Certain Bodies in Uncertain Fields:

Thinking about gender through queer theory & quantum mechanics

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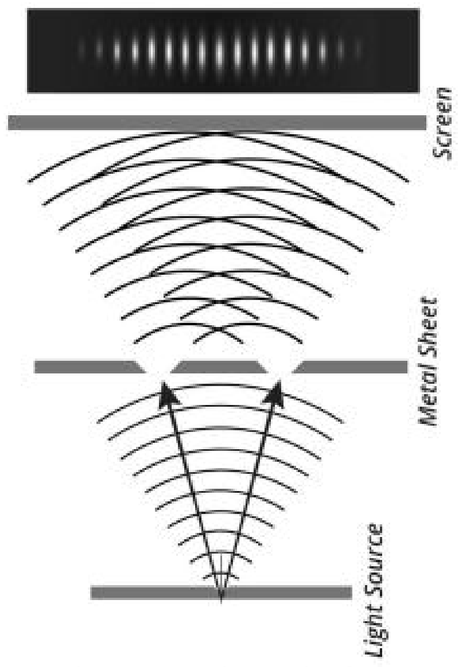
BUTLER'S PERFORMANCE THEORY

- Gender is a person's perceiving or internal perception of their identity [1]
- Sex is a person's biological and physiological characteristics [1]
- Two contrasting theories are biological determinism and Butler's Performance Theory
- Biological determinism asserts gender is a given characteristic assigned at birth [1]
- Butler's theory considers gender to be socially constructed and created through the way a person performs or enacts their gender identity [1,2]
- Identities, such as gender, may offer epistemic advantages in certain domains



https://tinyurl.com/2hzpfjuc

QUANTUM ONTOLOGY

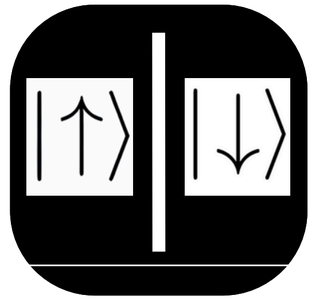
- Physicists must navigate two ontologies: classical and quantum
- Classical physics utilizes a positivist ontology due to its deterministic nature [3]
  - Objects can have their trajectories mapped
  - Current and future values of position and momentum can be known simultaneously
- Quantum physics utilizes a probabilistic ontology due to the inherent uncertainty [3]
  - The Heisenberg uncertainty principle asserts there is a restriction on the precision position and momentum can be simultaneously known
  - Particles can be described using particle model when interacting with detector [3]
  - Particles should be conceptualized as delocalized waves when propagating through space [3]
  - Gives rise to wave-particle duality [3]

$$\Delta x \Delta p \geq \frac{h}{4\pi}$$

EPISTEMOLOGICAL ADVANTAGE OF QUEER IDENTITIES IN UNDERSTANDING QUANTUM THEORY

- There are parallels between physics and gender ontologies
- Positivism is present in classical physics and biological determinism
  - Ability to determine trajectory of objects is analogous to prescribing the gender identity of a person at birth
- Superpositions and uncertainty exist in quantum physics and Butler's performance theory
  - Similar to how measurement using classical instrument collapses superposition of particle
    - Aspects of individual's gender identity collapses into binary of masculine or feminine when viewed through biological determinism
  - Entanglement allows for two or more particles to influence the state of the other regardless of the spatial distance between then [4]
    - Individuals' identities can be entangled with each other in complex ways that transcend conventional categories
    - One's gender identity might not be isolated or independent but rather intertwined with and influenced by the identities of others
- One study [6] found at times the stereotypes associated with being a queer woman provided those individuals with greater credibility and respect in STEM
- Glamrou's [7] account of locating their own identity within quantum theory raises curiosity over the epistemological advantage to identifying outside the gender binary when learning quantum concepts

> *"Quantum physics is to Newtonian physics what Queer theory is to heteronormativity."*
> *-Glamrou [7]*



QUEERING QUANTUM EDUCATION RESEARCH

- Future research may seek to understand the potential epistemological advantage that queer identities offer to quantum theory.
  - However, researchers must recognize the inherent biases within academic and heteronormative frameworks.
  - As [5] emphasizes the act of generating data and attempting to systematically analyze it may inadvertently reinforce existing power dynamics and perpetuate normative assumptions about gender and identity.
  - Researchers must critically reflect on their methodologies and ensure inclusivity and sensitivity to research participants with diverse experiences.
- [5] cautions against uncritical adoption of rigid scientific methodologies in studying human systems.
  - By blindly applying methods from physical sciences to social contexts, there is a risk of overlooking the intricacies of human experiences and perpetuating harmful stereotypes.
  - Humans are involved in PER, both as researcher and participant, inherently making the system both more complex and entangled with the social realities that dictate the lives of students.
- By decentering hegemonic narratives and embracing diverse methodologies researchers can foster inclusivity and advance a more nuanced understanding of physics education.
  - Researchers may uncover new insights into the epistemological advantage that queer individuals bring to the study of quantum phenomena, enriching both quantum educational research and broader scientific discourse.

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[1] A. L. Traxler, X. C. Cid, J. Blue, and R. Barthelemy, Phys. Rev. Phys. Educ. Res. 12, 020114 (2016).
[2] J. Butler, Theatre J. 40, 519 (1988); Gender Trouble: Feminism and the Subversion of Identity, (Routledge, 1990).
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5] M. Swirtz and R. Barthelemy, Queering methodologies in physics education research, presented at the Physics Education Research Conference 2022.
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[7] BBC Ideas, Gender identity: "What quantum physics taught me about my queer identity," Youtube (2019).
[8] W.K. Adams, K.K. Perkins, N.S. Podolefsky, M. Dubson, N. D. Finkelstein, and C.E. Wieman, Phys. Rev. Phys. Educ. Res. 2, 010101 (2006).