01. The 2-Slit Experiment

- *What is the world made of?*
- The dominant view in the 17th & 18th centuries: Newtonian corpuscular ontology:

![Diagram of Newtonian gravity model](image)

- **lump of matter**
- **empty space**
- *stable corpuscles of matter - held in place by forces*
- *model - Newtonian gravity*
• Extends to a theory of light:

• *Corpuscular theory of light*: Newton *Optiks* (1704).

• *Wave theory of light*
  - minority view (Huygens 17th cent.)
  - candle = source of light waves
  - stone = source of water waves...
- \textit{Decision in favor of Wave Theory:} interference phenomena.

\begin{center}
\textit{interference of water waves}
\end{center}

\begin{align*}
\text{constructive interference} & \quad \text{crest} + \text{crest} = \text{higher crest} \\
\text{destructive interference} & \quad \text{crest} + \text{trough} = \text{cancelation}
\end{align*}
• Thomas Young's 2-Slit Experiment (1800):

bands of light and dark according to whether waves interfere constructively or destructively
• Thomas Young's 2-Slit Experiment (1800):
• If light consists of corpuscles, should see...

but No!
2-Slit Experiment for electrons (Davisson & Germer 1927)

- Shoot electrons at double slits...

\[\text{All experiments reveal standard interference pattern (like Young’s experiment).}\]

\[
\begin{aligned}
\text{Are they particles being guided through slits to hit screen in interference pattern?} \\
\text{OR} \\
\text{Are they really waves?}
\end{aligned}
\]
2-Slit Experiment for electrons (Davisson & Germer 1927)

- Shoot one at a time...

- Which slit will it go through?
- Where will it hit?

- **Result of Experiment:** No determinate prediction!
  - Can only predict the *probability* of which slit it will go through and where it will hit!
• Suggests *Probability Interpretation* of electron position...

Region of constructive interference = region of high probability of finding an electron.

Region of destructive interference = region of low probability of finding an electron.
Different ways to interpret the notion of probability

A. **Ontic Interpretation**: A probability is a property of objects.

(1) **Relative Frequency Account**
- A probability is a property of a *group* of objects

  "Electron A has probability of 1/2 of going through upper slit."

  *means*

  "As sample of electrons shot through slits increases, the frequency of the proportion that go through upper slit approaches 1/2."

(2) **Propensity Account**
- A probability is a property of a *single* object

  "Electron A has probability of 1/2 of going through upper slit."

  *means*

  "Electron A has an intrinsic tendency (propensity) of 1/2 of going through upper slit."

B. **Epistemic Interpretation**: Probability is a measure of degree of belief.

"Electron A has probability of 1/2 of going through upper slit."

*means*

"We lack enough knowledge to know definitely which slit Electron A will go through."
Probabilities in QM are **ontic**.

\[ \implies \]

QM description is **complete**. No theory can predict with certainty which slit electron will go through.

Probabilities in QM are **epistemic**.

\[ \implies \]

QM description is **incomplete**. Some other complete theory can predict which slit electron will go through.