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Photonically Projected Atoms: A Paradigm Shift in Atomic Physics

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Abstract

This paper presents the discovery of photonically projected atoms, first observed serendipitously during the development of a smartphone-based technique for material identification through reflected light measurements. Upon illuminating samples with ≥75,000 lumen from a light-emitting diode, we observed exact atomic projections emanating from charged particles within the sample. Analysis determined that protons within each atom bond with and re-emit contacted photons. After proton emission, a spatial lensing effect enlarges the projections of the photons to a diameter of 0.5 mm when measured 1 mm from the surface. The smaller 1⁄3” sensors and pixel size of smartphone cameras provide a better resolution of the fine structural details compared with larger digital camera alternatives. Through seven years of imaging analysis under various conditions, fundamental insights emerged on atomic architectures, particle interactions, and the role of space, empirically revising mainstream quantum theory. This research aims to disseminate recent advancements in the direct visualization and updated modeling of atomic projections to enable ongoing physics discoveries through this accessible technique.

Keywords: photonically projected atoms, atomic gravitational lensing, contact bonding

All research videos of projected atoms are being uploaded to **here**.

1. Introduction

Projected atoms were first discovered serendipitously during the development of a novel method of material identification based on a smartphone camera. During initial testing, intriguing unknown objects were observed originating from metallic particles in the samples. Further investigation revealed these projections to be atoms (Figures 1–6). By recording and analyzing images of atom projections from various materials and various angles, we determined that the projected objects contained features aligning with the currently accepted model of atomic structure, including protons, neutrons, and electrons (Figures 7–8). We constructed a three-dimensional (3D) model of a hydrogen atom using our research and previous work by others on imaging the hydrogen atom (Stodolna, 2014) (Figures 9–16). However, some notable differences were also observed, as discussed below.

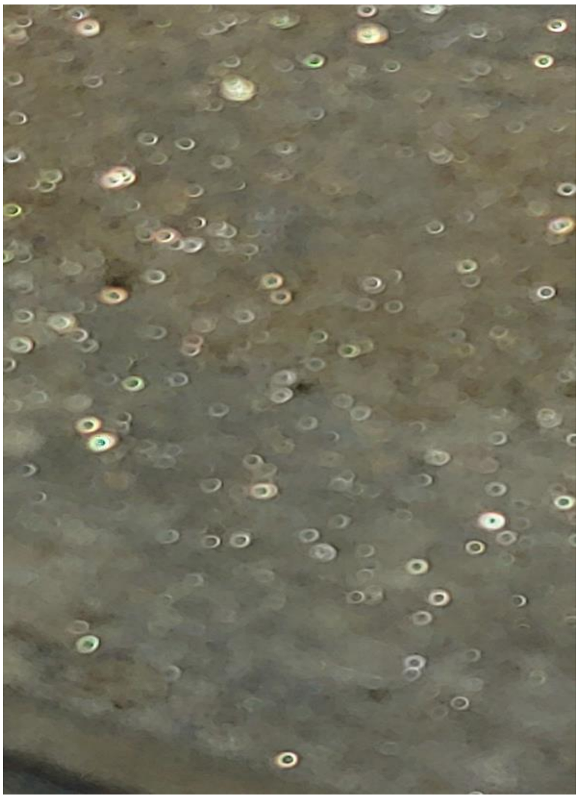

Figure 1. Proof-of-concept photograph from the development of a material identification method

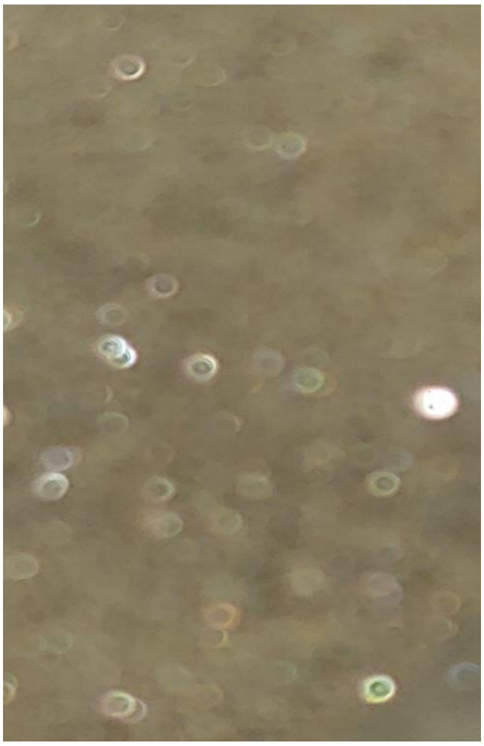

Figure 2. Proof-of-concept photograph

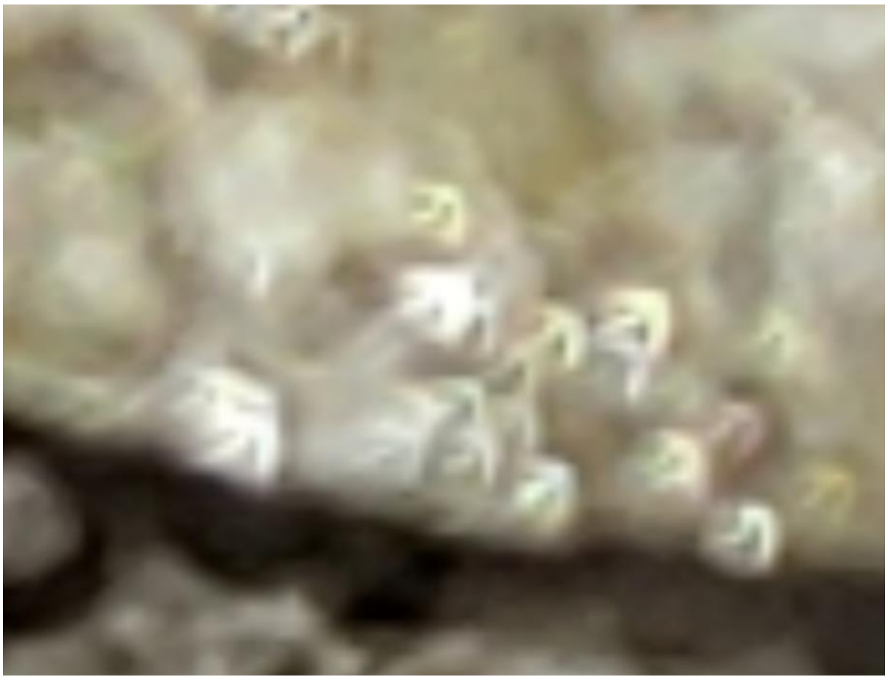

Figure 3. Proof-of-concept photograph

This photograph was acquired perpendicular to the light source, allowing us to capture the side of the projection.

Figure 4. This photograph was acquired perpendicular to the light source, allowing us to capture the side of the projection

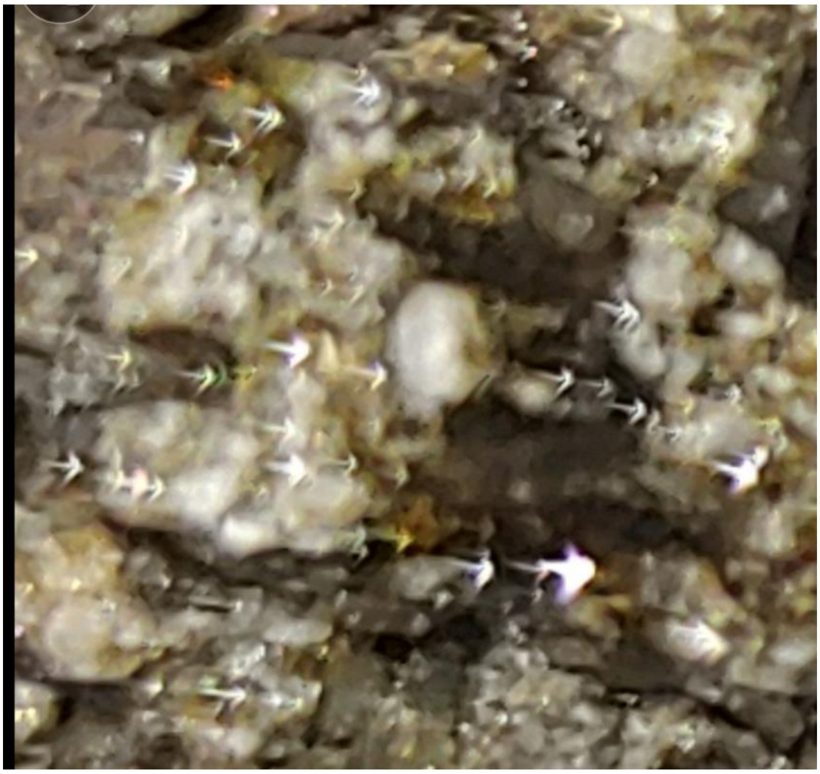

Figure 5. This photograph was acquired perpendicular to the light source, allowing us to capture the side of the projection

Figure 6. This photograph was acquired perpendicular to the light source, allowing us to capture the side of the projection

Figure 7. Electrons orbiting through the atom are always observed in alternating rows of positive (white positrons) and negative (dark electrons)

Figure 8. Water molecule with two hydrogen atoms highlighted

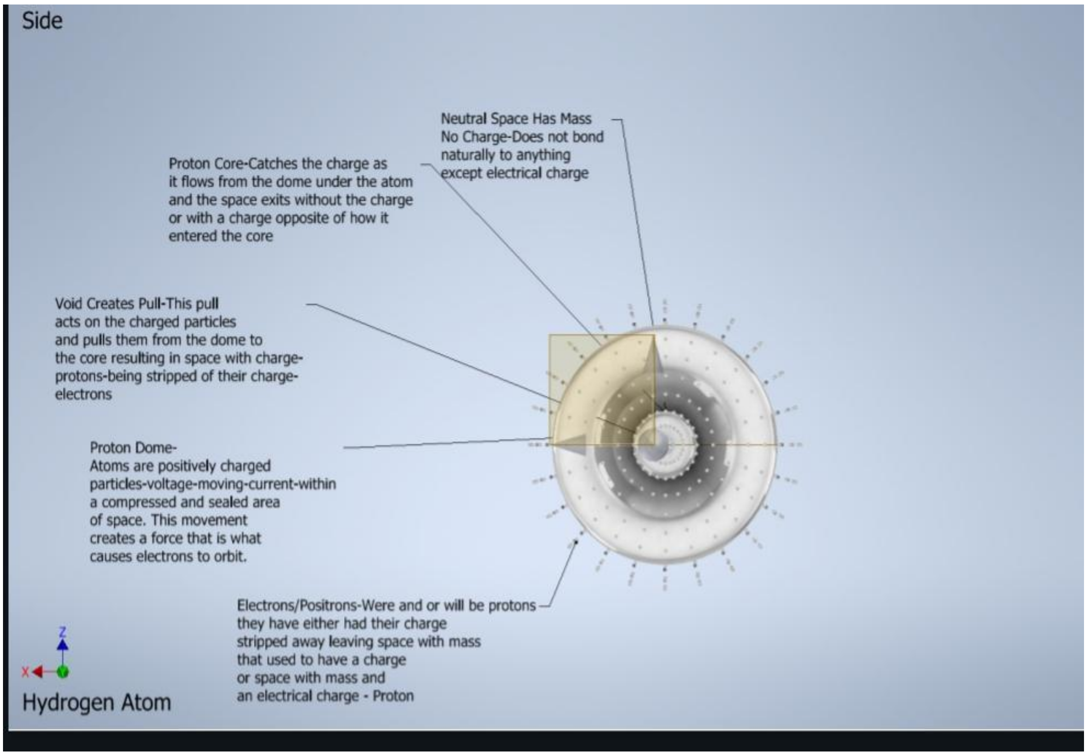

Figure 9. Figures 9–15 present 3D models that were created based on experiments with the shape of virtual atoms. This illustration presents our hypothesized appearance of hydrogen. The electron count is not accurate, as we found that the electrons vary widely.

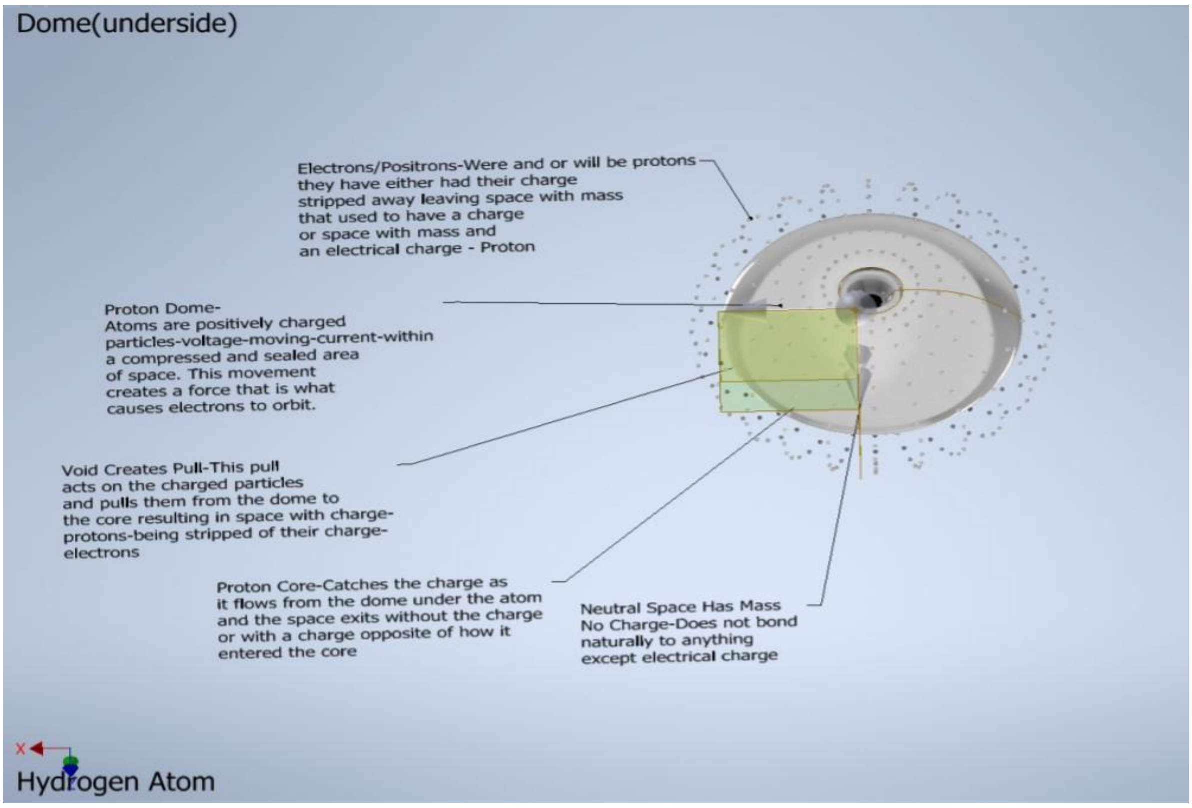

Figure 10

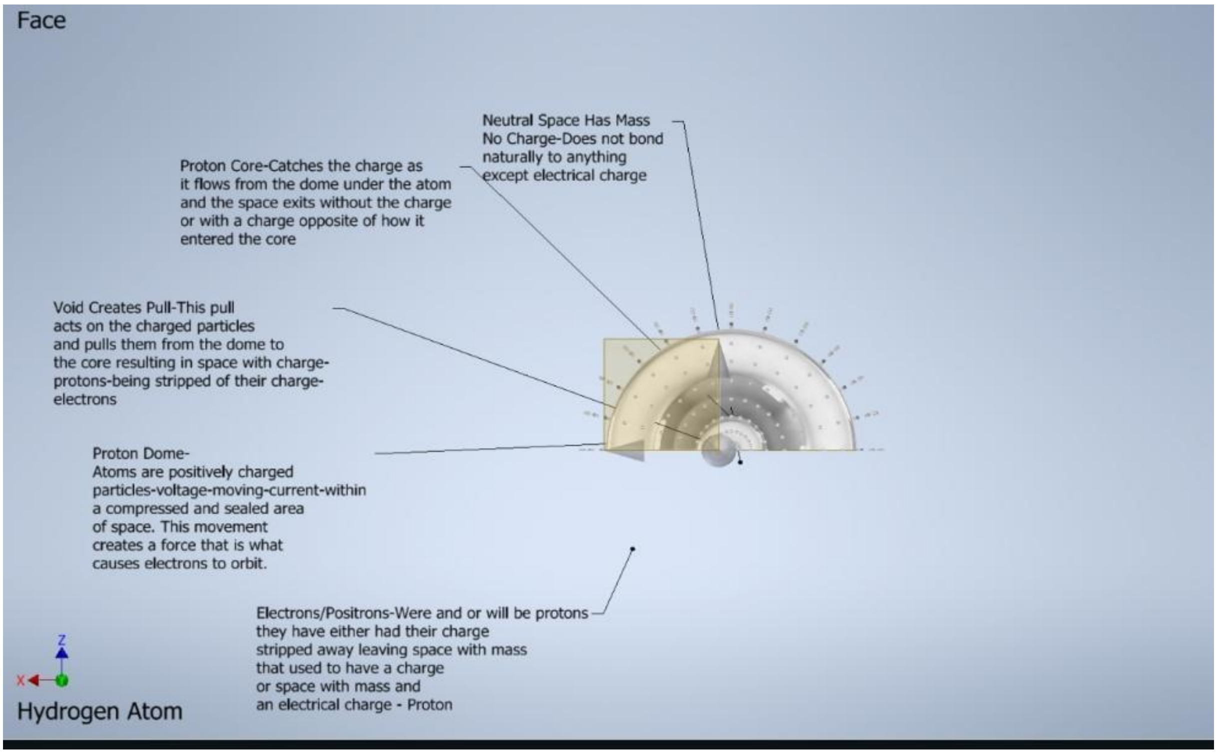

Figure 11

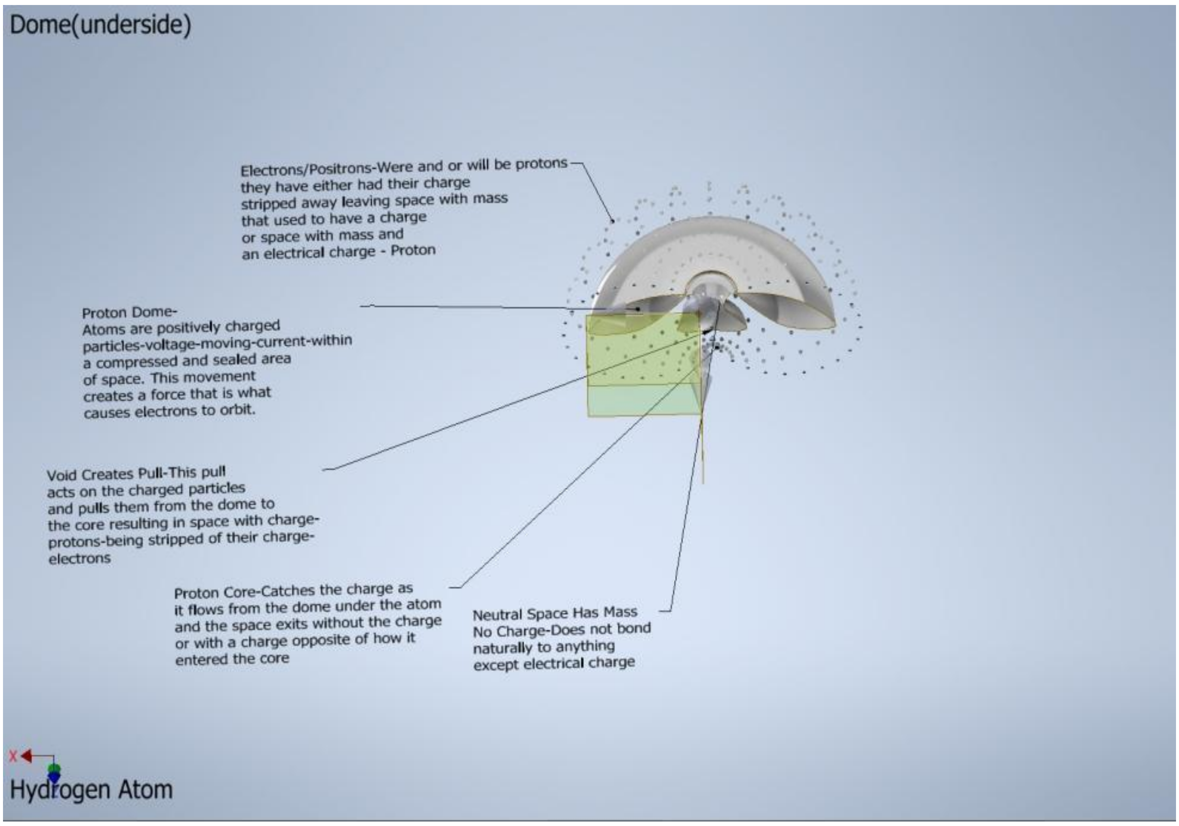

Figure 12

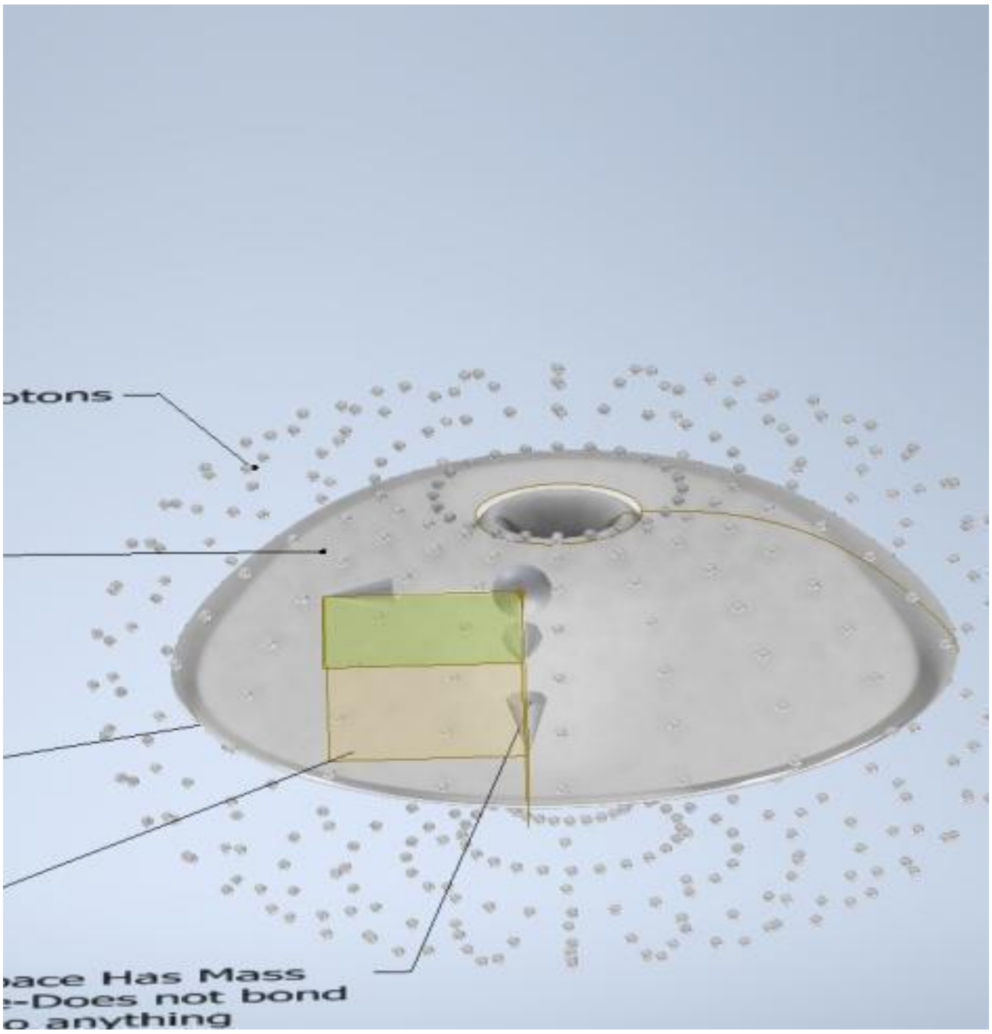

Figure 13

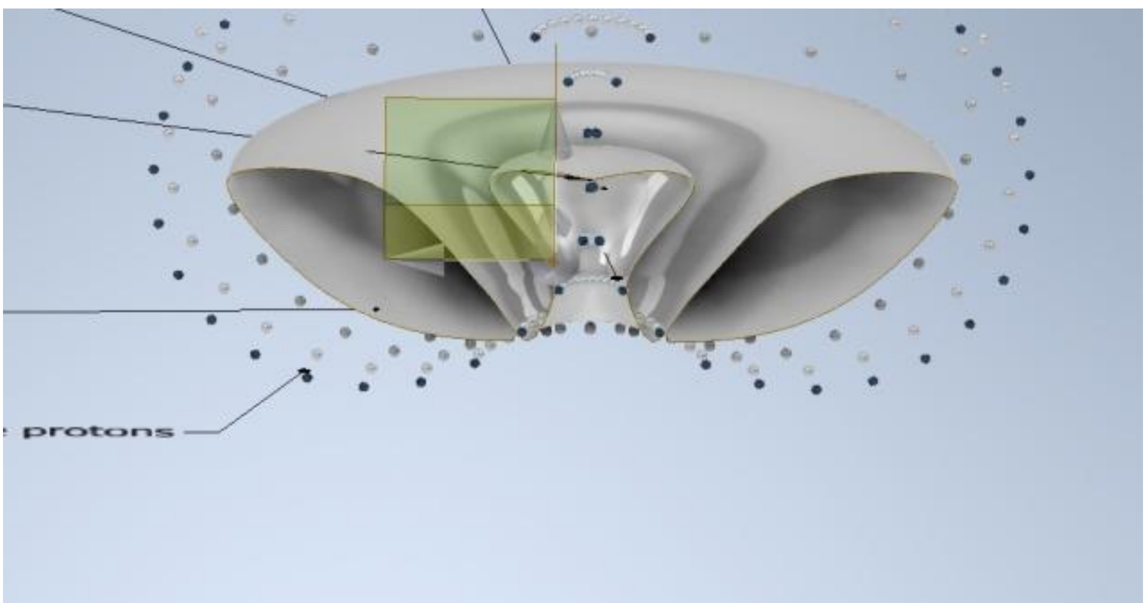

Figure 14

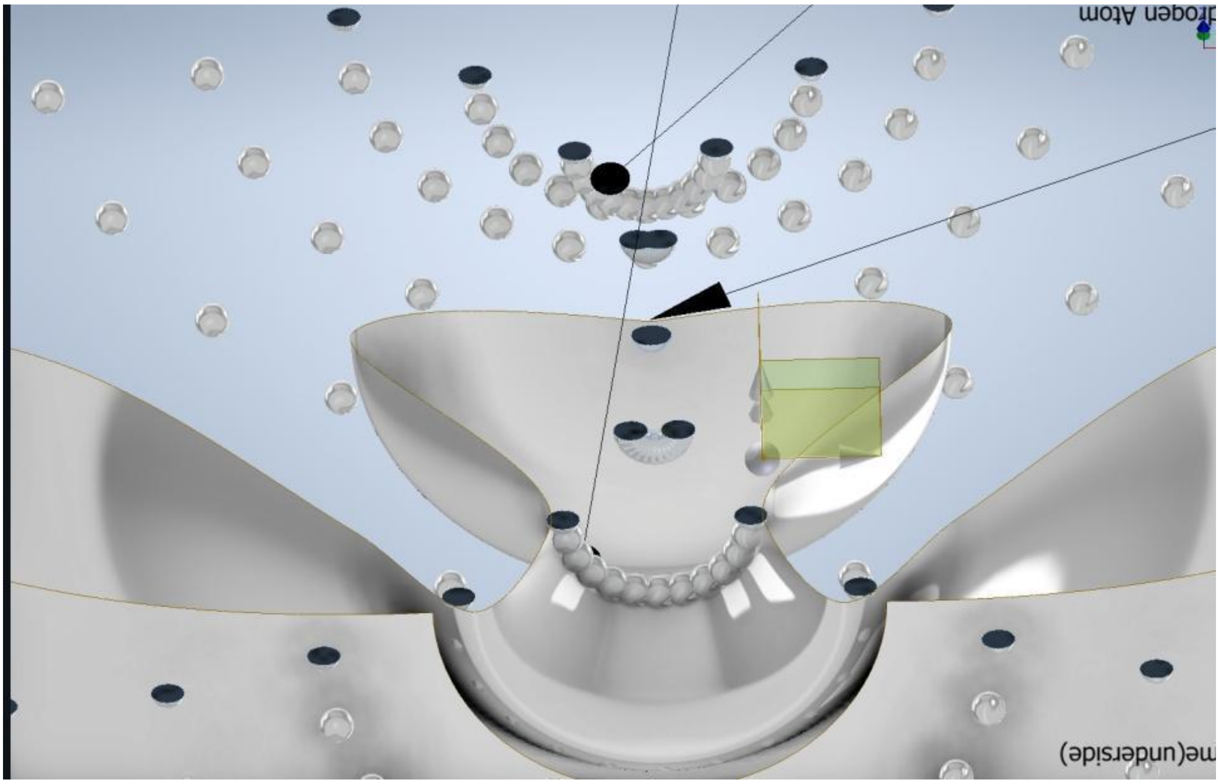

Figure 15

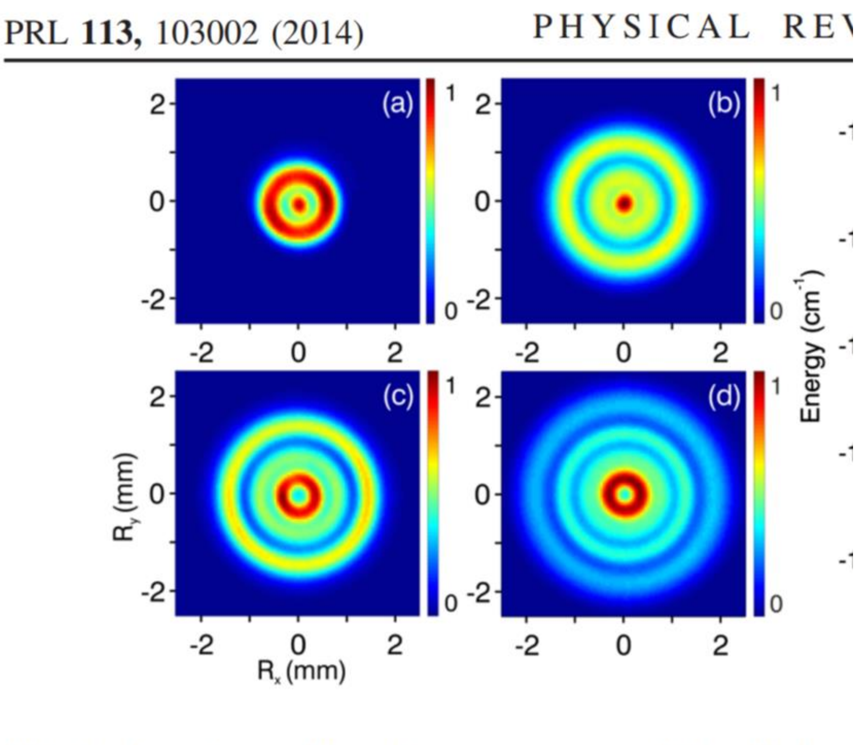

Figure 16. Image from (Stodolna, 2014)

Through extensive image and video analysis, measurement, and testing under various conditions (e.g., temperature changes [Figures 17–19], applied voltage/current, acid dissolution [Figures 20–22]), we aimed to characterize and understand the structure and behavior of these atom projections. The use of specialized equipment (Figures 23–25) enabled more controlled testing and documentation.

Figure 17. Stainless steel at a temperature of 250 ℃

Figure 18. Projected atoms in stainless steel at a temperature of 250 ℃

Figure 19. Projected atoms in stainless steel at a temperature of 38 ℃

Figure 20. Projected gold atom from a contact on a circuit board

Figure 21. Projected atoms from 4.5-mm zinc ball bearings dissolved in acid

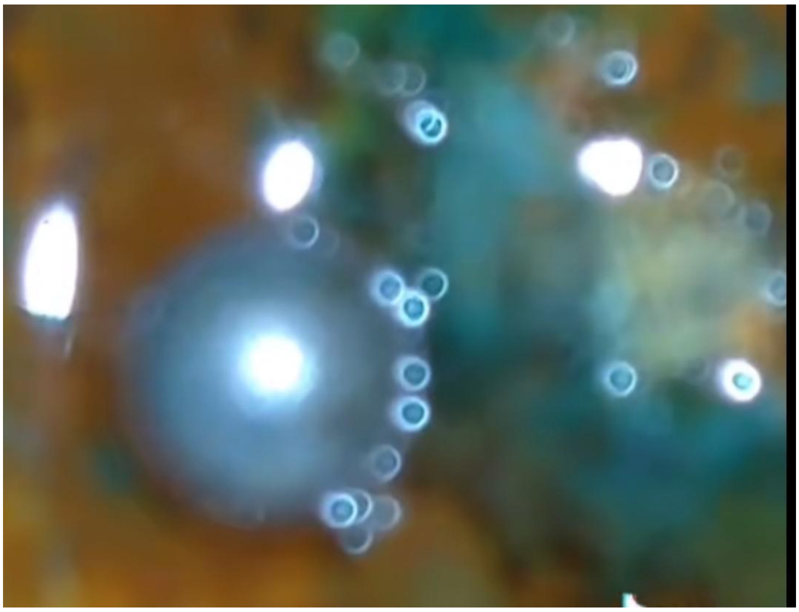

Figure 22. Projected atoms from 4.5-mm zinc ball bearings dissolved in acid

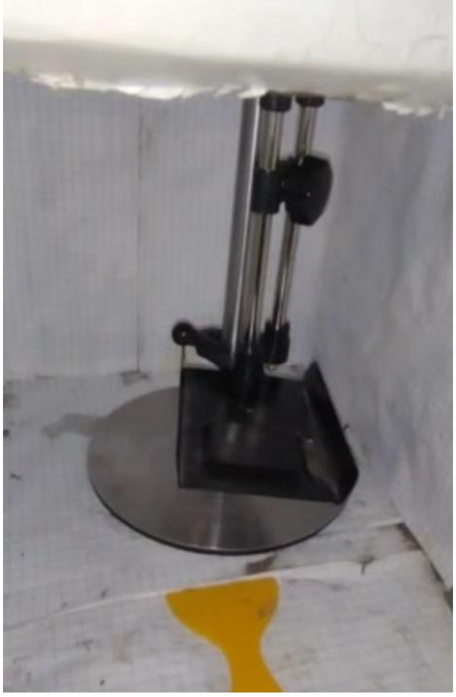

Figure 23. Adjustable stand for recording projected atoms

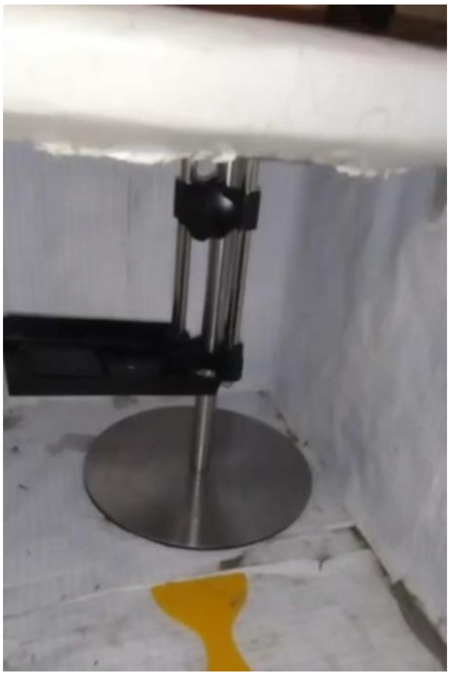

Figure 24. Adjustable stand for recording projected atoms

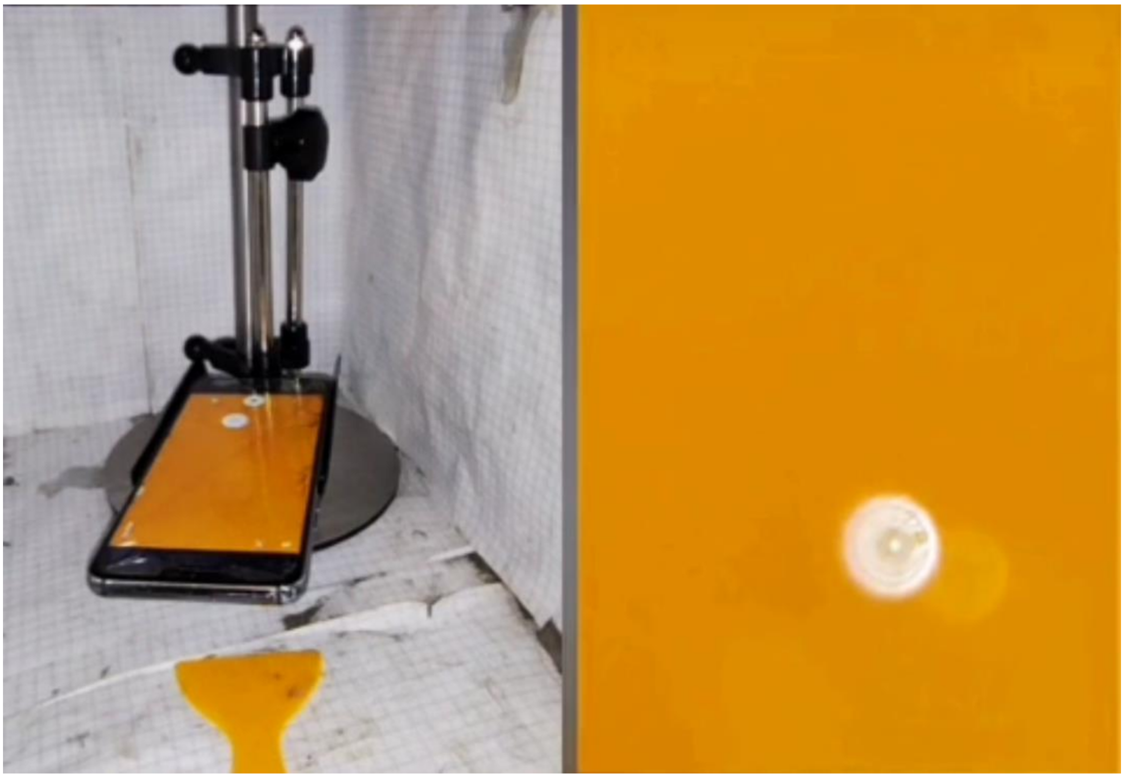

Figure 25. Adjustable stand for recording projected atoms

The observed projected atoms shared some visual similarities with the photographic bokeh effect, but exhibited an additional well-defined internal structure not explainable by bokeh artifacts. In contrast to work on imaging helium atoms published in 2012 (Stodolna, 2014), shapes of observed projections were confirmed (Figure 16, 26). Projections were captured from many materials, with each material exhibiting distinct atom projections. By adjusting the camera distance, different layers of the atoms could be visualized and analyzed. A concave mirror also provided additional perspective by capturing reflections. Orbiting particles presumed to be electrons and positrons were observable traversing through the atom projections (Figures 7–8, 27–28).

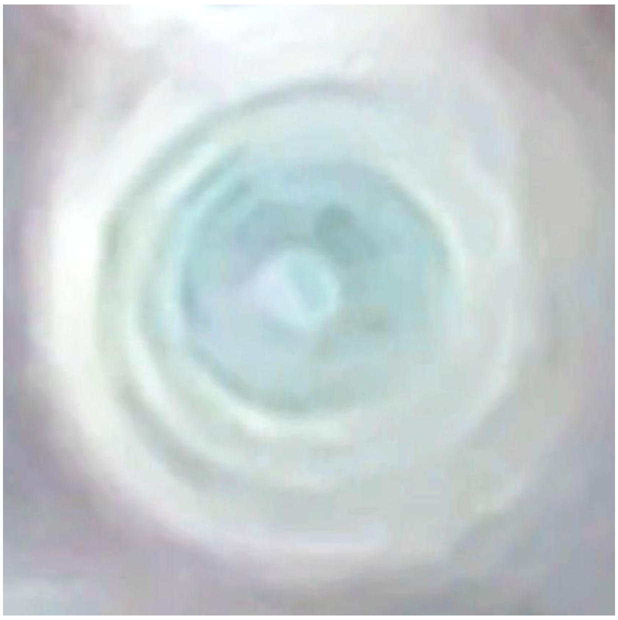

Figure 26. Projected aluminum atom face

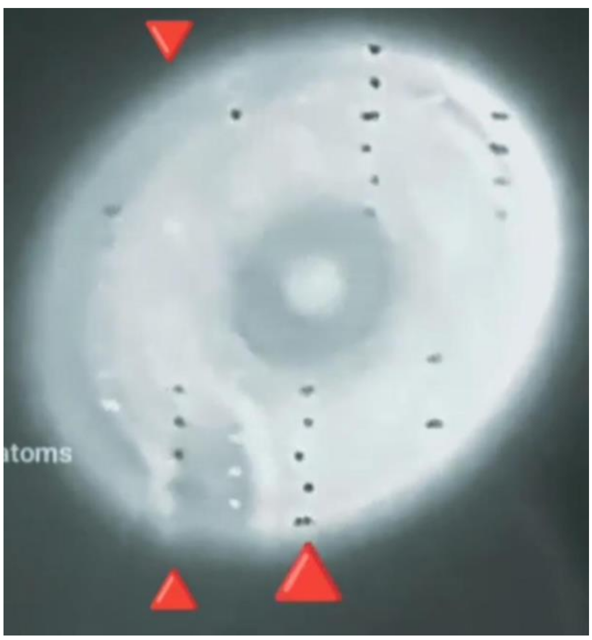

Figure 27. Water molecule protons/positrons (white), electrons (black), and neutrons (grey)

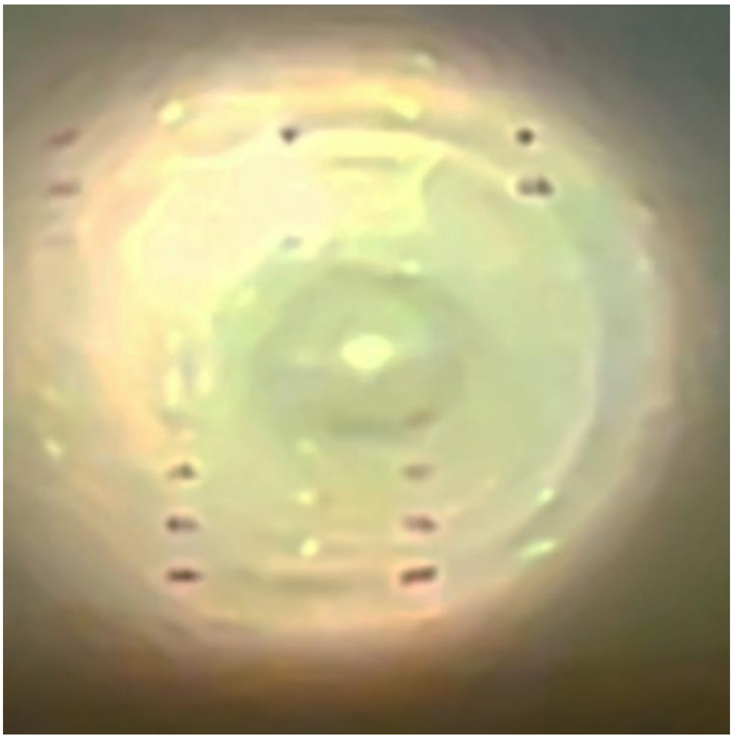

Figure 28. Projected atom with electrons from 18-karat gold

This work led to a re-evaluation of some mainstream atomic modeling based on real-time direct observations and known experimental data, such as the masses of protons, neutrons, and hydrogen (Table 1).

Table 1

	Mass	Charge	Atomic Mass Unit
Neutron	1.674 ×10^-27 kg	0	1.0087
Proton	1.6726 ×10^-27 kg	1.602176634 ×10^-19 C	1.0073
Electron	9.1093837 ×10-31 kg	1.60217663 ×10-19 C	0.00055
Hydrogen Atom	1.6735 ×10^-27 kg	Neutral??	1.00797

The cause of gravitational forces and other corrections to accepted physics are proposed based on evidence from this research. The discussion below contextualizes these findings on projected atoms with relation to the current understanding and accepted models of atomic structure, noting areas of alignment and deviations. Implications on scientific knowledge in physics and chemistry are considered.

Observations indicated a rapidly moving core (Figures 26, 29) confined within a darker area, hypothesized to be the connection point between the neutral space inside and outside of the atom (Figures 29–32). This compressed inner space pulls on the externally connected space, flattening the atom's face and causing an atomic form of gravitational lensing. The first and most pronounced feature observed when the projections are brought into focus is a large, thick outer ring (Figure 26, 31, 33–34) encircling each atom. This ring indicates a change in the proton flow direction (Figure 29); the inner portion of each ring has an upward flow, while the outer edge shows a downward flow. At distances of 60–85 mm, the outer rings were consistent across material types. The inner rings varied in size, density, and number, appearing highly defined in some cases and having a cloud-like appearance in other cases.

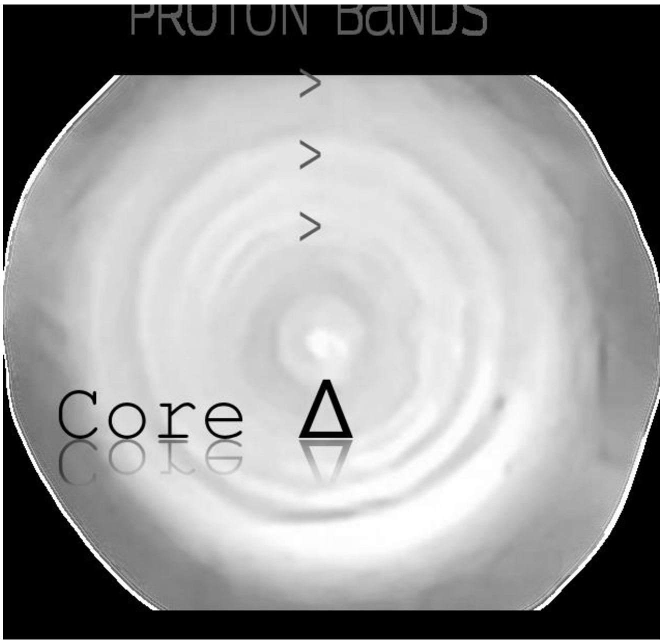

Figure 29. Projected atom in stainless steel. Core: Δ. Proton rings: >>

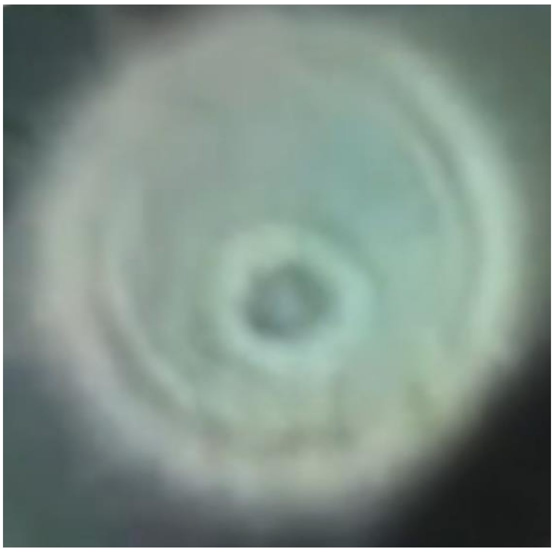

Figure 30. Visually identifiable ionized-proton dome

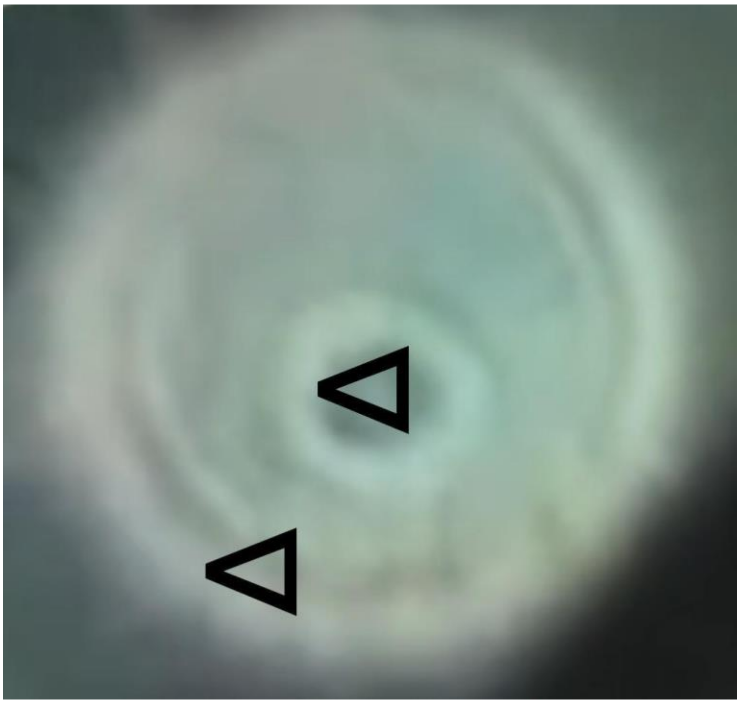

Figure 31. Ionized atom. Δ: Proton rings

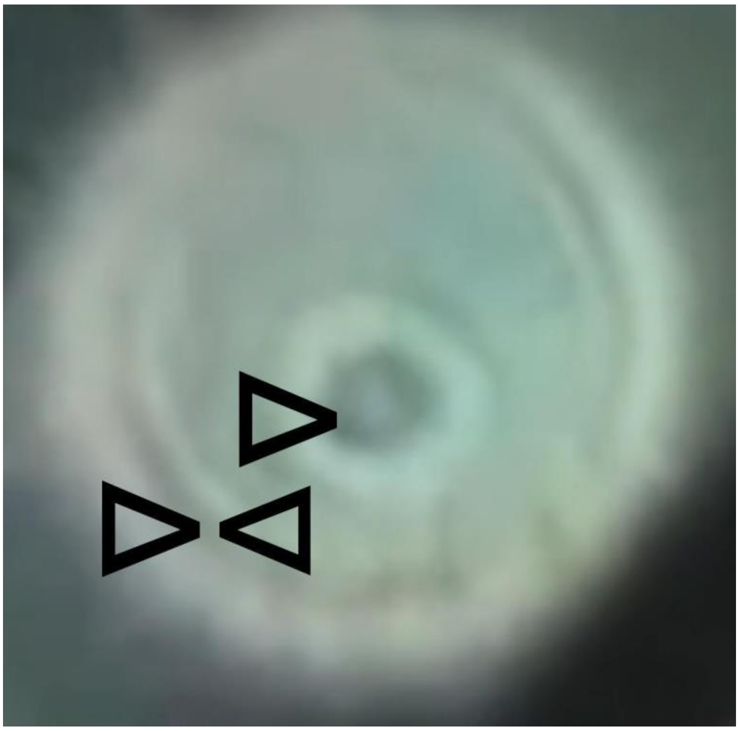

Figure 32. Ionized atom. Δ: Electrically neutral mass/space

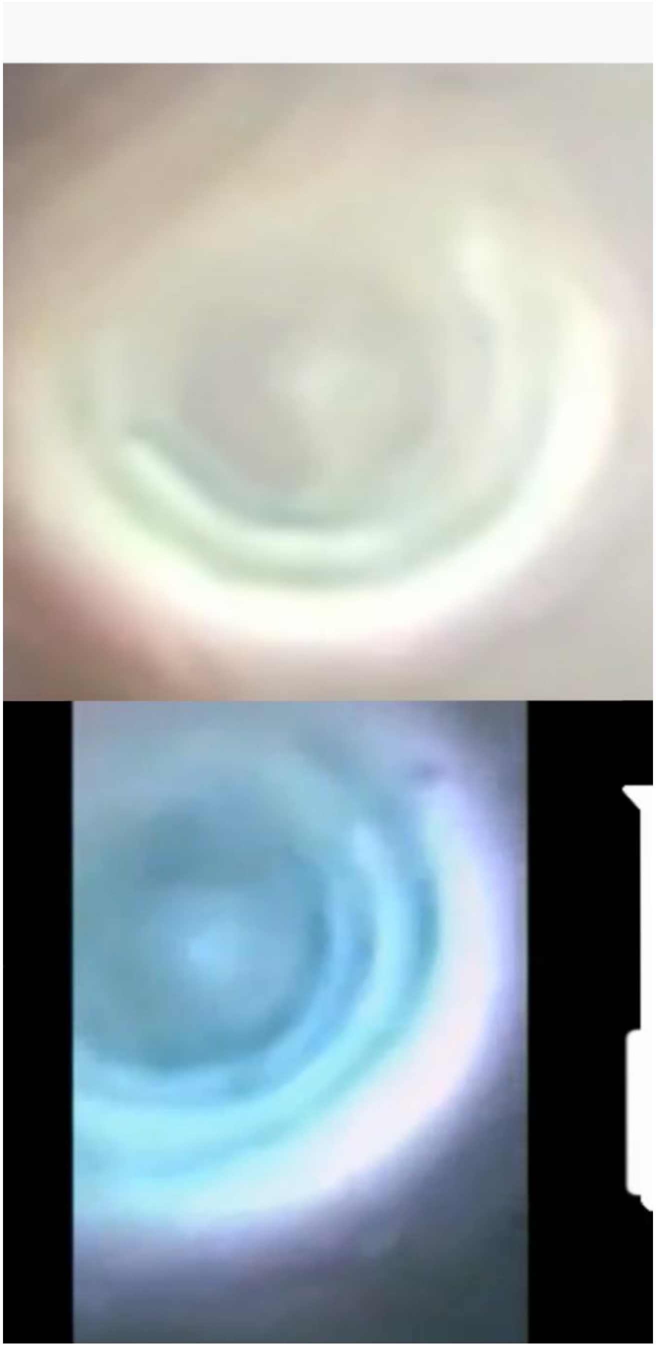

Figure 33. A comparison of two DC motor rotators composed of mixed metal

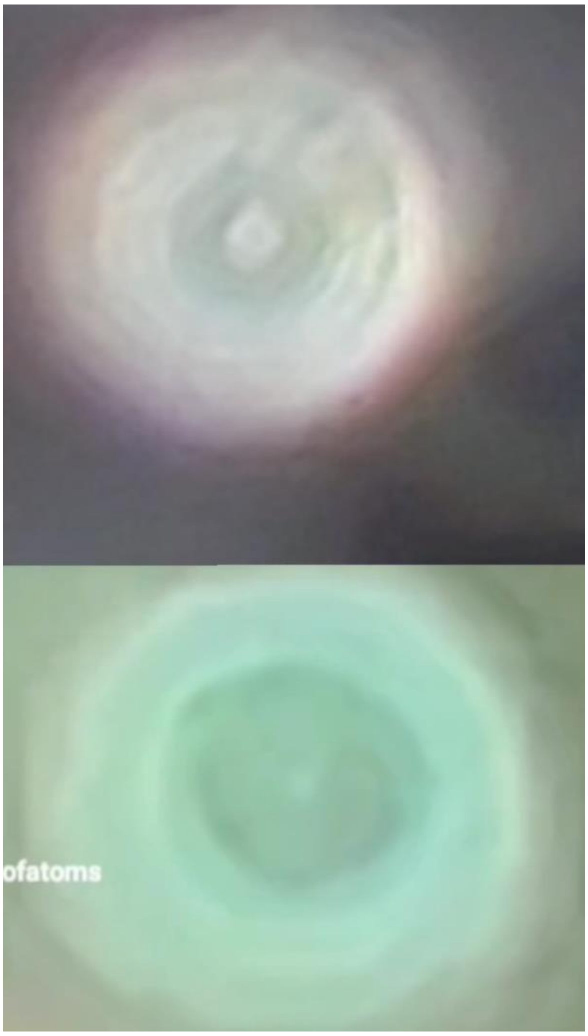

Figure 34. Projected aluminum atoms at a temperature of 40 ℃ (top) or 0 ℃ (bottom)

We observed two notable abnormalities. Atoms appeared with a white dome on the typically unseen underside. This dome had a small ring around a central dark hole, where protons turned back into the atom. The dome was determined to form from excess charge buildup or external electromagnetic fields, causing proton spread. Heat, the application of electricity, and events such as solar flares induced this dome capping (Figures 7, 30–32, 35–37).

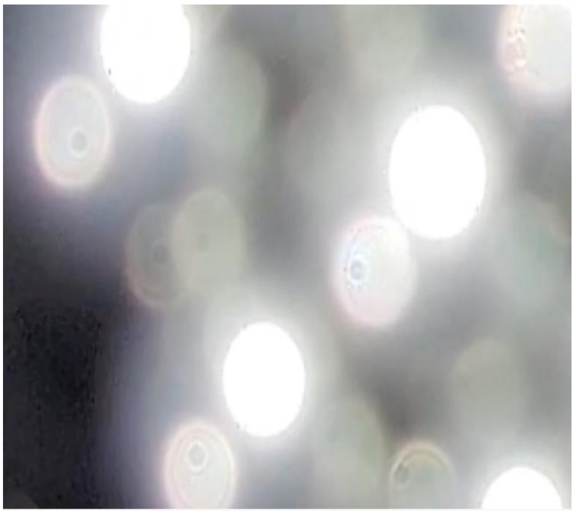

Figure 35. Projected zinc atom with the dome directed upward, indicating ionization

Figure 36. Projected atoms from 4.5-mm zinc ball bearings with a visible dome

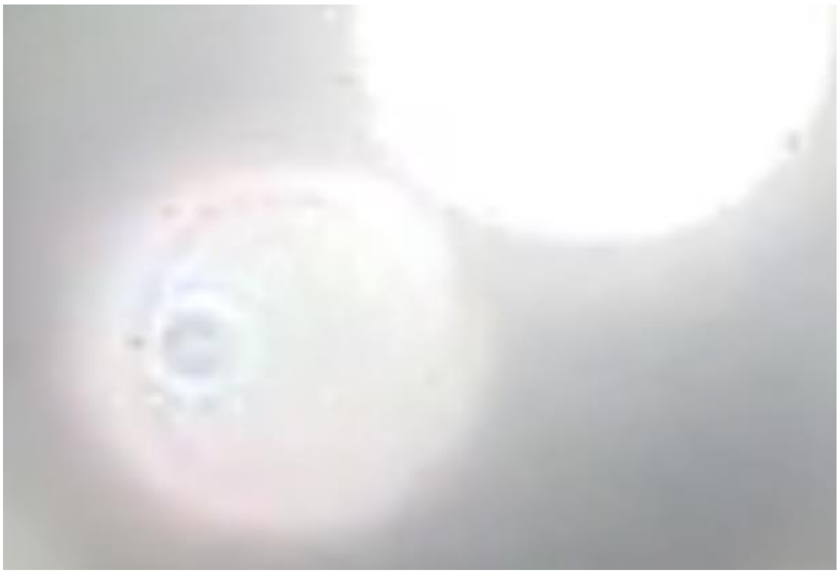

Figure 37. Projected atoms from 4.5-mm zinc ball bearings with a visible dome and visible electrons

In a single incident in which gallium and mercury were mixed, a distortion was produced in the atom projection, preceded by an audible sound (Figure 38).

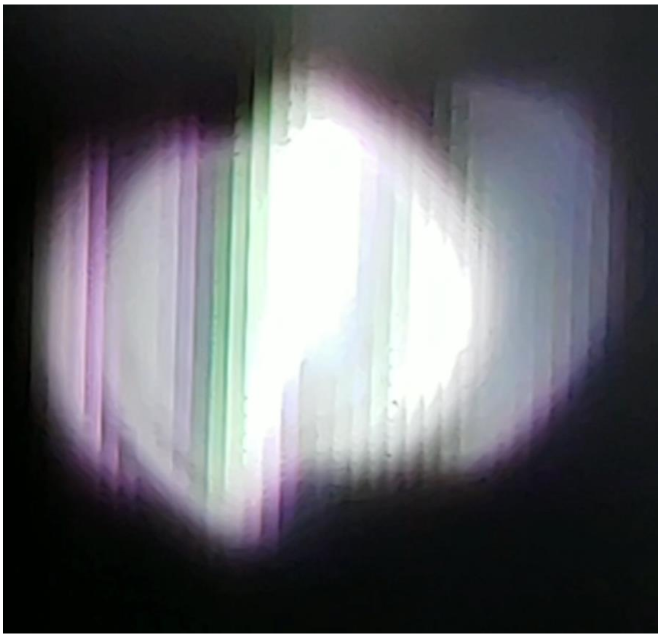

Figure 38. Gallium being absorbed by mercury

The consistent outer and variable inner rings were omnipresent atomic features. Dome formation and atom distortion were rare events tied to environmental stimulus and the introduction of gallium/mercury, respectively.

2. Discussion

2.1 Atomic Gravitational Lensing

The ability to visualize projected atoms is enabled by a phenomenon termed "atomic gravitational lensing." This lensing is caused by the neutral space (Figures) within the atom pulling on externally connected space, flattening the face of the atom. The compressed inner space enhances the photon enlargement after the photons bond to protons.

2.2 Smartphone Camera Advantages

Smartphone cameras possess advantages for capturing atom projections compared with larger digital cameras. Their smaller lenses, sensors, and barrels cause less diffusion before the light reaches the sensor, which enables fine details of atomic structure to be resolved. In general, the small camera sensor and resulting small pixel size result in better resolution for recording projected atoms (Figures 39–41).

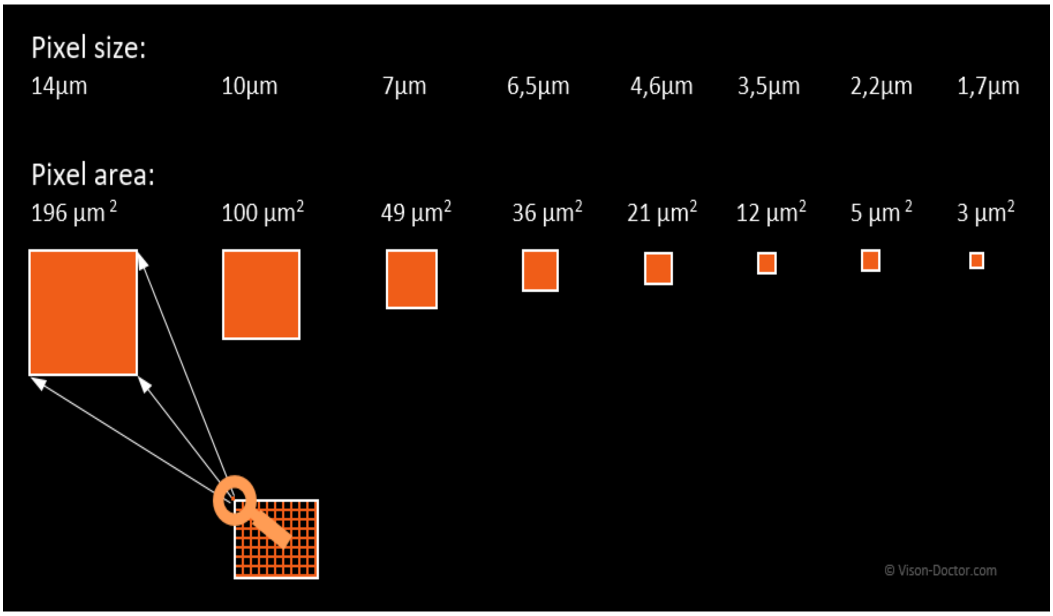

Figure 39. Pixel size compared with sensor size

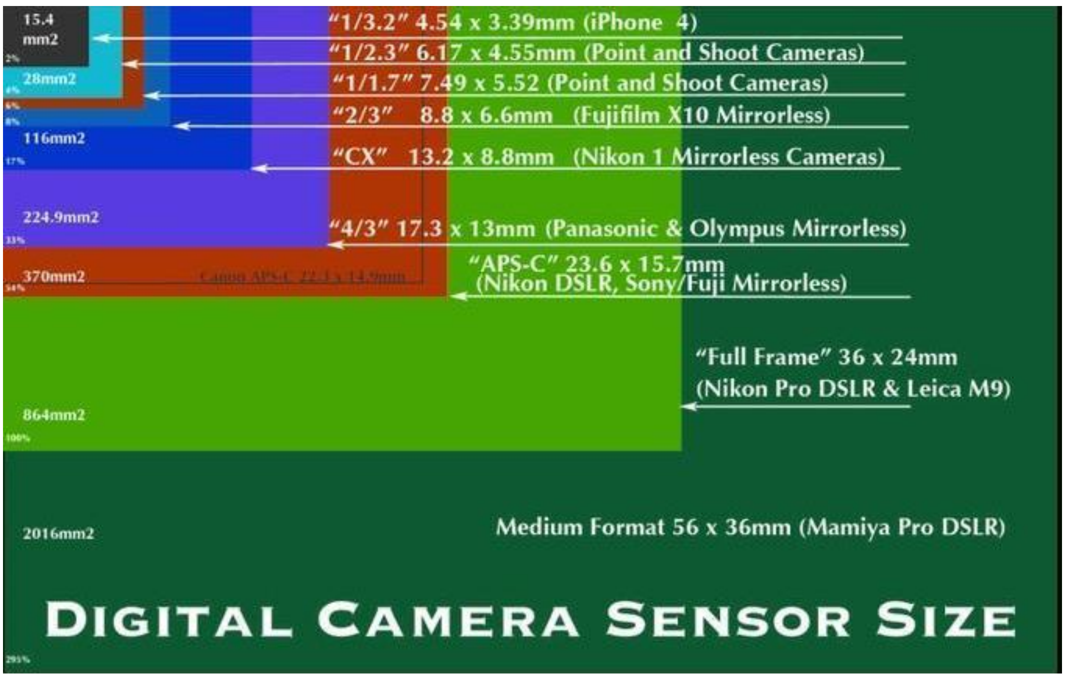

Figure 40. Sample of cameras and camera sensor sizes

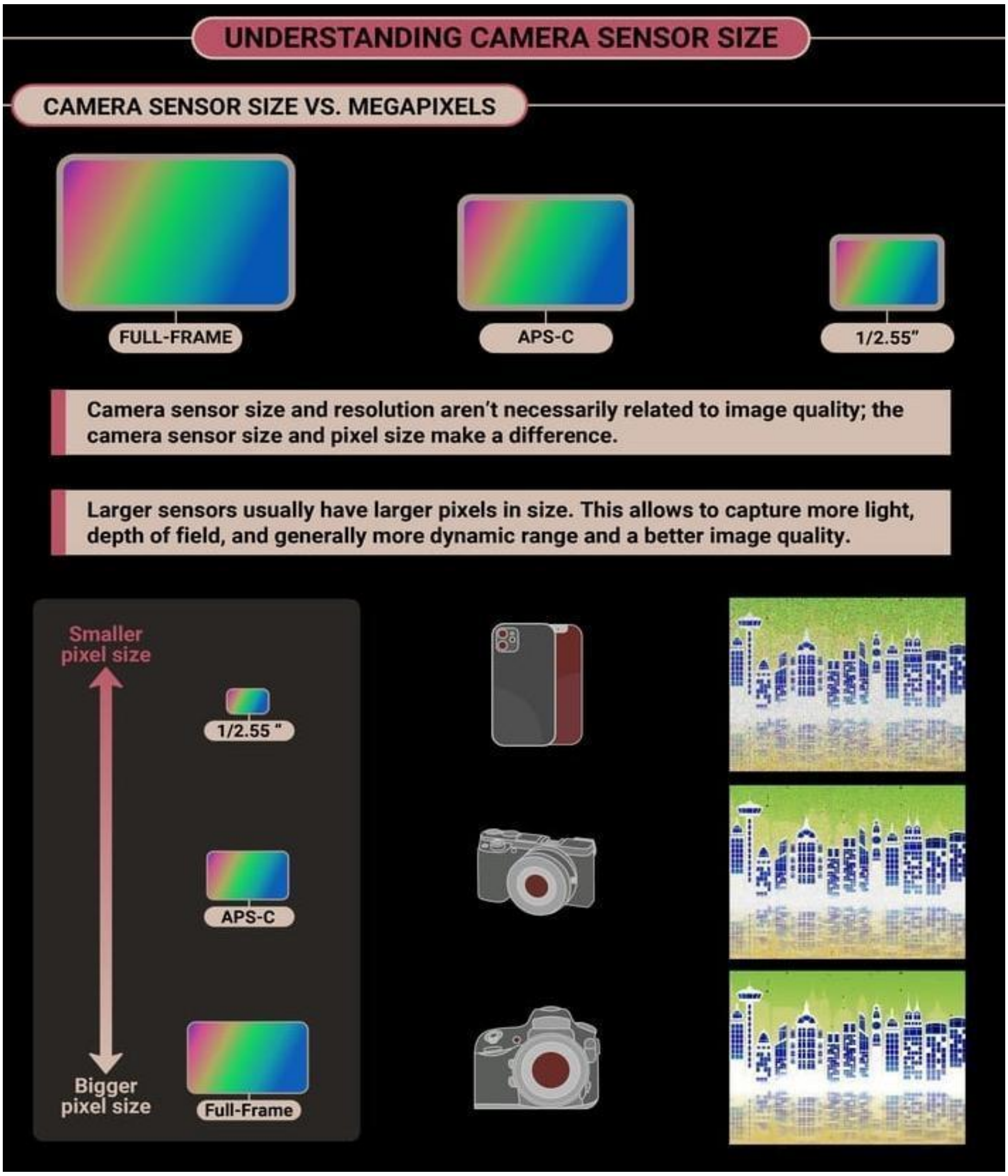

Figure 41. Relationship between camera sensor and pixel size

2.3 Unexpected Discoveries

Many observations were unexpectedly captured during experimentation, such as electrons orbiting atoms. Varying the light angle and distance modulated the focal depth, elucidating different atomic layers in separate recordings. Multiple images were acquired of the same materials under various conditions (e.g., heated/non-heated steel) (Figures 17–19) to study atom state changes (Figures 20–21, 28, 33–37). Individual gold atoms were compared, exhibiting intra-material variations in electron orbiting patterns (Figure 28).

2.4 Proposed Revisions to Accepted Atomic Theory

The observed phenomena suggest that revisions may be needed for mainstream atomic models based primarily on secondary interaction experiments. Direct visualization provides new primary data to advance theories. For example, the application of electrical principles such as Ohm's law can help explain proton flow and current within atoms. We believe that prior foundational work contained interpretive errors that compounded, such as Rutherford's gold foil alpha scattering experiments (Rutherford, 1911). Alpha particles likely passed through atoms and around atom groups rather than being deflected by a concentrated nucleus (Smith, 2001). Cathode ray tube experiments also involved questionable assumptions about electron behavior. Various papers have noted discrepancies between atomic/quantum experimental data and mainstream theory (Padavic-Callaghan, 2022; Hattula, 1987; Comay, 2017; McCormick, 2023; *A hint of excitement*, 2022; Proton Spin Crisis; Rueckner, 2013; Lincoln, 2023; Demmin, 2023). Direct observations provide an opportunity to correct theories. Even foundational work such as the double-slit experiment may warrant re-evaluation based on the projection data reported herein (Rueckner, 2013). This discussion aims to contextualize our technique's advantages, key learnings, and opportunities for theoretical impact. Additional data and analysis will further develop the atomic gravitational lensing model and refine our understanding of subatomic dynamics based on real-time visualization.

2.5 Hypothesis

This research centered around several key hypotheses originating from initial photographic projections and subsequent investigation:

1). Intriguing orb projections initially presumed to be photographic artifacts represent actual projections of subatomic particles originating from within material samples.

2). Through multi-angle testing, these projections will demonstrate consistent orientation, indicating true material emission rather than external reflections (Figures 3–6).

3). Each material tested will project unique atom-specific projections related to its elemental properties.

4). Manipulation of parameters, such as distance, angle, magnification, and temperature, will expose further details of atomic structure and behavior because of lensing effects and adjustments to the focal point.

5). Analysis of photographs, slowed videos, and supplemental tests will enable characterization of these atomic projections to identify features aligning with modern atomic theory as well as novel observations necessitating theory updates.

6). Imaging varied atomic forms, such as emissions from gaseous states, can enable comparative analysis (Figure 42).

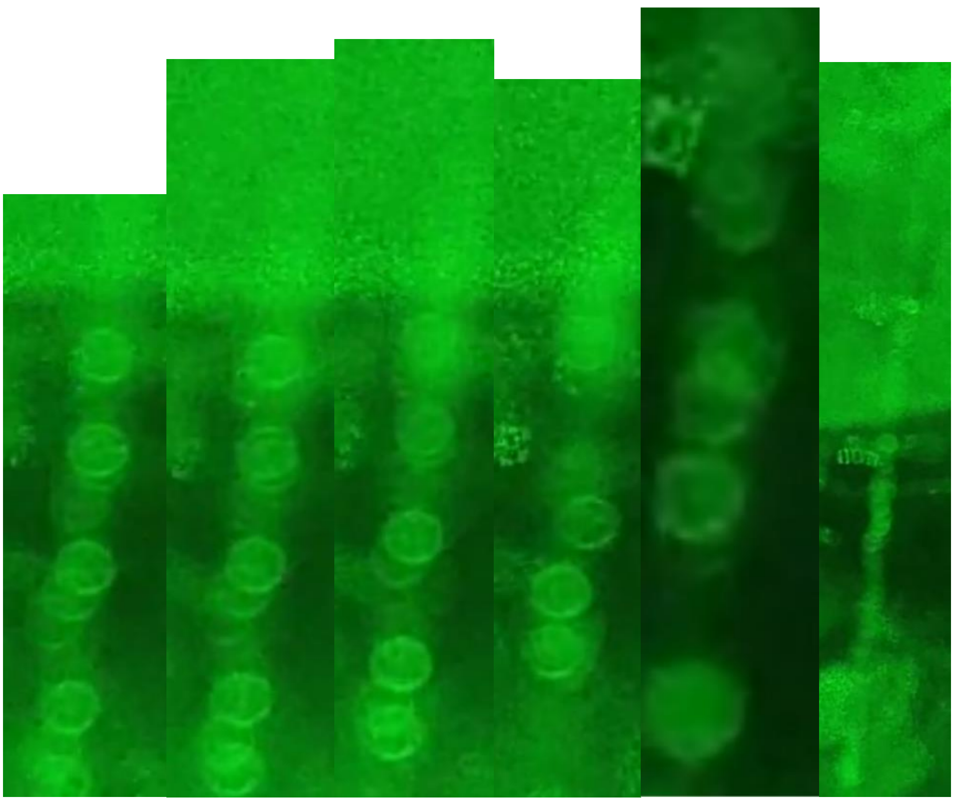

Figure 42. Gas passing through a laser beam inside a vacuum chamber. The projected atoms from the gas were recorded by using the laser as a light source

7). The simplicity of this technique allows casual smartphone-based exploration of atomic projections, enabling widespread direct observations to rapidly advance our understanding based on primary visual evidence.

8). The concentric ringed structure surrounding a rapidly shifting core across elemental projections suggests a common internal architecture arising from a shared formative process within stars rather than unique random constructions.

9). Analyzing movement patterns and charge flows within projected atoms of differing materials can reveal foundational bonding behaviors, leading to generalized atomic modeling.

10). Imaged anomalies, such as dome formations, represent reversible state changes induced by external energy sources, further illuminating innate mechanisms.

11). Subatomic components exhibit certain unifying interactions stemming from primal origins still imprinted within atomic projections eons later, elaborating fundamental particle relationships based on direct visualization.

12). Visualizations of quantum projections indicate that fundamental particles emerge from compressed electrically neutral mass, aligning with a pre-Big Bang uniform state.

13). The rapid motion of atomic cores stems from an imbalance within this compressed space, initiating energy creation and material propagation.

14). Neutron decay observations support the hypothesis that compression instigates the conversion of mass into energy, suggesting an underlying equation of E=m^2.

15). Gravitational, electromagnetic, and quantum forces originate from stabilized pockets of unevenly distributed compressed space, structuring cosmos propagation.

16). Chromodynamic modeling of projected lattice-like arrays can reconstruct initial compression symmetry breaking and phase transitions.

The above set of hypotheses frames the progression of inquiry from initial anomalous projections through increasingly sophisticated imaging, parameterized testing, comparative benchmarking, and atomic modeling revisions. The overarching goal centers around direct visualization of atoms, enabling granular insights to refine accepted theories in physics. The additional hypotheses aim to leverage the consistent projections observed to hypothesize about the standardized atomic genesis and universal bonding rules that shape basic matter. The observed transient anomalies and energy effects can also clarify mechanisms through visual interrogation. Furthermore, foundational constitutive particles within atoms may demonstrate generalized connection patterns linked to their very emergence.

2.6 Methods & Materials

2.6.1 Key Technique Notes

- Adjusting the smartphone camera distance and angle modulates atom projection clarity and focal depth.
- Keeping the lens, flash, and sample surfaces clean is essential.
- No specialized equipment or training is needed.

2.6.2 Materials

- Smartphone with 16-megapixel camera and optical zoom (LG ThinQ G7 used in this work)
- Adjustable helping hands to secure and position phone (Figures 23–25)
- Highly reflective small sample materials
    - Metals: Gold (Figure 28), mercury (Figure 43), gallium, silver (Figure 44), aluminum, sodium
    - Non-metals: Neodymium magnet, water (Figures 8, 27), ice, stainless steel

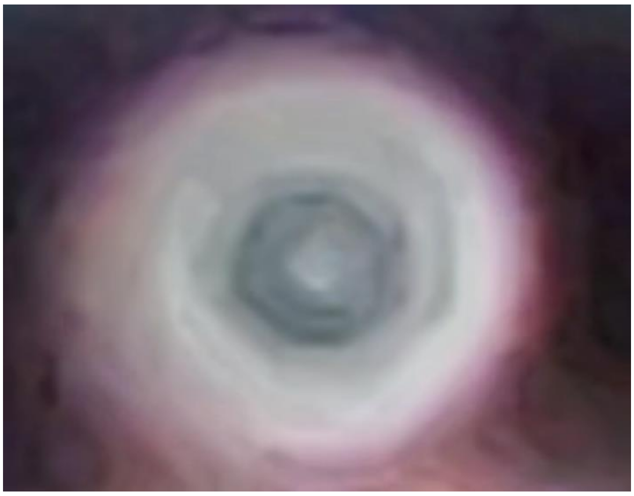

Figure 43. Mercury atom

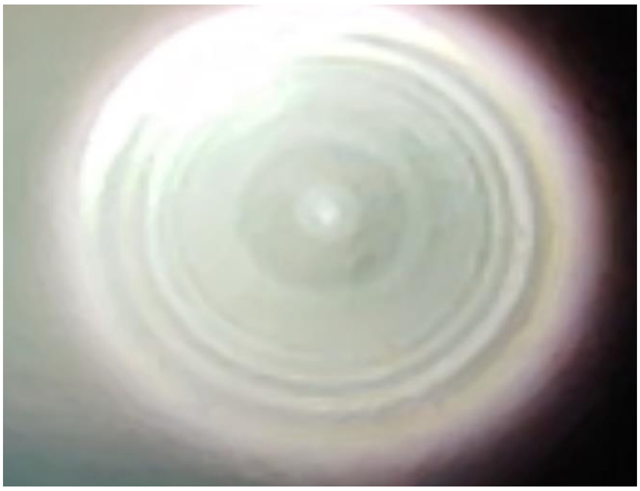

Figure 44. Projected silver atom

2.6.3 Methods

1). Clean phone lens and flash before recording. Clean sample surfaces.

2). Place small material samples on a flat surface under the phone camera.

3). Secure the phone 1.5–2.5 inches over the sample using helping hands. Direct camera and flash straight down.

4). Adjust the height, angle, and distance to clarify projections. Note focal point changes.

5). Record with the flash on. Fine-tune the clarity.

6). For bright metals such as mercury/gallium, reduce camera brightness.

7). Zoom/move the camera until the projection is focused.

8). Slow the playback speed to a minimum of 1/5x to analyze atomic movements.

Supplementary: An improvised smoke vacuum chamber with a laser can capture weak gas atom projections (Figures 23–25).

2.6.4 Materials

- Smartphone with a 16-megapixel camera with optical zoom
- Various sample materials that are highly reflective
- A helping hands device to hold the phone over the sample to allow for easy adjustments

- Small samples

Smaller samples work better, as it is easier to isolate single atoms. The following materials were used in this work: aluminum (Figure 26), gold (Figures 20, 28), mercury (Figure 43), gallium, silver (Figure 44), azimuth, sodium, neodymium magnet, water (Figures 8, 27), ice, and stainless steel (Figure 29).

3. Results & Conclusion

Using three smartphone models (LG ThinQ G7, Samsung Note 21, Moto 5G Stylus), we visually captured and analyzed projected atoms from various materials. Two key atomic structural features were elucidated across materials: a rapidly moving core surrounded by concentric rings flowing with protons. The outermost ring was consistently thick and dense, marking changes in the internal charge flow direction. We hypothesize that the movement is initiated by "compressed space" at the atom's center, an absence of mass and charge resulting from the immense pressures within parent stars. This void perpetually pulls surrounding mass and energy inward, providing the foundational forces of gravity and electromagnetism. As charged particles flow through the atoms pulling on and compressing electrically neutral space/mass, they generate observable electromagnetic waves and fields.

We also performed variations of Young's double-slit experiment (Rueckner, 2013) and observed multiple projections of the source projected from the slit when different types of light sources were used. This led us to conclude that interference arises from photons interacting with matter inside the slit. Both the air and material of the slit would absorb and re-emit light, each acting as a source.

Notable abnormalities occurred during two events:

1) Solar flares induced an excess proton density, manifested as a white dome encapsulation of projected atoms. This observation correlates to an overcharged or ionized state. There may also be a possible correlation between ionization and distance from the sun.

2) A merging event between gallium and mercury atoms elicited visible distortion and audible artifacts in a recording (Figure 38). We posit that this event captured the precise moment of contact and absorption.

These direct visualizations provide enhanced resolution, revealing subatomic activities and interactions. Phenomena such as proton flows, void-induced forces, and electromagnetic consequences support a reconceptualization of mainstream quantum models. Unexpected observations of anomalies also further atomic theory. The accessibility of the technique presented here can empower anyone to contribute to physics discovery. This study significantly advances our understanding of atomic structures and dynamics through real-time projection footage and analysis. Materials science and other domains stand to benefit from the granular insights enabled by this approach.

This method falls short in producing quantifiable data and in providing accurate measurements of the observed phenomena. Although this limitation can be overcome, we lacked the resources to do so. It is my hope that our next step in development will be to overcome this limitation in order to perfect this technique. For the purpose of this paper, this method was used to verify or disprove previous theories and to identify the cause for various phenomena such as gravitational forces and the beginning of our universe, which will prove to be beneficial. This breakthrough will allow humanity to find ways to produce limitless energy through the compression of electrically neutral mass or space. Just as space is limitless, so too are the possibilities for advancement from this culmination of countless scientists who have dedicated themselves to the advancement of our civilization.

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I would like to thank the various Facebook physics groups. I am a member along with Quora for providing an excellent place to apply my hypothesis to various real physics questions. Thank you to my followers on social media who helped me verify these objects when no one else would and provided a place to get feedback regarding various aspects of this study.

Authors' contributions

Ethan Richards was the only contributing author and also conducted all experiments and analysis of data.

Funding

Research was self funded.

Competing interests

I declare I have no competing interests financial or otherwise.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of the Canadian Center of Science and Education.

The journal and publisher adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

Open access

Copyrights

References

Ashman, J., Badelek, B., Baum, G., Beaufays, J., Bee, C. P., Benchouk, C., ... European Muon Collaboration. (1988). A measurement of the spin asymmetry and determination of the structure function g1 in deep inelastic muon-proton scattering. *Physics Letters B*, *206*(2), 364-370. https://doi.org/10.1016/0370-2693(88)91523-7

Bass, S. D. (2017). Spinning gluons in the proton. *Physics, 10*, 23. https://doi.org/10.1103/Physics.10.23

Comay, E. (2017). On the Significance of Standard Model Errors. *Open Access Library Journal, 4*(12), 1-10. https://doi.org/10.4236/oalib.1104164

Demming, A. (2023, June 27). *Scientists tried to solve the mystery of the helium nucleus — and ended up more confused than ever*. Live Science. Retrieved from https://www.livescience.com/physics-mathematics/particle-physics/scientists-tried-to-solve-the-mystery-of-the-helium-nucleus-and-ended-up-more-confused-than-ever

Deur, A., Brodsky, S. J., & de Teramond, G. F. (2019). The Spin Structure of the Nucleon. *Reports on Progress in Physics, 82*(76201), 076201. https://doi.org/10.1088/1361-6633/ab0b8f

Electro-Technic Products. *K1-11: CATHODE-RAY TUBE - DEFLECTION BY CURRENT*. Operating Instructions, Cathode Ray Tube, Model CR-100-A, Electro-Technic Products.

Hansson, J. (July 2010) [8 March 2010]. The "proton spin crisis" – a quantum query (PDF). *Progress in Physics, 3*, 51-52. Archived from the original (PDF) on 2012-05-04.

Hattula, J., Juutinen, S., Jaaskelainen, M., Lonnroth, T., Pakkanen, A., Piiparinen, M., & Sletten, G. (1987). Neutron and proton bands in 122Xe at high spins. *Journal of Physics G: Nuclear Physics, 13*(1), 57-68.

Hetherton, S. (2015, June 1). Are scientists finally on the brink of understanding where proton spin comes from?. Phys.org. Retrieved from https://phys.org/news/2015-06-scientists-brink-proton.html

Jaffe, R. (1995). Where does the proton really get its spin? (PDF). *Physics Today, 48*(9), 24-30. https://doi.org/10.1063/1.881473

Ji, X. (2017). Proton tomography through deeply virtual Compton scattering. *National Science Review, 4*(2), 213–223.

Ji, X., Yuan, F., & Zhao, Y. (2020). Proton spin after 30 years: what we know and what we don't? arXiv preprint arXiv:2009.01291.

Ji, X., Zhang, J.-H., & Zhao, Y. (2013). Physics of the gluon-helicity contribution to proton spin. *Physical Review Letters, 111*(11), 112002. https://doi.org/10.1103/PhysRevLett.111.112002

Lincoln, D. (2023, February 15). *An attempt to solve a quantum problem just deepens the mystery*. Big Think. Retrieved from https://bigthink.com/hard-science/standard-model-discrepancy-fermi-lab/

Liu, K.-F. (2022). Status on lattice calculations of the proton spin decomposition. *AAPPS Bulletin, 32*(1), 8. https://doi.org/10.1007/s43673-022-00037-4

Londergan, J. T. (2009). Nucleon resonances and quark structure. *International Journal of Modern Physics E, 18*(05n06), 1135-1165. https://doi.org/10.1142/S0218301309013415

McCormick, K. (2023, June 12). A New Experiment Casts Doubt on the Leading Theory of the Nucleus. *Quanta Magazine.* Retrieved from https://www.quantamagazine.org/a-new-experiment-casts-doubt-on-the-leading-theory-of-the-nucleus-20230612/

Padavic-Callaghan, K. (2022, August 31). Protons inside some types of hydrogen and helium are behaving weirdly. *New Scientist.* Retrieved from https://www.newscientist.com/article/2335724-protons-inside-some-types-of-hydrogen-and-helium-are-behaving-weirdly/

Proton Spin Crisis. In *Wikipedia.* Retrieved from ttps://en.m.wikipedia.org/wiki/Proton_spin_crisis

Rueckner, W., & Peidle, J. (2013). Young's double-slit experiment with single photons and quantum eraser. *American Journal of Physics, 81*(12), 951-958.

Rutherford, E. (1911). The scattering of α and β particles by matter and the structure of the atom. *The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science, Series 6*, *21*(125), 669-688.

Smith, G. E. (2001). JJ Thomson and the electron, 1897–1899. Histories of the electron. *The birth of microphysics*, 21-76.

Stodolna, A. S., Lepine, F., Bergeman, T., Robicheaux, F., Gijsbertsen, A., Jungmann, J. H., ... Vrakking, M. J. J. (2014). Visualizing the Coupling between Red and Blue Stark States Using Photoionization Microscopy. *Physical Review Letters, 113*(10), 103002.

Thomas, A. (2008). Interplay of spin and orbital angular momentum in the proton. *Physical Review Letters, 101*(10), 102003. https://doi.org/10.1103/PhysRevLett.101.102003

Walsh, K. M. (2016, February 16). Physicists zoom in on gluons' contribution to proton spin. Phys.org. Retrieved from https://phys.org/news/2016-02-physicists-gluons-contribution-proton.html

Notes

Note 1. The datasets generated and/or analyzed in the current study are available in the [Youtube] repository.

Note 2. The datasets used and/or analyzed in the current study are available from the corresponding author (erich6707@gmail.com) upon reasonable request.