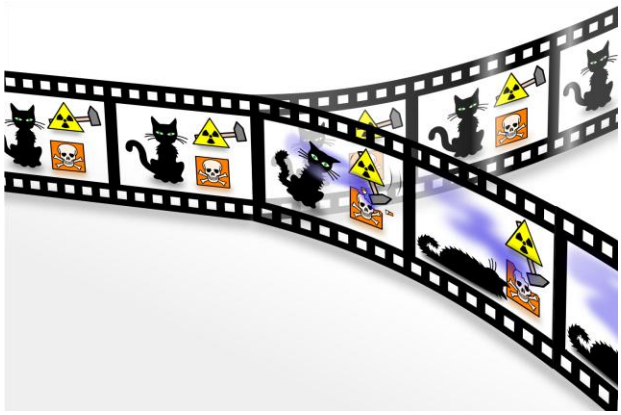
PHYS 190: The Multiverse in Physics and Fiction



> "In fact plural realities did exist superimposed onto one another like so many film transparencies. What I still do not grasp, however, is how one reality out of the many becomes actualized in contradistinction to the others."—Philip K. Dick
>
> "Could the solution to the dilemma of indeterminism be a universe in which all possible outcomes of an experiment actually occur?"—Bryce S. DeWitt

Multiverse stories are popular in fiction and film. The multiverse is popular even in serious discussions of quantum physics and cosmology. We will read a small sampling of multiverse fiction as well as nonfiction explorations of the many worlds interpretation (MWI), quantum decoherence, local realism, the fine-tuned universe, cosmological inflation, the simulation hypothesis, and related topics.

READING LIST:

Books:

Rizwan Virk, *The Simulated Multiverse*.

Catriona Silvey, *Meet Me in Another Life*.

Dexter Palmer, *Version Control*.

Short texts (free, follow hyperlinks):

Jorge Luis Borges, "The Circular Ruins."

Isaac Asimov, "The Last Question."

Philip K. Dick, "If You Find This World Bad, You Should See Some of the Others."

A PLAYGROUND OF IDEAS:

This course is a playground of ideas. We can explore ideas and their implications without agreeing with them. When we ask, "Are there other worlds that we can't see?" we wander into theological territory. Our readings explicitly raise various theological questions, which I think are fun to explore regardless of our own personal beliefs.

CONTENT WARNING:

Meet Me in Another Life: A brief scene of murder/suicide.

Version Control: Several minor characters are offensive and racist, and there is brief but extremely offensive language (mostly in Chapter 25, which you may skip). I think the author is giving examples of obviously bad behavior to motivate us to evaluate our own behavior and try to be better.

GRADING:

We may all wish we lived in a universe where there were no grades, or everyone automatically got an A. However, in this timeline, the grades have to be based on something. The course grade will have three components:

Pre-class questions: At least one hour before the beginning of each class (except the first class), submit two questions you have about any of the reading for that class (anything you want to discuss, phrased as questions). Please do not use AI for this.

Reading quizzes: In every class (except the first class), there will be a very brief quiz about the readings for that class. You should be able to recall major features of the readings, like the main characters' names.

Final essay or review or story: A minimum of 1500 words. You have three options:

- Write an essay about any aspect of multiverse physics, philosophy, or fiction.
- Write a review of a book or film with a multiverse theme (not the class readings).
- Write a short story with a multiverse theme.

You may submit as many drafts as you want, starting any time. Please do not use AI for this. Writing teaches us to think. We don't want to outsource our thinking to a machine.

Grades will be computed as follows:

40%: the best 20 of 27 pre-class question submissions (no late submissions)

45%: the best 15 of 27 reading quizzes (no make-up quizzes; you need only 15)

15%: final essay or review or story (in lieu of final exam)

READINGS:

9/1: Borges, Asimov, Dick

9/3: Virk (Ch. 1), Silvey (“Welcome to Forever”)

9/8: Virk (Ch. 2), Silvey (“Open Your Eyes,” “No Going Back”)

9/10: Virk (Ch.3), Silvey (“Love Is War”)

9/15: Virk (Ch. 4), Silvey (“Meant to Be,” “Not Enough Sky”)

9/17: Virk (Ch. 5), Silvey (“A Better World”)

9/22: Virk (Ch. 6), Silvey (“We Are Here,” “Till Next Time”)

9/24: Virk (Ch. 7), Silvey (“Look Behind You”)

9/29: Virk (Ch. 8), Silvey (“The Vanishing Now,” “Never Means Never”)

10/1: Virk (Ch. 9), Silvey (“Nothing to Lose”)

10/6: Virk (Ch. 10), Silvey (“Follow the Light,” “Who We Are”)

10/8: Silvey (“In the Stars,” “Only One Choice”)

10/15: Virk (Ch. 11), Palmer (Ch. 1-4)

10/20: Virk (Ch. 12), Palmer (Ch. 5-6)

10/22: Virk (Ch. 13), Palmer (Ch. 7)

10/27: Virk (Ch. 14), Palmer (Ch. 8-9)

10/29: Palmer (Ch. 10-11)

11/3: Palmer (Ch. 12-14)

11/5: Palmer (Ch. 15-16)

11/10: Palmer (Ch. 17-19)

11/12: Palmer (Ch. 20-21)

11/17: Palmer (Ch. 22-24)

11/19: Palmer (Ch. 25-26)

11/24: Palmer (Ch. 27-29)

12/1: Palmer (Ch. 28-34)

12/3: Palmer (Ch. 35-36)

12/8: Palmer (Ch. 37-38, Coda)

OUTLINE OF PHYSICS TOPICS:

Interpretations of Quantum Mechanics

- Bell's theorem
    - Everyday assumptions ("local realism") impose mathematical constraints (Bell inequalities)
    - Quantum theory disobeys these constraints
    - Two conflicting predictions: does experimental data agree with everyday assumptions or quantum theory?
- Collapse of the wavefunction and the measurement problem
    - Solved by the many worlds interpretation (MWI)?
    - Quantum decoherence
- Other interpretations
    - Copenhagen
    - Bohmian (pilot wave, nonlocal realism)
    - Spontaneous collapse
    - QBism
- Thought experiments and real experiments
    - Schrodinger's cat
    - Infinite square well
    - Double slit
    - Quantum eraser
    - Delayed choice

Special Relativity

- The speed of light in empty space is the same for all observers
    - The speed of light is absolute, so:
    - Time and space warp when shifting perspectives ("reference frames")
- Time dilation
- Length contraction
- Simultaneity depends on observer; chronological order may depend on observer
- Can superluminal signaling send messages to the past (and split timeline)?

Quantum Computing

- Foundations: qubits and quantum gates
- Experimental test of Bell inequalities
- Deutsch and other quantum algorithms: “collaboration with other universes”?
- No-cloning theorem, no-signaling principle, and impossibility (?) of sending messages to the past
- Quantum teleportation (actually achieved but not actually teleportation)

Optional Additional Readings

- Perkowitz, "How Two Rebel Physicists Changed Quantum Theory."
- Mermin, “Is the moon there when nobody looks? Reality and the quantum theory.”
- Gibney, “Physicists disagree wildly on what quantum mechanics says about reality, *Nature* survey shows.”
- Deutsch and Lockwood, “The Quantum Physics of Time Travel.”
- Goff, “Our Improbable Existence Is No Evidence for a Multiverse.”
- Musser, “Alternate Timelines Can’t Help You, Quantum Physicists Say.”
- Bostrom, “Are You Living in a Computer Simulation?”
- Becker, *What Is Real? The Unfinished Quest for the Meaning of Quantum Physics*.
- Brody, *Quantum Entanglement*.
- Brody, *The Joy of Quantum Computing: A Concise Introduction*.

Simulations

- Falstad, 1-D Quantum Mechanics Applet
- Becker, Quantum Roulette and the Nature of Reality.
- Brody, The Riddle of the Quantum Triplets.
- The Quantum Mechanics Visualization Project.