01. Introduction

- **Central topic**: Nature of space(time).
- Three approaches:

A. **Metaphysics**: What kind of thing is space?

*Sample responses:*

- Space is an absolute substance existing independently of physical objects. If you take all physical objects out of the world, space would be left.  
  - Issac Newton

- Space consists merely in the relations between physical objects. If you take all physical objects out of the world, nothing would be left.  
  - W. G. Leibniz
B. Epistemology: *How is knowledge of space possible?*

**Sample responses:**

*Immanuel Kant*

> Knowledge of space is based entirely on pure reason alone, and reason says it's geometry is necessarily Euclidean.

*Henri Poincaré*

> Knowledge of space is based entirely on experience, and experience indicates that the geometry of space is a matter of convention.
C. **Physics:** *What role does space play in theories of motion?*

- What is the role of space in Newtonian mechanics?

> Absolute space and absolute time are necessary to provide the unique fixed frame of reference by means of which motion can be unambiguously defined.

- What is the role of space in relativistic mechanics?

> Measurements of space and time are relative to inertial reference frames: inertial observers will disagree on the spatial distance and time interval separating two events (but they will all agree on the spatiotemporal distance between two events).

- What does general relativity tell us about the nature of space?

- How does what we take to be the nature of space influence our approach to quantum gravity?
Preliminaries
1. Logic.

• Study of deductive arguments:

\[ \text{argument} = \text{a set of sentences consisting of} \]

(1) conclusion (the claim being argued for)
(2) premises (reasons given for the claim)

\[ \text{valid-deductive argument} = \text{an argument in which, if} \]

the premises are true, the conclusion must be true.

1. Joe is British.
2. No British citizens are president.
\[ \therefore \text{Joe is not president.} \]

1. Some people become nuns.
2. I'm a person.
\[ \therefore \text{I'll become a nun.} \]

1. All pigs can fly.
2. Wilbur is a pig.
\[ \therefore \text{Wilbur can fly.} \]

If the conclusion of a valid-deductive argument is false, then one or more premises must be false.
**Indirect Proof (reductio ad absurdum):**

- To argue that claim $p$ is false:
  1. Assume $p$ is true.
  2. **Derive** an **unacceptable** conclusion $q$ (*i.e.*, construct a valid-deductive argument with $q$ as conclusion, where $q$ is known to be false, self-contradictory, or inconsistent with $p$).
  3. Conclude that $p$ must be false.

- **Ex.** $p =$ Zeno wasn't in class.
  1. Zeno wasn't in class.
  2. If Zeno wasn't in class, he would not have signed the roster.

  \[ \therefore \] Zeno did not sign the roster. ($q$)

- **Now:** Suppose $q$ is false.
- Since we have a valid-deductive argument with a false conclusion, one or more of its premises must also be false.
- **Premise 2** seems acceptable.
- **So:** Premise 1 (our claim $p$) must be false.
2. Scientific Theories.

\[ theory = \text{a set of basic principles (laws and definitions) from which further claims can be derived.} \]

\[ possible \ world = \text{a world in which a theory and all the claims that can be derived from it are true.} \]

Two ways in which a theory can be good:

(1) \textit{(Applied aspect.)} A theory is good if it matches the facts \textit{(i.e., if its claims are true in the actual world).}

(2) \textit{(Logical aspect.)} A theory is good if it is consistent \textit{(i.e., if there is at least one possible world it describes).}

\begin{itemize}
  \item \textit{Analogy:}
    \begin{itemize}
      \item A \textit{sound} argument is a valid-deductive argument with true premises.
      \item A \textit{valid-deductive} argument has premises that need not be true, but \textit{if} they are, then the conclusion must be true.
    \end{itemize}
\end{itemize}

\textit{Goal of theorist:} construct a theory that is \textit{both} consistent (has at least one possible world) \textit{and} matches the facts (is true of the actual world).