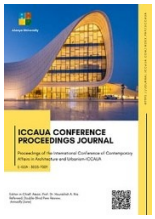

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Architecture on Modern Physics

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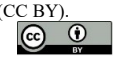

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A b s t r a c t

The question "What is architecture?" is challenging to answer due to its complexity, diverse implications, and its integration into human activity worldwide, from prehistoric history to contemporary applications. This study proposes a methodological approach combining theoretical and experimental exercises. These exercises address environmental laws, the physical dynamics of small and large towns, and the impact of the built environment on both the collective population and individual inhabitants. Our findings highlight the significance of daily construction practices and reveal how modern physics discoveries influence not only the artistic but also the scientific and emotional understanding of the built environment. The global implications of this research are substantial, offering deeper insights into architectural practices and enabling the reproduction and amplification of these insights, ultimately enriching our understanding and engagement with the world.

K e y w o r d s : Architecture; Modern Physics; Built Environment; Methodological Approach.

1. Introduction

Architecture speaks a material language of light, colour, shadow and motion that often eludes verbal explanation. Yet recent advances in modern physics—especially relativity and quantum-scale investigations—offer conceptual and analytical tools for decoding that language and reshaping it in practice. Visual studies of relativistic effects, such as the Terrell–Penrose distortion (Hornof et al., 2025) and first-person simulations of time-dilation (Sherin et al., 2016; Kraus, 2008; Smith, 2011), have shown how space-time elasticity can be rendered perceptible. Parallel progress in building physics has clarified the interplay between ambient conditions, material behaviour and human comfort (Hens, 2016), prompting designers to integrate thermodynamic and radiative principles at the earliest design stage (Lucchi, 2023).

Against this backdrop the present study explores how theories and methods drawn from modern physics can inform both the artistic imagination and the technical performance of the built environment. Using a set of theoretical and experimental exercises applied to small and large urban contexts, we aim to (a) visualise abstract physical phenomena in architectural form, (b) test their environmental implications, and (c) evaluate their experiential impact on occupants (Figure 1). Ultimately, the work seeks to demonstrate that architecture conceived “in the laboratory” of contemporary physics can yield spaces that converse more closely with the laws governing the universe and, by extension, with the everyday lives of their users.

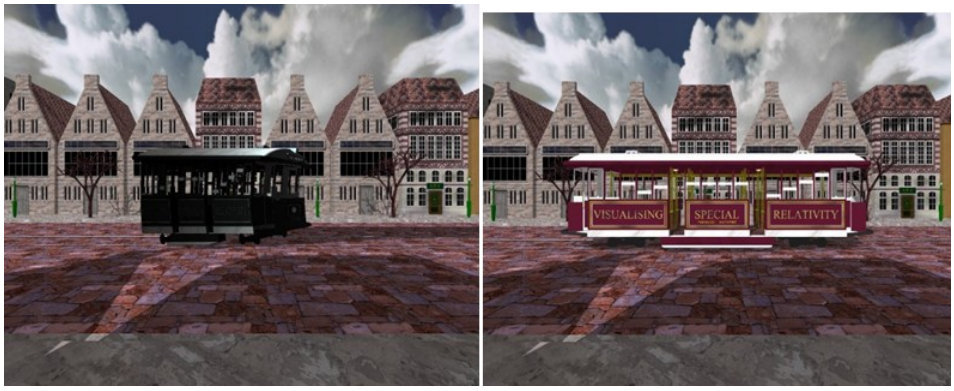

Figure 1. The everyday urban context and its perceptual complexity.

2 Discussion

2.1 Visualising relativity in architectural space

Relativistic visualisation techniques translate the malleability of space-time into compelling geometric distortions and light paths (Figure 2). When mapped onto building envelopes, these transformations unsettle conventional notions of façade flatness and orthogonality, inviting designers to conceive volumes that embody curvature and temporal layering. Hornof et al. (2025) show that relativistic motion compresses and elongates perceived forms; embedding such effects in parametric modelling platforms enables architects to generate massings that morph with the viewer's trajectory. These explorations resonate with earlier pedagogical tools like OpenRelativity (Sherin et al., 2016) and Kraus's first-person renderings (2008), which situate the observer within a continuously recalibrated spatial field.

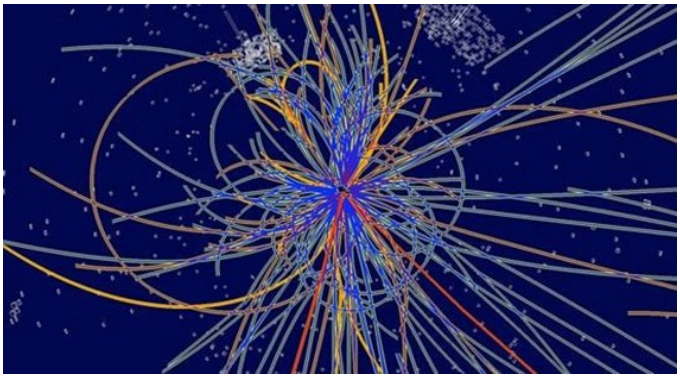

Figure 2. Concept sketch of space-time curvature expressed as façade deformation.

2.2 Material and environmental implications

Modern physics does not end at formal expression; it also deepens our understanding of matter–energy exchanges. Building-physics scholarship emphasises that envelope performance hinges on precise knowledge of heat flow, radiation and moisture dynamics (Hens, 2016). Recent studies in both temperate and severe-cold climates confirm that optimised envelope assemblies can cut operational energy while maintaining indoor comfort (Haj Hussein et al., 2022; Zhang et al., 2024; Huynh et al., 2021; Al-Shatnawi et al., 2024). By aligning those insights with quantum-scale explanations of thermal conductivity and photon transport, architects can tailor material stratifications that respond adaptively to diurnal and seasonal fluxes (Lucchi, 2023).

Moreover, the experimental exercises conducted here—such as manipulating surface geometries derived from relativistic light-deflection scenarios (Figure 3)—reveal measurable shifts in solar gain and daylight distribution. These outcomes support the proposition that physics-informed aesthetics can reinforce, rather than compromise, environmental performance.

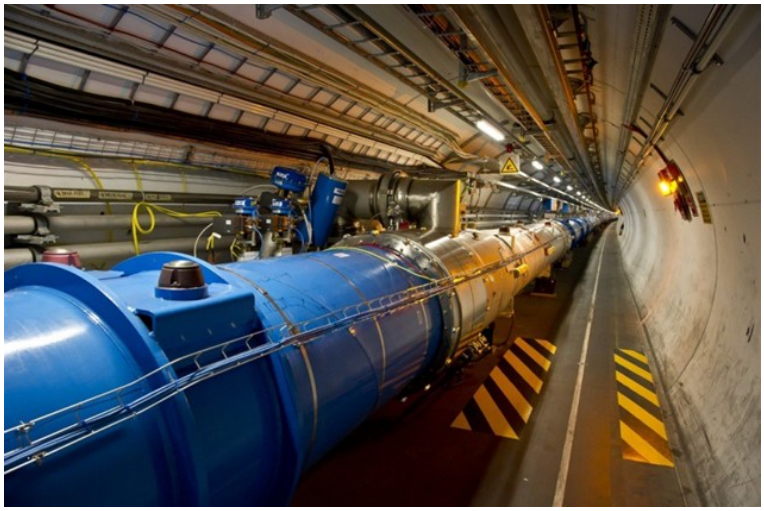

Figure 3. Relativistic light-path study informing daylighting strategy.

2.3 Experiential and socio-cultural dimensions

Architecture's ultimate test lies in lived experience. Our preliminary user-walkthroughs of digitally prototyped spaces suggest that physics-derived geometries heighten spatial awareness, encouraging occupants to move, pause and re-orient in ways that conventional rectilinear layouts seldom provoke (Figure 4). Such kinaesthetic engagement accords with phenomenological claims that perception is inseparable from bodily movement. By foregrounding scientific narratives—relativity, quantum indeterminacy, Higgs-field mass generation—the built environment becomes an interpretive interface, fostering public understanding of complex scientific ideas while enriching daily routines.

Figure 4. Virtual walkthrough highlighting occupant re-orientation in physics-informed space.

3 Conclusion

This paper has argued that modern physics can serve as both muse and metric for contemporary architecture. Relativistic visualisation techniques provide a fertile source of formal inspiration, while advances in building physics ground those forms in environmentally responsible practice. Empirical evidence from envelope-performance research (Haj Hussein et al., 2022; Zhang et al., 2024; Huynh et al., 2021; Al-Shatnawi et al., 2024) and from our own simulation exercises demonstrates that scientifically informed design can couple aesthetic novelty with tangible thermal and luminous benefits.

Future work should expand the methodological repertoire to include quantum-optical materials and real-world prototyping, thereby testing the socio-psychological impacts observed in virtual environments. By sustaining this dialogue between architecture and modern physics, designers may cultivate spaces that not only shelter but also educate, inspire and resonate with the fundamental structures of reality.

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