12. Kant and Handedness

- "Concerning the Ultimate Foundation of the Differentiation of Regions of Space" (1768).

**Claim:** Absolute space is necessary to explain the existence of incongruent counterparts.

[An incongruent counterpart is]...an object which is completely like and similar to another, although it cannot be included exactly within the same limits."

- An incongruent counterpart is a *certain type* of mirror image.
Maps (1) and (2) reproduce the same relations between objects.

A relationist must say they are the same.

An absolutist can say they are different; namely, they differ in their locations with respect to absolute space.
Two types of mirror image

Let $O$ be an object and let $O'$ be its mirror image.

(1) $O'$ is a **congruent counterpart** of $O$ if it can be made to coincide with $O$ by rigid motions.
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   ![congruent counter]({})

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**Important Fact**: Whether or not a mirror image is an incongruent counterpart depends on the properties of the space it is located in.
• If the space is 3-dimensional, then F and its mirror image are congruent counterparts.
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- If the space is 2-dimensional and non-orientable, then $F$ and its mirror image are congruent counterparts.

*Example*: A Möbius strip.
• If the space is 2-dimensional and non-orientable, then $\mathbf{F}$ and its mirror image are congruent counterparts.

**Example:** A Möbius strip.

• Obtained by identifying edge points $x$ with $x'$, and $y$ with $y'$ on a 2-dim strip.

• **Result:** A global "twist" that allows the mirror image of $\mathbf{F}$ to be rigidly transported around the entire space back onto $\mathbf{F}$. 
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![Diagram of a Möbius strip](image)
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Modified definition:

An object is an *incongruent counterpart* of another if they cannot be made to occupy the same place by rigid motions in a local (closely surrounding) region of space.

- An object is said to possess *handedness* (chirality) just when it and its mirror image are incongruent counterparts.

- An object is said to lack *handedness* (chirality) just when it and its mirror image are congruent counterparts.

spherical cow
Kant's Argument for Absolute Space

"Let it be imagined that the first created thing were a human hand, then it must necessarily be either a right hand or a left hand."

- But: A relationist cannot determine the handedness of an object in the absence of other objects.
- So: Relationalism is not adequate.

- Left and right hands agree on all relational properties.
- Absolutist: They disagree on their locations with respect to absolute space.
Letter Example Again

Do F and its mirror image have the same relational properties?

- Depends on how many properties one is willing to consider as relational.

THE QUICK BROWN FOX JUMPED OVER THE LAZY DOG.

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- F and its mirror image differ in their relational properties to the other letters in the sentence.

- There is no way to make the mirror image of F fit into the sentence in the same way that F does.

- Similarly, there is no way to fit a right hand into a left-handed (Freddy Krueger) glove (and vice versa).
• *But:* How can a relationist determine the handedness of an object when there are no other reference objects to define distinguishing relational properties?

• *Moreover:* What if such reference objects themselves have been reflected?

**THE QUICK BROWN FOX JUMPED OVER THE LAZY DOG.**

• Since F and its mirror image share all relational properties in these sentences, a relationist will not be able to distinguish them.

• *Absolutist intuition:* Aren't F and its mirror image distinct, independent of their relations to other objects?
Relationist's Reflection Argument

• **Suppose**: Absolute space exists.

• **Then**: The following two universes must be possible:

  - An absolutist must claim the reflection produces distinct worlds.
    - They differ on their values of absolute position.

  - A relationist will claim that the reflection does not produce distinct worlds.
    - Since the relations between material objects are unaffected (and there's no such thing as absolute space), the worlds are not distinct.
Possible Absolutist Retort:

- Would a reflected world be indiscernible from an unreflected world?
- Replace Spock with a decaying Cobalt-60 atom:

\[ \text{Co}^{60} \rightarrow \text{Ni}^{60} + e^- + \bar{\nu}_e \]

- Co\(^{60}\) decay (electron emitted in direction of nuclear spin) is observed more often than Mirror Co\(^{60}\) decay (electron emitted in opposite direction of nuclear spin) (Wu et al. 1957).
- Evidence that the weak force (that governs decay) violates mirror symmetry (\textit{i.e.}, "parity").
• **Absolutist Claim**: The reflected and unreflected worlds are not observationally indiscernible.
  - *In world 1, the Co$^{60}$ atom decay occurs more frequently than in world 2.*

• Onus is now on the relationist to explain the physical difference between worlds 1 and 2.
  - *Recall Clarke's Dynamic Shift, with parity-violating experiments now replacing inertial effects.*
Let it be imagined that the first created thing were a Co\textsuperscript{60} decay process, then it must necessarily be either a right-handed Co\textsuperscript{60} decay process, or a left-handed Co\textsuperscript{60} decay process... and there's a law-like physical difference between the two!

- Can a relationist both \textit{ground} the distinction between right- and left-handed processes and \textit{explain} why one is more probable than the other?

  (a) Claim that the difference is \textit{intrinsic}: Co\textsuperscript{60} decay processes possess an intrinsic monadic (non-relational) property that \textit{both} determines their handedness \textit{and} their weak-force-governed behavior.

  (b) Claim the difference is \textit{extrinsic}:

   - What determines whether the first created Co\textsuperscript{60} decay process is right- or left-handed is its relation to all subsequent Co\textsuperscript{60} decay processes.

   - \textit{And}: It is a brute lawlike fact (in need of no further explanation) that one of these decay processes is more probable than the other.
A Lingering Concern about Option (b)

**First:** What explains Newton's First Law? How does a force-free object know to move inertially?

- Absolutist: A *local* interaction between spacetime and the object (local spacetime "feelers").
- Relationist: A *nonlocal* correlation between the object and other objects (nonlocal *inertial* antennae).

**Similarly:** What explains the parity-violating weak force? Why do Co$^{60}$ atoms prefer decay modes of one chirality rather than another (given chirality is not intrinsic)?

- Absolutist: A *local* interaction between spacetime and the object.
- Relationist: A *nonlocal* correlation between the object and other objects (nonlocal *weak-force* antennae).

**Is one set of mysterious antennae (absolutist) better than two (relationist)?**