

PHYSICOMETRIC AUTHENTICATION FACTORS

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Abstract

Authentication of high-value cultural heritage objects relies primarily on legacy empirical frameworks developed prior to modern statistical decision theory, digital identity management, and multi-factor authentication (MFA) [9]. While conservation science provides diverse analytical techniques to evaluate material, structural, and chemical properties [3-5], these investigations typically operate as independent silos rather than components of a unified identity framework. Consequently, combining provenance, connoisseurship, and scientific analysis into a coherent protocol with quantifiable confidence levels remains an unaddressed challenge. This paper reformulates cultural heritage authentication as a statistical identity problem. Building on standards-based hyperspectral authentication and physical multi-factor frameworks [12,13], we formalize a new class of authentication factors called physicometric factors, defined as the measurement and statistical characterization of invariant physical properties of inanimate objects. These stable descriptors arise from an object's material composition, structural organization, fabrication history, and physical response to controlled interrogation. Examples include spectral reflectance, micro-topographic surface structure, chemical signatures, refractive index transitions, and fabrication-derived entropy patterns [3-5,10,11]. To implement this framework, we introduce OMASIE (Optical Multiscale Aperture Synthesizing Invariant Extractor), an architecture employing structured illumination, coded apertures, and computational reconstruction to translate object responses [12-15] into high-dimensional identity vectors suitable for statistical comparison. This methodology resolves measurement degeneracy, including metamerism and related ambiguities [1,2,10,11], through dimensional expansion, covariance-aware evidence fusion, and identity vector comparison [7,8]. Beyond immediate verification, aggregating these physical identity vectors establishes a structured knowledge base to support retrospective scholarship, workshop attribution, and conservation monitoring

1. Motivation

1.1 Introduction The cultural heritage community faces a fundamental paradox: while the monetary and scholarly value of important cultural objects continues to escalate, confidence in the methodologies used to authenticate them remains difficult to quantify. High-value masterpieces, historical manuscripts, and archaeological artifacts routinely command multi-million-dollar valuations. These attribution decisions dictate museum acquisitions, legal proceedings, insurance liabilities, and historical scholarship. Yet, the evidentiary frameworks underlying these decisions remain fragmented, subjective, and difficult to reproduce.

This landscape contrasts sharply with identity verification paradigms deployed in other critical domains. Financial

networks, secure enterprise computing, and national border systems routinely minimize false acceptance rates by deploying multi-layered authentication architectures. These systems combine independent evidence channels spanning possession, knowledge, and biometrics [6,9]. Conversely, cultural heritage authentication has lagged behind this transition. Although sophisticated scientific instrumentation is widely accessible, its deployment remains secondary or reactive—commissioned to support or challenge preexisting connoisseurship claims rather than serving as foundational infrastructure within a formal statistical architecture.

This analytical deficit is particularly stark given the rapid technological expansion of conservation science over the past half-century. Modalities such as hyperspectral imaging, Raman spectroscopy, X-ray fluorescence (XRF), infrared reflectography (IRR), and optical coherence tomography (OCT) provide unprecedented physical insight [3-5,14,15]. These technologies have dramatically expanded the volume of measurable data available to researchers. What has not expanded at the same pace is the theoretical framework required to interpret this high-dimensional information in the specific context of authentication.

Modern identity systems, physical or digital, depend upon characteristics that uniquely distinguish one entity from another. While instrumentation differs across domains, the underlying objective remains constant: identity must be established through the precise measurement and comparison of distinguishing characteristics. The central challenge confronting cultural heritage authentication is not a lack of scientific instrumentation, but a lack of a systematic framework to determine which physical features reliably encode identity and how to mathematically synthesize them.

This investigation builds on previous research demonstrating that standards-based color science and hyperspectral imaging provide an objective baseline for authentication [3,4,10-12]. While powerful, pure spectral profiles capture only a single dimension of physical reality. Subsequent work addressed this limitation by borrowing multi-factor authentication (MFA) principles from information security [9,13], proposing that combining independent evidence channels minimizes ambiguity. However, deploying an effective physical MFA architecture requires answering a deeper question: what specific physical characteristics are capable of functioning as reliable authentication factors? Formalizing this foundational category of descriptors is the primary motivation of this paper.

1.2 The Physicometric Need

Developing an object identity framework requires a critical distinction between observation and identity. Standard analytical instruments capture discrete observations: cameras record reflected light, spectrometers resolve wavelength intensities, and surface profilers map micro-geometry. While each tool generates rich datasets, not all observations possess equal utility for identity verification. True identity tracking requires physical traits that remain highly stable over relevant, multi-century timescales. A transient surface contaminant or environmental dust layer is highly observable but holds zero identity value. Conversely, a stochastic structural pattern embedded during an object's fabrication persists indefinitely, offering robust identity verification.

Historically, conservation science has lacked a unifying discipline and vocabulary to isolate and evaluate these invariant physical traits as formal authentication factors. Discussions typically separate chemical, spectral, or structural analysis without organizing them under a singular identity framework. To address this structural gap, we propose the term *physicometrics*: the measurement and statistical characterization of invariant physical properties of inanimate objects. Physicometrics shifts the analytical focus from aesthetic interpretation or isolated material analysis to the systematic extraction of stable, unique descriptors that mathematically define an object's distinct identity.

The conceptual analogy to biometrics is deliberate. Human biometrics relies on fingerprints, iris patterns, and facial geometry because these traits exhibit exceptional stability, measurability, and discriminative power [6]. Physicometrics translates this methodology to inanimate objects, replacing biological attributes with fabrication histories, material boundaries, spectral responses, and microscopic topographies. Current authentication practices frequently evaluate traits simply because they are easily observable, such as a prominent signature or a documented provenance trail. Physicometrics reverses this paradigm, starting from the mathematical requirements of identity to determine which physical characteristics are sufficiently invariant, discriminative, and reproducible to serve as definitive authentication factors.

Under this rigorous framework, spectral responses, surface topographies, chemical compositions, and fabrication-derived microstructures cease to be isolated datasets; they become formal candidate dimensions within a high-dimensional identity space. This conceptual shift positions factor discovery as a systematic scientific pursuit, opening up applications across advanced manufacturing, forensic verification, supply chain security, and materials research. Cultural heritage provides an ideal foundational proving ground due to its unique combination of extreme asset values, scarce ground truth, and fragmented evidence streams. Formalizing physicometric factors thus establishes a broader measurement discipline centered on objective physical identity.

2. Problem

2.1 Current Authentication Paradigms

Authentication of cultural heritage objects has historically evolved through the accumulation of empirical practices rather than through the development of a unified theory of object identity. Contemporary authentication methodologies consist of several distinct evidentiary traditions, each possessing assumptions regarding what constitutes proof of authenticity.

The first tradition is provenance, which attempts to establish authenticity through documentary continuity. Ownership records, auction catalogs, correspondence, inventory lists, collection records, exhibition histories, customs documents, and other historical materials are assembled to create a chain of custody linking an object to its origin. When complete and reliable, provenance can provide powerful contextual evidence. Its value is constrained by the quality of surviving documentation, which may be incomplete, lost, forged, altered, or misinterpreted. Gaps exist throughout the historical record due to political upheaval, theft, migration, and neglect. More fundamentally, provenance describes the history surrounding an object rather than the object itself. It represents external evidence, providing information about ownership and movement while contributing little direct data regarding the physical identity of the object under examination.

The second tradition relies upon markings. Signatures, seals, stamps, labels, workshop marks, foundry marks, inscriptions, and collection numbers are examined for evidence of origin. Such markings can provide clues regarding authorship, workshop practices, ownership history, or geographic origin. Yet markings possess an inherent vulnerability because they are among the most accessible features of an object and therefore among the easiest to imitate, modify, remove, or fabricate. The history of art forgery contains numerous examples where signatures were added to unrelated works, removed from authentic works, or artificially aged to create an appearance of legitimacy. Modern scholarship therefore treats markings as suggestive evidence rather than definitive proof.

The third tradition consists of expert observation, often referred to as connoisseurship. This methodology depends upon the accumulated knowledge of specialists who study stylistic characteristics, compositional decisions, brushwork, material choices, construction techniques, and other attributes associated with a particular artist, workshop, school, or historical period. Connoisseurship remains influential because experienced specialists recognize subtle patterns that are difficult to formalize and may identify inconsistencies overlooked by analytical instruments. However, expert observation is influenced by individual experience, training, cognitive bias, visual limitations, and differences in interpretation. Two experts examining the same object may reach different conclusions despite reviewing identical evidence. This highlights the difficulty of translating expert judgment into a reproducible statistical framework.

The fourth tradition consists of scientific analysis. Conservation science has developed analytical tools capable of examining cultural heritage objects with high sophistication. Visible imaging, hyperspectral imaging, infrared reflectography, ultraviolet fluorescence imaging, Raman spectroscopy, X-ray fluorescence, Fourier transform infrared spectroscopy, optical

coherence tomography, scanning electron microscopy, radiography, and neutron techniques are established components of the cultural heritage toolkit [3-5,14,15]. Scientific analysis differs from provenance and connoisseurship because it derives information directly from measurable physical properties of the object. The resulting data are reproducible, quantifiable, and suitable for independent verification. Paradoxically, the rapid expansion of these analytical tools has exposed a new limitation. The number of available measurements has expanded rapidly, while the theoretical framework for combining those measurements has not kept pace. Scientific methods often operate as isolated examinations producing isolated conclusions. One study may report pigment composition, another may report spectral characteristics, and a third may examine underdrawings. Without a common statistical architecture, these independent observations cannot be integrated into a single authentication decision, leaving the final synthesis fragmented and heavily reliant on subjective interpretation.

2.2 Limitations of Existing Approaches

The limitations of current authentication methodologies become more apparent when viewed through the lens of measurement theory. Every analytical technique observes only a subset of physical reality. No instrument measures everything, and no observation space contains all possible information regarding an object. This principle establishes a direct relationship between measurement dimensionality and ambiguity. When observations are confined to a limited space, distinct physical realities may become indistinguishable within that space.

Color science provides a familiar example through the phenomenon of metamerism [1,2,10,11]. Two objects may possess substantially different spectral reflectance distributions while appearing identical under a given illuminant and observer model. Distinct physical states collapse into identical perceptual observations due to dimensional reduction. A spectral reflectance curve may contain hundreds of measurements, but human vision compresses this information into a smaller representation. This compression is useful for perception but discards critical diagnostic data. Once information has been discarded, different physical realities become indistinguishable [1,10,11].

The same principle appears repeatedly throughout authentication science. Chemical analysis may identify a pigment while providing little information regarding spatial organization. Surface imaging may reveal morphology while providing limited insight into chemical composition. Elemental analysis may identify constituent materials while providing little information regarding fabrication processes. Infrared imaging may reveal subsurface features while remaining insensitive to other material properties. Every measurement domain illuminates part of reality while leaving other portions unobserved. The result is a condition described as measurement degeneracy, which occurs whenever multiple physical states produce similar or indistinguishable observations within a particular measurement space [7,8].

Figure 1. Conceptual representation of measurement degeneracy. Distinct physical states occupy separate positions in physical

reality but collapse into overlapping regions when projected into lower-dimensional observation spaces.

Authentication uncertainty arises because the dimensionality of available observations is insufficient to uniquely characterize the underlying physical state of the object. The traditional response has been to seek increasingly sophisticated measurements. While this strategy has produced substantial advances, it does not fully address the underlying problem. A more powerful solution involves combining measurements drawn from multiple physical domains. Such combinations are not merely additive, they alter the geometry of the observation space itself.

A colorimetric measurement may be ambiguous, but a spectral measurement reduces that ambiguity. A spectral measurement combined with topographic information reduces it further, and the addition of chemical signatures and fabrication-derived characteristics reduces it still further. Ambiguity decreases as physically meaningful dimensions are added. This principle provides the conceptual bridge between conservation science and multi-factor authentication [9,13]. Modern authentication systems rarely rely upon a single factor because single-factor systems are inherently vulnerable [9]. A password may be compromised, a token may be stolen, or a biometric may be spoofed. Combining factors reduces vulnerability because successful deception requires simultaneous manipulation of multiple evidence channels. The same logic applies to cultural heritage objects. A forged signature may imitate a marking, a copied composition may imitate appearance, and similar pigments may imitate chemistry. Yet simultaneous replication of multiple invariant physical characteristics becomes progressively more difficult as additional dimensions are introduced. Cultural heritage authentication should not be viewed as a search for a single definitive measurement. It should be viewed as a search for multiple invariant physical characteristics capable of functioning as authentication factors within a unified statistical framework.

3. Approach

3.1 Physicometrics

Physicometrics provides the framework for identifying which observations are most useful for expressing physical identity. It is defined as the measurement and statistical characterization of invariant physical properties of inanimate objects. The discipline concerns the discovery, extraction, quantification, and comparison of physical characteristics that remain stable over time to function as authentication factors. It operates above traditional analytical disciplines, asking which specific measurements contribute to the expression of identity.

An invariant physical characteristic is a measurable property arising from an object's material composition, structural organization, fabrication history, or physical evolution that remains stable under normal observation, handling, storage, and conservation conditions. Absolute immutability is not required. Rather, a trait's stability must exceed the uncertainty associated with authentication to support meaningful comparison over relevant timescales.

Six primary classes of physicomtric factors emerge from existing conservation science:

Spectral invariants treat continuous electromagnetic interactions as high-dimensional identity signals rather than low-dimensional colorimetric values [1,2,10,11]. Traditional systems compress spectral information into representations like XYZ or CIELAB values, which discards diagnostic data [10,11]. Physicomtric analysis treats the full spectral response as the identity-bearing signal to achieve physical distinction rather than mere visual equivalence.

Topographic invariants capture micro-surface geometries embedded within surface structure by fabrication processes. Brush strokes, tool marks, substrate texture, craquelure development, and abrasion patterns form unique topographic signatures that are difficult to reproduce precisely.

Chemical invariants map the elemental and molecular composition of materials including pigments, binders, fillers, varnishes, and corrosion products. This analysis provides direct evidence of material origins and becomes powerful when combined with other physicomtric factors [5].

Volumetric invariants expand authentication beneath visible boundaries to examine layer structures, refractive index transitions, internal inclusions, density variations, underdrawings, and hidden construction features. This factor class moves verification beyond surface appearance into the object's internal architecture.

Fabrication entropy measures the stochastic microscopic irregularities introduced during manufacture by material variability, tool behavior, environmental conditions, and human action. Examples include pigment particle distributions, brush stroke variability, fiber orientations, and weave irregularities. These random patterns provide unique protection against forgery because replicating microscopic stochastic structures is exceptionally challenging.

Encoded response factors emerge from active interrogation of the object using structured illumination, coded apertures, phase modulation, or active measurement techniques [14,15]. The resulting responses reveal structural and material relationships that remain invisible under conventional, passive observation.

This initial framework is not a closed taxonomy. Physicometrics is defined by its objective, the extraction of invariant physical characteristics, rather than by any specific measurement technology. This ensures the framework can seamlessly integrate future factors discovered in magnetic, radiographic, nuclear, acoustic, or thermal measurement domains.

3.2 OMASIE

Existing conservation instruments are engineered to measure specific physical phenomena in isolation. Spectrometers measure localized wavelengths, surface profilers map geometry, and chemical systems isolate elemental outputs. Physicomtric authentication requires the coordinated extraction of multiple

factor classes across multiple dimensions within a common framework. OMASIE, the Optical Multiscale Aperture Synthesizing Invariant Extractor, balances this operational requirement [12,13].

Authentication presents a different optimization problem than conventional imaging. Imaging systems maximize visual fidelity and appearance reconstruction, whereas OMASIE optimizes for invariant factor extraction to identify stable physical traits. The system replaces broad, uncontrolled illumination with structured interrogation using controlled wavelengths, energies, geometries, and temporal sequences to maximize information extraction. Instead of a conventional imaging pathway, it employs coded aperture structures that transform object responses into high-information optical fields. Computational reconstruction serves as an intermediate step to output a collection of spatially registered physicomtric descriptors [14,15].

Figure 2. Conceptual OMASIE architecture showing structured illumination, coded aperture modulation, multiscale interrogation, computational reconstruction, and physicomtric factor extraction.

The core hardware implementation utilizes a three-dimensional factor-optimized sensor manifold containing thirty-seven sensing arms grouped into six primary factor families. This layout optimizes for factor diversity rather than simple planar coverage. Sensor placement, angular orientation, spectral sensitivity, and sampling geometry are calibrated to maximize the extraction of complementary information. By introducing controlled variation along the optical axis, the manifold captures volumetric and phase-related data that remain inaccessible to conventional two-dimensional imaging sensors [14,15].

Figure 3. Thirty-seven arm factor-optimized sensor manifold showing spectral, topographic, volumetric, chemical, fabrication entropy, and aperture-derived factor families.

OMASIE aligns physical instrumentation with the baseline requirements of identity science. It transforms authentication from independent analytical procedures into a coordinated data-gathering pipeline. This architecture establishes a new paradigm where objects are characterized by multidimensional physicomtric identity vectors derived from multiple invariant factor classes.

4. Results

4.1 Statistical Authentication

The extraction of structured physicomtric factors successfully reformulates cultural heritage authentication as a statistical identity problem. Rather than chasing a singular, definitive proof, which remains highly vulnerable to forgery and interpretation error, the framework aggregates multi-channel physical data into a unified decision engine to calculate a quantifiable confidence level [7,8]. This approach shifts authentication away from the search for singular proof and toward the accumulation of convergent evidence. Historically, cultural heritage authentication has sought decisive

observations, such as the discovery of an anachronistic pigment or a previously unknown provenance document. Such observations are valuable, but they remain isolated events whose significance depends upon subjective interpretation.

The physicomeric framework approaches the problem differently. Each physicomeric factor contributes a measurable quantity describing some aspect of physical identity. No individual factor is expected to establish authenticity independently. Factors are evaluated collectively, with each contributing a portion of the overall evidentiary picture. The statistical framework begins with the construction of an identity vector:

$$F = (F_1, F_2, F_3, \dots, F_n)$$

where each component represents a quantified physicomeric factor extracted from the object under examination [7,8].

The identity vector serves as a mathematical representation of physical identity, describing measurable characteristics arising from the object's underlying physical reality. Authentication then becomes a direct mathematical comparison between two vectors captured at different times. Given two measurements, $F(A)$ and $F(B)$, statistical distance metrics are computed across individual factors and across the vector as a whole. Similarity, covariance, uncertainty, and confidence estimates are subsequently evaluated using established statistical techniques [7,8].

This approach parallels modern digital authentication systems where confidence increases when multiple evidence channels, such as passwords, possession tokens, and biometric factors, are evaluated simultaneously [6,9]. The same logic applies to physical objects. A sophisticated forgery might reproduce visual appearance, select surface features, or basic chemical profiles, but simultaneous replication of numerous independent or partially independent physicomeric factors becomes progressively more difficult as dimensionality increases.

The framework does not require all factors to contribute equally. Certain factors possess greater discriminative power or exhibit higher stability than others. Spectral factors might prove highly informative in one object class, while fabrication entropy factors dominate another. The statistical framework accommodates these differences through weighting, normalization, covariance estimation, and confidence modeling [7,8]. The result is a flexible evidence fusion architecture capable of incorporating new factor classes and measurement technologies as they emerge.

4.2 Statistical Independence, Covariance, and Evidence Fusion

Early discussions of multi-factor authentication naturally emphasize statistical independence. In information security, independence reduces the probability that the compromise of one factor will compromise another [9]. When these principles are translated into the physical world, the issue becomes more nuanced. Complete statistical independence among physicomeric factors is unlikely because all physical measurements are derived from the same underlying object. Consequently, some degree of correlation should be expected, as surface structure influences spectral behavior and material composition shapes topography.

Figure 4. Evidence Fusion and Authentication Confidence: False Acceptance Probability vs Number of Physicomeric factors.

Rather than viewing such relationships as weaknesses, the physicomeric framework treats them as measurable properties of the identity system itself. The objective is controlled covariance tracking [7,8]. Covariance provides a quantitative description of how factors vary relative to one another, allowing the framework to distinguish between meaningful identity information and redundant observations. Factors exhibiting low correlation contribute substantial new information, while factors exhibiting moderate correlation provide vital cross-verification [7,8].

Highly correlated factors contribute robustness even when they add relatively little new information. Overlap produces beneficial effects because redundancy creates resilience. If a measurement is unavailable, corrupted, or noisy, the covariance model can infer the expected behavior from surrounding factors [7,8]. This introduces error correcting properties analogous to communications engineering, transforming what might appear to be a theoretical weakness into a practical strength. The resulting authentication model remains functional under imperfect, real-world museum and field conditions where objects may be damaged, restored, or partially obscured.

4.3 Identity Space

The concept of identity space provides a mechanism to visualize the operation of the physicomeric framework. Every physicomeric factor adds one or more dimensions to a multi-dimensional geometry. An asset characterized across fifty distinct factors is mapped as a singular coordinate within a fifty-dimensional space. As additional dimensions are integrated, the mathematical separation between distinct physical entities expands exponentially.

Low-dimensional observation spaces frequently exhibit overlap, causing distinct physical realities to collapse into identical configurations when dimensionality is reduced. This is precisely what occurs during metameric matching, where distinct spectral realities collapse into a common colorimetric representation [1,2,10,11]. Whenever physical complexity is projected into a lower-dimensional space, information is lost and ambiguity is generated.

Identity space reverses this process by expanding dimensionality through the incorporation of multiple evidence channels. As dimensions accumulate, overlapping clusters separate and objects previously considered indistinguishable become separable. Authentication confidence increases because measurement degeneracy is systematically resolved. The objective is not absolute certainty, but rather quantifiable confidence supported by measurable evidence [7,8].

4.4 Retrospective Knowledge Generation

A significant consequence of physicomeric authentication emerges after measurements begin to accumulate. Traditional authentication systems typically generate static, closed reports, whereas physicomeric authentication generates structured data arrays. Every measurement event produces identity vectors,

covariance relationships, and factor statistics that remain useful long after the immediate authentication question is resolved. Over time, these data products form an interoperable, global database of physical reality.

This development transforms authentication from a purely prospective activity into a retrospective analytical resource. Advanced machine learning models can query this repository to reveal macro-patterns across entire collections [7]. Hidden statistical clusters may emerge corresponding to specific workshops, studios, regions, or historical periods. Material usage patterns can reveal previously unknown supply networks, and fabrication signatures can expose relationships among objects separated by geography or ownership.

Unlike provenance records that depend upon historical documentation, physicomtric databases derive directly from measured physical reality. This distinction is significant because physical evidence persists even when documentary evidence is lost or fractured. An object may lose its provenance, but it continues to retain traces of its fabrication, materials, and history. Physicometrics provides a mechanism for preserving and exploiting that information, creating a growing repository of historical knowledge.

4.5 A New Authentication Paradigm

Physicometrics shifts the core question of verification from whether a specific observation supports authenticity to whether an object's complete, multi-dimensional physical identity is consistent with its baseline. The fundamental unit of analysis is no longer the individual observation, but the comprehensive identity vector. Authentication is no longer interpreted as a collection of disconnected examinations, but as a statistical comparison between multidimensional physical identities [7,8]. This shift integrates conservation science, statistical decision theory, and optical computing into a single cohesive discipline, providing a rigorous foundation for cultural heritage preservation.

5. Conclusions

5.1 Implications

This paper addresses a critical vulnerability in cultural heritage management: the reliance on fragmented, subjective, and isolated verification protocols for high-consequence decisions. By reformulating authentication as a high-dimensional statistical identity problem, we provide a mathematical architecture to synthesize provenance, connoisseurship, and material analysis into an objective decision framework [7,8]. This framework moves attention away from individual observations and toward the measurable, invariant physical characteristics that define identity itself. Physicometrics does not replace existing scientific disciplines, but rather organizes their outputs around a common objective, providing a theoretical structure to identify, measure, compare, and exploit physical evidence even when historical documentation is completely lost.

The practical implementation of this framework is represented by OMASIE, an architecture designed entirely around identity extraction rather than conventional visual representation. By utilizing structured illumination, coded apertures, multiscale interrogation, and factor-optimized sensing, the system

demonstrates that abstract identity theory can be successfully translated into hardware, measurement protocols, and operational workflows [12-15]. This methodology proves that confidence can emerge from evidence fusion rather than singular proof. Multiple factors, each imperfect individually, collectively provide a highly discriminative representation of identity, aligning cultural heritage authentication with the multi-layered security architectures used in modern digital infrastructure [9,13].

Crucially, the accumulation of these identity vectors creates an enduring, retrospective knowledge base that functions as a form of collective physical memory. Every measurement event produces data arrays that remain useful long after the immediate authentication query is resolved. Over time, these repositories create entirely new possibilities for cultural scholarship, allowing researchers to retrospectively decode historical workshop practices, track global material supply chains, identify regional traditions, and monitor long-term conservation states. Measurements collected now will answer historical questions that have not yet been asked, offering an analytical resource that operates simultaneously in the present and the future.

The physicomtric factors discussed in this work arise primarily from optical interrogation because optical methods currently provide the most practical, conservation-friendly pathway for large-scale deployment [14,15]. However, optical factors do not represent the limits of this discipline. Invariant characteristics capable of contributing to object identity exist across numerous non-optical factor classes, including magnetic interactions, radiometric signatures, nuclear responses, acoustic phenomena, thermal behavior, and hybrid measurement domains. Future physicomtric systems will incorporate factor classes that are presently unexplored or unimagined. Major scientific advances frequently begin not with the invention of a new instrument, but with the recognition of a new category of information. Invariant physical characteristics constitute such a category, serving as the first proving ground for a broader measurement science whose influence will eventually extend far beyond cultural heritage itself.

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Author Biography

The author, CEO of Spectral Masters Digital Imaging, Inc. develops imaging systems for graphical, medical and military applications, and has been granted multiple hyperspectral imaging patents. Based upon insights gained analyzing CIE protocols and synthetic aperture computational imaging systems, the concept of a unique Multi-Factor Authentication method using only invariant characteristics of an art object was created.

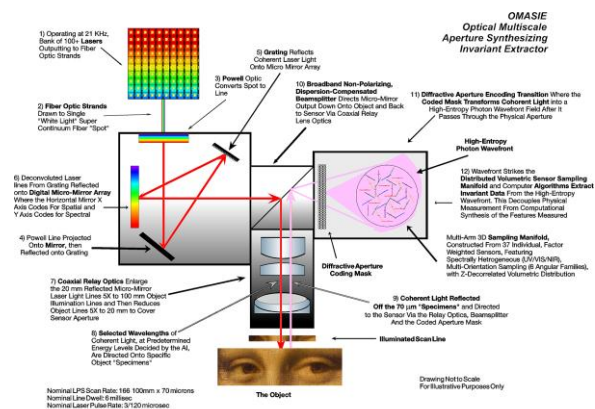
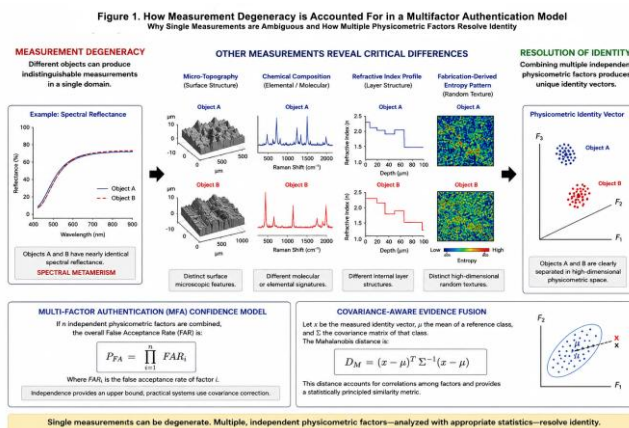


Figure #2 OMASIE Schematic Diagram

3D OMASIE Aperture (Object-Optimized Z Distribution)

Figure 3

