "flying qubits," and even host multiple qubits in one atom.

BISMUTH RESEARCH STUDY

Such versatility is rare. Competing spin qubit systems (like phosphorus donors in Si or color centers in diamond) offer some of these features but not all – for instance, P in Si has only a $I=1/2$ nuclear spin (one qubit per atom) and a smaller hyperfine splitting (~117 MHz), whereas bismuth's $I=9/2$ and giant hyperfine splitting allow multi-level control and microwave integration (phys.org) (phys.org). The downside of bismuth donors is that their larger nuclear spin could potentially be more sensitive to electric field noise (electric quadrupole effects), but experimental results so far indicate that coherence remains robust, especially at clock transitions. In summary, bismuth-based spin qubits represent one of the most coherent and connectable qubit implementations known. They fill an important niche as quantum memories and intermediate processors that can bridge solid-state quantum processors with long-lived storage. As quantum computing architectures mature, we may see bismuth spin qubits used as memory banks or backup qubits – for example, buffering quantum information during communication or acting as a quantum cache for a superconducting processor (physics.aps.org) (physics.aps.org). The continued research into donor qubits in silicon (often dubbed "hot silicon" for quantum) places bismuth at the forefront of materials enabling ultra-high coherence in solid-state systems.

BISMUTH RESEARCH STUDY

One of the most radical approaches to quantum computation is to encode information in topologically protected states, which are immune to local disturbances by virtue of global properties of the system. Bismuth is a crucial player in the quest to realize such topological qubits. The central idea is to exploit materials with strong spin–orbit coupling and non-trivial band topology to host Majorana fermions or other exotic quasiparticles that can serve as qubits. Majorana zero modes, in particular, are their own antiparticles bound to defects (like vortices or wire ends) and can be used to store quantum information non-locally, providing built-in error protection (phys.org) (phys.org). Bismuth-based materials have emerged as leading platforms for engineering these states.

BISMUTH RESEARCH STUDY

Topological insulators (TIs) – materials that insulate in the bulk but conduct on the surface via spin-helical edge states – rely on heavy elements like bismuth to achieve the required band inversion and strong SOC. Indeed, several prototypical TIs are bismuth compounds: bismuth selenide (Bi_2Se_3) and bismuth telluride (Bi_2Te_3) are well-studied three-dimensional TIs with single Dirac-cone surface bands (numberanalytics.com). These materials exhibit "high levels of topological protection" on their surfaces (numberanalytics.com), meaning the surface electrons have locked spin-momentum textures that forbid back-scattering off non-magnetic disorder. For quantum computing, such surface states can be used to carry currents or even as qubit states if one can induce superconductivity in them. Bismuth's large SOC is essential here – it ensures a strong separation between surface and bulk states and opens substantial bulk bandgaps (e.g. Bi_2Se_3 has a ~0.3 eV gap (sciencedirect.com) so that the topological surface state is well isolated. These Bi-based TIs are not just theoretical curiosities; they are central to topological quantum computing proposals. For example, by depositing an ordinary s-wave superconductor onto the surface of Bi_2Se_3 or Bi_2Te_3, one can induce superconducting pairing in the topological surface state via the proximity effect. This creates a so-called topological superconductor at the interface, which is expected to host Majorana zero modes at its boundaries or vortex cores (phys.org) (phys.org). The 2013 experiment with Bi_2Se_3 and BSCCO discussed earlier was a prime demonstration of this: a d-wave high-T_c superconductor induced a full superconducting gap in the Dirac surface state of Bi_2Se_3, and the observed gap magnitude and behavior strongly suggested that Majorana-carrying states would appear in the presence of magnetic vortices (phys.org) (phys.org). In that study, the researchers noted that their $Bi_2Se_3/Bi_2Sr_2CaCu_2O_8$ heterostructure has an order-of-magnitude larger superconducting gap (and higher operative temperature) than previous attempts, making it a superior platform to search for Majorana zero modes (phys.org).

BISMUTH RESEARCH STUDY

In parallel, bismuth-rich superconductors like β-Bi_2Pd provide an "all-in-one" route to topological qubits. As described, β-Bi_2Pd naturally combines superconductivity with a topologically non-trivial band structure (phys.org) (phys.org). When thinned and tuned, its surface hosts Majorana modes at vortices without the need for an external superconducting layer (phys.org). This is exciting because it implies a material platform for Majorana qubits that is chemically uniform and perhaps easier to fabricate into devices (e.g. thin films, junctions) than a complex heterostructure. Researchers have already achieved the visualization of these Majorana candidates in β-Bi_2Pd (phys.org) (phys.org). If each vortex in a β-Bi_2Pd device traps a stable Majorana mode, one can conceive of encoding qubits in pairs of such modes and performing logic operations by moving (braiding) the vortices – a foundation of topological quantum computing (phys.org). The non-Abelian statistics of Majoranas mean that swapping two vortices effects a quantum gate operation that is intrinsically fault-tolerant at the hardware level (phys.org). While fully braiding Majoranas remains an experimental challenge, having material systems like bismuth palladium where these quasiparticles naturally arise is a big step forward.

BISMUTH RESEARCH STUDY

Beyond Majoranas, bismuth's physics may enable other exotic states relevant to quantum computing. For instance, quantum spin Hall (QSH) insulators – the 2D cousins of 3D TIs – have been realized in bismuth-based systems. Monolayer bismuth (sometimes called "bismuthene") on a substrate has been proposed as a high-temperature QSH insulator with a bandgap on the order of 0.8 eV, vastly larger than earlier QSH materials (advanced.onlinelibrary.wiley.com). If experimentally realized, such a room-temperature QSH system would carry dissipationless spin currents on its edges, potentially useful for spin-based logic or as interconnects in a quantum computer (imagine directing spins between qubits along edges that don't back-scatter). Bismuth is also a component in certain topological crystalline insulators and higher-order topological materials, which might host more complex quasiparticles like Majorana corner modes or fractional fermions. Its strong SOC has been cited as an enabler for spin–orbit torque devices and spintronic elements that could interface with quantum processors (link.aps.org). For example, a bismuth selenide layer can convert a spin current to a charge voltage very efficiently (via the inverse spin Hall effect) (link.aps.org). This could be harnessed to read out the state of a spin qubit or to generate spin-polarized currents for initializations, bridging conventional electronics with quantum spins.

BISMUTH RESEARCH STUDY

In summary, bismuth's role in topological qubits is indispensable. It provides the materials platform (TIs and TSCs) for creating and manipulating Majorana modes – the linchpins of topological quantum computing. Thanks to bismuth, we have candidate systems where qubits are not simple two-level systems but rather delocalized quasiparticles protected by topology. These bismuth-enabled qubits promise orders of magnitude improvement in coherence (since, in theory, local noise cannot easily flip or decohere a qubit encoded in a pair of Majoranas). Although a full topological quantum computer has yet to be realized, each experimental milestone – from Bi-based heterostructures with induced superconductivity (phys.org) to detecting Majorana-like signals in Bi_2Pd (phys.org) – reinforces the view that bismuth is a key to unlocking this approach. As research progresses, we may see bismuth selenide or bismuth telluride nanostructures incorporated into qubit chips, perhaps as part of a "Majorana transmon" where a Josephson junction is replaced by a bismuth topological insulator hosting Majorana modes. In such a device, the qubit's logical states could correspond to different parity configurations of Majorana pairs, combining the advantages of superconducting circuits with topological protection. All of these developments underscore the versatility of bismuth: it is one of the rare elements that is contributing to three very different qubit paradigms – superconducting charge/flux qubits (via materials and memory integration), spin qubits (via donor spins), and topological qubits (via Majorana modes).

BISMUTH RESEARCH STUDY

Considering the breadth of applications discussed, bismuth clearly stands out as a strategic element for the quantum computing era. Its multifaceted contributions – enabling long-lived spin memories, high-speed superconducting circuits, and topologically protected qubits – make it a linchpin material in current research and future quantum technologies. We can draw an analogy to how silicon was the cornerstone of the classical computing revolution; bismuth, in its own way, may become a cornerstone of quantum hardware. As quantum computers advance from laboratory prototypes to practical machines, certain elements and materials will become "quantum-critical" resources. Bismuth's unique properties position it as one such quantum-critical metal. It is already being recognized for its suitability in quantum applications (phys.org), and governments and industries might soon list bismuth alongside other critical materials (like indium or rare earths) whose supply and demand need monitoring for high-tech development.

One reason for this is that bismuth is largely obtained as a byproduct of lead and zinc mining (thermofisher.com). If quantum technologies create new demand for ultra-pure bismuth (for example, in bismuth-based topological insulator substrates, bismuth-doped silicon chips, or superconducting alloys), the supply chains may need adaptation to ensure availability of high-quality bismuth at scale. Fortunately, bismuth's increasing use in green technologies (as a lead replacement in solders, brass, etc.) has already spurred interest in it as an "environmentally friendly" metal (thermofisher.comthermofisher.com). This means production and refining capacities are likely to grow, and techniques for producing ultra-high purity bismuth (needed for semiconductor and qubit applications) will become more mature. The relatively low toxicity of bismuth also means we can more easily recycle and handle it during device fabrication, which is important for sustainable manufacturing of quantum hardware.

BISMUTH RESEARCH STUDY

From a technical perspective, the ongoing research directions involving bismuth point to its expanding role. In superconducting qubits, we anticipate further integration of bismuth-based materials to improve coherence and connectivity – for instance, using bismuth selenide as a wiring layer that provides low-loss, non-dissipative microwave channels on a chip, or incorporating bismuth ions in circuit elements to reduce two-level system defects (bismuth's filled $6s^2$ shell might help passivate surfaces). In spin qubits, there is active work on coupling bismuth donor spins to photonic interfaces, aiming for quantum repeaters: the long-lived Bi spin could store entanglement until an optical photon (perhaps via a telecom-frequency transition in a Bi-doped crystal) transmits it. The demonstrated quantum memory using bismuth impurity ensembles (physics.aps.org) (physics.aps.org) could evolve into quantum buffer units in larger processors, which require critical materials (like isotopically enriched silicon and bismuth sources) to produce. And in topological quantum computing, if and when Majorana qubits become functional, bismuth-containing components (such as Bi_2Te_3 thin films, Bi-nanowire networks, or Bi superconductors) will be fundamental building blocks. It is telling that many major Microsoft Quantum labs and academic consortia working on topological qubits frequently utilize bismuth-chalcogenide materials in their device recipes – a clear sign of bismuth's importance.

BISMUTH RESEARCH STUDY

From a technical perspective, the ongoing research directions involving bismuth point to its expanding role. In superconducting qubits, we anticipate further integration of bismuth-based materials to improve coherence and connectivity – for instance, using bismuth selenide as a wiring layer that provides low-loss, non-dissipative microwave channels on a chip, or incorporating bismuth ions in circuit elements to reduce two-level system defects (bismuth's filled $6s^2$ shell might help passivate surfaces). In spin qubits, there is active work on coupling bismuth donor spins to photonic interfaces, aiming for quantum repeaters: the long-lived Bi spin could store entanglement until an optical photon (perhaps via a telecom-frequency transition in a Bi-doped crystal) transmits it. The demonstrated quantum memory using bismuth impurity ensembles (physics.aps.org) (physics.aps.org) could evolve into quantum buffer units in larger processors, which require critical materials (like isotopically enriched silicon and bismuth sources) to produce. And in topological quantum computing, if and when Majorana qubits become functional, bismuth-containing components (such as Bi_2Te_3 thin films, Bi-nanowire networks, or Bi superconductors) will be fundamental building blocks. It is telling that many major Microsoft Quantum labs and academic consortia working on topological qubits frequently utilize bismuth-chalcogenide materials in their device recipes – a clear sign of bismuth's importance.

BISMUTH RESEARCH STUDY

In conclusion, bismuth's strategic value for quantum technology lies in its rare ability to blend properties that advance coherence, control, and protection of quantum bits. It provides heavy-element physics (SOC, band inversion) without the usual drawback of toxicity, and it is adaptable to both semiconductor and superconductor platforms. As the quantum computing industry matures, the demand for such enabling materials will sharply increase. We foresee bismuth being regarded as a "quantum-era critical metal," much like lithium is critical for batteries or silicon for classical chips. Its availability and refinement could become factors in the supply chain for quantum hardware. The good news is that science is continually uncovering new ways to exploit bismuth – from novel thin-film growth methods for ultra-thin crystals (azom.com) to new bismuth compounds with engineered properties. Each discovery reinforces the notion that bismuth, long an "overlooked" element in electronics, is now a key to unlocking robust and scalable quantum computers. With its unique combination of quantum-friendly attributes – low toxicity, strong spin–orbit coupling, topological surface states, long-lived spins, and compatibility with superconductors – bismuth is poised to play a foundational role in the next revolution of computing. The element famed for its colorful crystal symmetry may indeed help bring about the colorfully complex quantum processors of the future, making it as vital to quantum information science as it has quietly been to topological materials science (phys.org).

BISMUTH RESEARCH STUDY

Sources:

1. Fuseya Y. et al., “Topological blocking at the Bi(111) surface due to surface relaxation,” Phys. Rev. B 111, L201303 (2025) – via Kobe University/Phys.org (phys.orgphys.org).
2. Jarryd Pla, “Chirping toward a Quantum RAM,” APS Physics 15, 168 (2022) – Overview of quantum memory using bismuth in silicon (physics.aps.orgphysics.aps.org).
3. Morley G. W. et al., “Quantum control of hybrid nuclear–electronic qubits,” Nature Mater. 12, 103 (2013) – Demonstration of coupled Bi electron and nuclear spin qubits in silicon (phys.orgphys.org).
4. Chang T. et al., “Strong coupling of a superconducting flux qubit to single bismuth donors,” arXiv:2411.02852 (2024) – Hybrid circuit linking Bi donor spins with a flux qubit (arxiv.org).
5. Fedorov A. et al., “Fully gapped topological surface states in Bi_2Se_3 induced by a d-wave high temperature superconductor,” Nature Phys. 10, 857 (2014) – High-T_c superconductivity induced in bismuth selenide, suggesting Majorana modes (phys.orgphys.org).
6. Lv Y. et al., “Experimental signature of topological superconductivity and Majorana zero modes on β-Bi_2Pd thin films,” Science Bulletin 62, 852 (2017) – Evidence of Majorana zero modes in a bismuth palladium superconductor (phys.orgphys.org).
7. NumberAnalytics Blog, “Advancements in Topological Quantum Computing” (June 2025) – Summary of topological qubit developments, noting Bi_2Se_3 and Bi_2Te_3 as key materials (numberanalytics.com).
8. Thermo Fisher Scientific, “Bismuth – The Heaviest Among Heavy Metals” (2016) – Notes bismuth’s status as a non-toxic heavy metal and growing industrial use (thermofisher.comthermofisher.com).
9. Northeastern Univ. News, “This exotic crystal is fueling the quantum revolution” (2019) – Discussion of bismuth’s topological properties and low-scattering surface conduction (news.northeastern.edunews.northeastern.edu).

MEET OUR TEAM

CHAD P. GUZZI

— Chief Executive Officer / Founder

Chad Guzzi graduated from Carnegie Mellon with a degree in Finance and Decision Science and is currently studying Technology Law with a focus on crypto at Northeastern Law. He serves as a blockchain expert on the NLU Global Initiative. Additionally, he was honored as a Kentucky Colonel by Governor Beshear and The Honorable Order for his public service contributions.

BRANDON L. SANCHEZ

— Chief Crypto Advocate

Brandon co-founded Blockchain@USC, a group supported by a16z, Optimism, VanEck, and USC. He was the first to graduate with an accredited blockchain minor while launching a food truck business. After graduating, he worked at several crypto startups and at Bakkt, a publicly traded crypto firm. He now leads Encrypto.fun, a crypto payments company issuing debit and credit cards.

ZACHARY G. GLADSTEIN

— Chief Financial Officer

Zachary Gladstein studied Finance at Carnegie Mellon University, where he developed a strong foundation in markets and investment strategy. He began his career at Goldman Sachs and still currently works in the financial industry.

MEET OUR TEAM

JACK KELLY

— Senior Marketing Manager

Experienced community and social media manager in the Web3 space, currently managing the Wanderers NFT community. Active mod across multiple Discord servers and deeply involved in the crypto industry for over a decade.

2025

GET IN TOUCH

Connect with us at support@backedbybismuth.com, BackdByBismuth.com or follow us on Instagram, Facebook, X, and LinkedIn for the latest updates.

BACKEDBYBISMUTH

BACKEDBYBISMUTH

BACKEDBYBISMUTH

BACKEDBYBISMUTH