

Psych 289

Winter quarter 2019

Course Title: Nature of Reality

Instructor: Kourosh Saberi

This course examines the nature of physical reality and its perceptual representation. The course is inherently interdisciplinary, drawing from topics in physics, cognitive science, evolutionary biology, and philosophy. The following is a tentative schedule and reading list. The course will be run as a seminar in which students lead the discussion of each week's topic.

Week 1: Introductory papers (What is reality?)

Max Tegmark (2014). "Internal Reality, External Reality, and Consensus Reality", in *Our Mathematical Universe*, pp. 233-242.

Max Tegmark (2014). "Physical Reality and Mathematical Reality", in *Our Mathematical Universe*, pp. 243-271.

[Max Tegmark is Professor of Physics at MIT]

Week 2: Perceptual representation of reality

Plato (514a–520a). "The Allegory of the Cave", in *The Republic*. Book VII (pp. 1-5)

Freeman, E. (1951). Veridical Perception. *Am J Optom Arch Am Acad Optom.* 28, 213-20.

Hoffman, D. (2015). "The interface theory of perception", *Psychonomic Bulletin & Rev.*, 22, 1480-1506.

Anderson, B. (2015). "Where does fitness fit in theories of perception?", *Psychonomic Bulletin & Review*, 22, 1507-1511. [A Critique of Hoffman's theory]

Week 3: Perception of Time

Einstein, A. (1905). "On the Electrodynamics of Moving Bodies", translated from *Annalen der Physik*. 17:891, 1905. (pp. 1-23). [Original paper on special relativity]

Petkov, V. (2013). "Spacetime and the Illusion that time flows", Published in *From Illusions to Reality: Time, spacetime, and the nature of reality*. pp. 109-117

Max Tegmark (2014). "Is Time an Illusion?", Published in *Our Mathematical Universe*, pp. 272-318.

Feynman, R. (1965). "The Distinction of Past and Future." In *The Character of Physical Law*, pp. 108-126.

Week 4: The Anthropic Principle

Carter, Brandon (1974). "Large number coincidences and the anthropic principle in cosmology". In M. S. Longair (ed.) *Confrontation of Cosmological Theories with Observational Data*, 291-298.

[First use of the phrase: Anthropic Principle]

Schombert, James (2018). "Anthropic Principle," *Lectures from the Dept. of Physics, Univ. of Oregon*.

John Maynard Smith & Eors Szathmary (1996). "On the likelihood of habitable worlds", *Nature*, 384, 107. [John Maynard Smith was a pioneer in development of evolutionary game theory]

Week 5: Consciousness and physics

Rosenblum, B., and Kuttner, F. (2011). "The mystery of consciousness", In *Quantum Enigma: Physics Encounters Consciousness*. pp. 221-236.

Penrose, R. (1995). "Consciousness involves nocomputable ingredients", In *The Third Culture: Beyond the Scientific Revolution* (edited by Steven Pinker and Stephen J. Gould), Chapter 14, pp. 239-261.

[Rosenblum is Professor of Physics and former Chair of Physics Department at UC Santa Cruz; Kuttner is Lecturer in Physics at UC Santa Cruz; Penrose is Professor of Mathematics at Oxford University]

Week 6: Probability and uncertainty (Epistemic vs. ontological randomness):

Feynman, R. (1965). "Probability and uncertainty: The quantum mechanical view of nature", In *The Character of Physical Law*, pp. 127-148.

George Gamow (1966). "W. Heisenberg and the uncertainty principle", In *Thirty Years that Shook the World*, pp. 98-117.

Grangier, P., and Aufferes, A. (2018). "What is quantum in quantum randomness", *Philosophical Transactions of the Royal Society (A)*, 376, 1-12.

Week 7: Action at a distance: Entanglement & superposition

Einstein, A., Podolsky, B. and Rosen, N. (1935). "Can Quantum-Mechanical Description of Physical Reality Be Considered Complete?" *Physical Review*, 47, 777-780 [known as the EPR paper, first reference to quantum entanglement].

Rosenblum, B., and Kuttner, F. (2011). "Seeking a Real World: EPR." In *Quantum Enigma: Physics Encounters Consciousness*. pp. 155-169.

Rosenblum, B., and Kuttner, F. (2011). "Spooky Action: Bell's Theorem." In *Quantum Enigma: Physics Encounters Consciousness*. pp. 173-192.

Rosenblum, B., and Kuttner, F. (2011). "Schrodinger's controversial cat." In *Quantum Enigma: Physics Encounters Consciousness*. pp. 143-153. [thought experiment related to the finding that an object (particle) could be in two different places or two different states at the same time]

Week 8: Real world manifestations of quantum theory

Ball, P. (2018). "Real-life Schrodinger's cats probe the boundary of the quantum world." *Quanta Magazine*, June 25, 2018, pp 1-7.

DiVincenzo, D. P. (1995). "Quantum Computation". *Science*. **270** (5234): 255–261

Knight, W. (2018). *Serious quantum computers are finally here: What are we going to do with them?* MIT Technology Review, pp. 1-14.

Week 9: What we don't observe: Dark Matter and Antimatter

De Swart, J. G., Bertone, G., and van Dongen, J. (2017). "How dark matter came to matter." *Nature Astronomy*, 1, pp. 1-7.

Hossenfelder, S., and McGaugh, S. S. (2018). "Is dark matter real." *Sci Am.*, 319 no. (8). pp. 36-43.

George Gamow (1966). "Dirac and Anti-particles." Published in *Thirty Years that Shook the World*, pp. 118-138.

Week 10: A new kind of reality: String theory

Holt, J. (2018). "The String Theory Wars: Is Beauty Truth?" In *When Einstein Walked with Godel: Excursions to the Edge of Thought*. pp. 219-229.

Bousso, R., and Polchinski (2004). "The String Theory Landscape." *Sci Am.*, 291, no. 3, pp. 78-87.