

12. Kant and Handedness

1. Incongruent Counterparts
2. Kant's Argument for Absolute Space



Immanuel Kant
(1724-1804)

1. Incongruent Counterparts

- "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.

Example 1



(1)



(2)

- 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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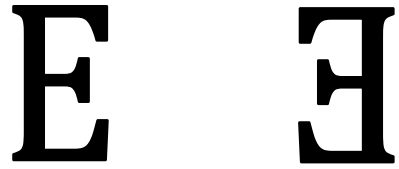
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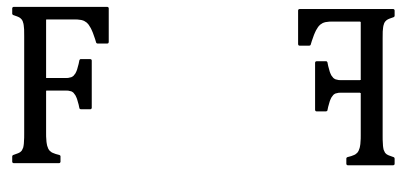
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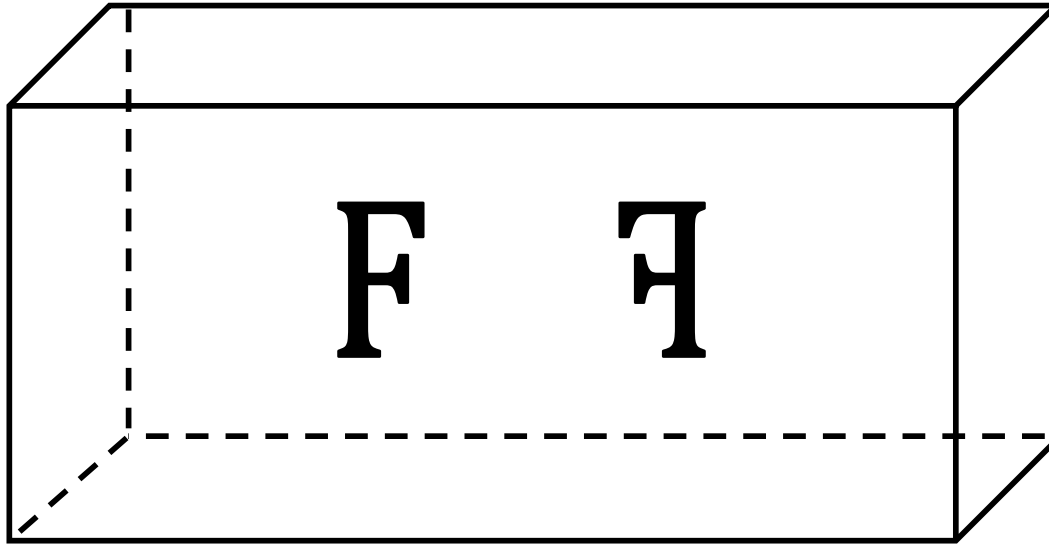


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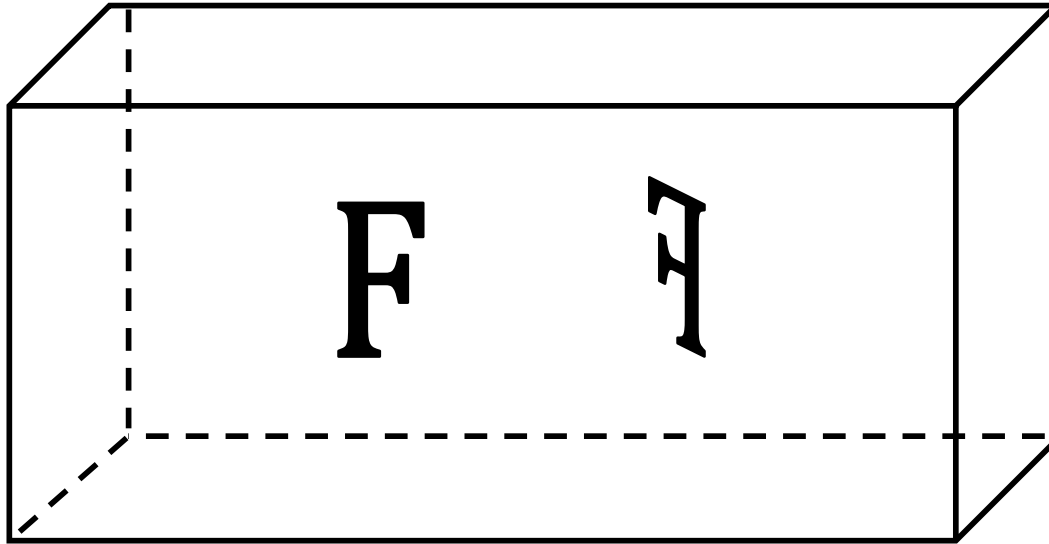


Important Fact: Whether or not a mirror image is an incongruent counterpart depends on the properties of the space it is located in.

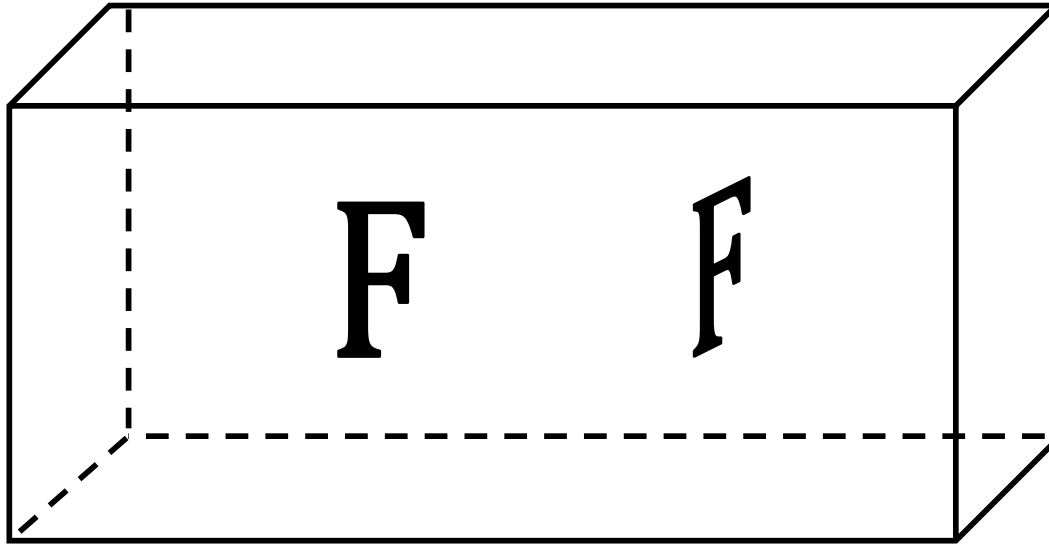
- If the space is 3-dimensional, then F and its mirror image are congruent counterparts.



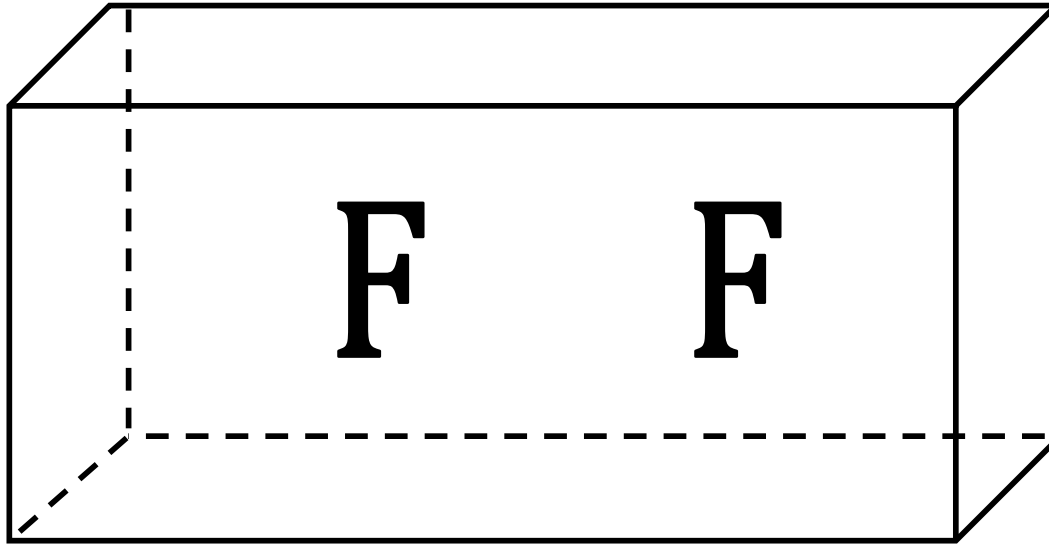
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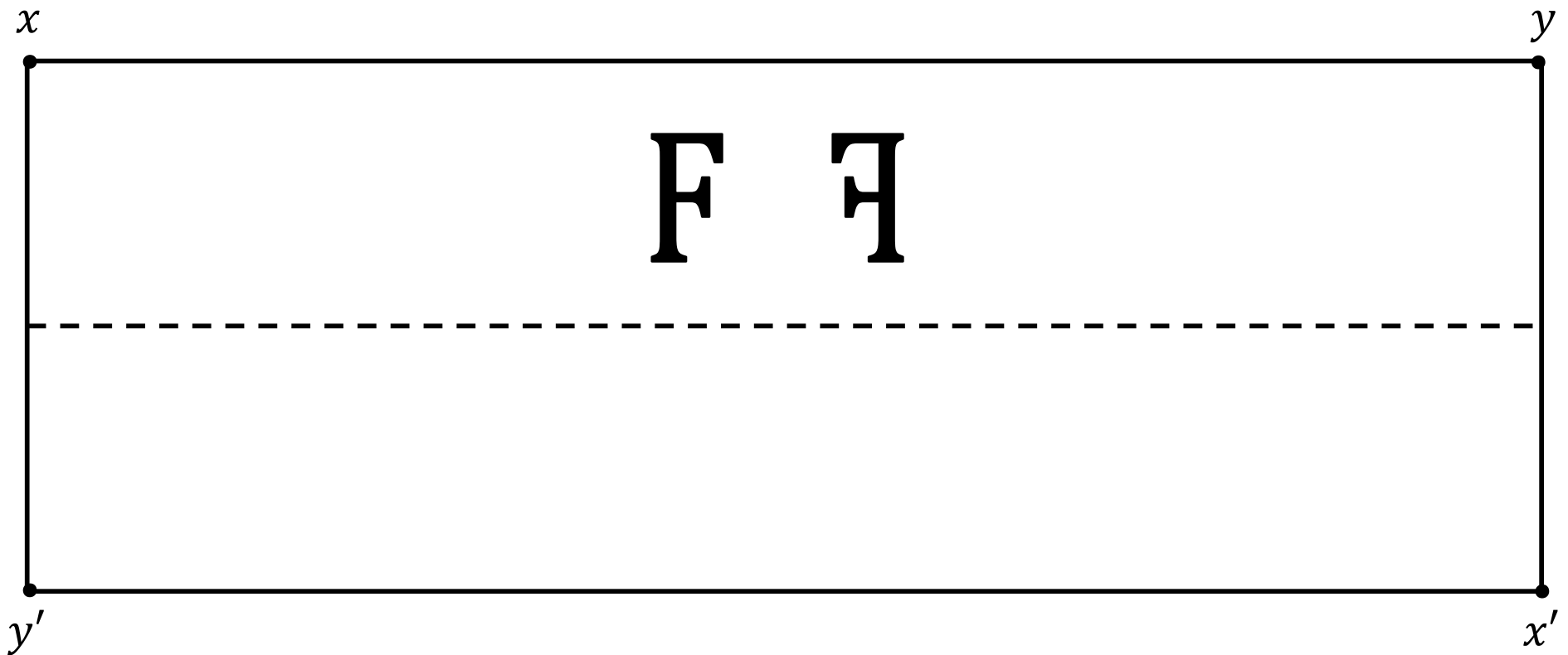
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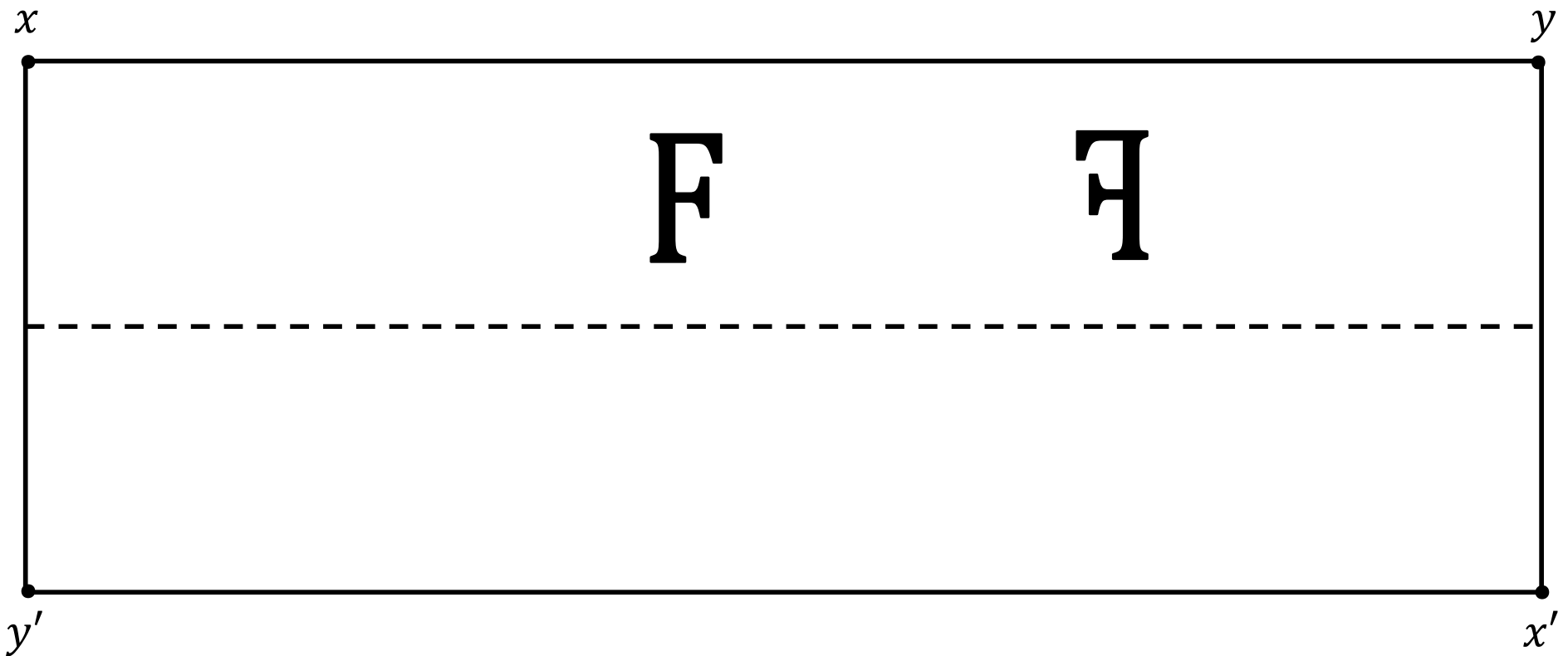
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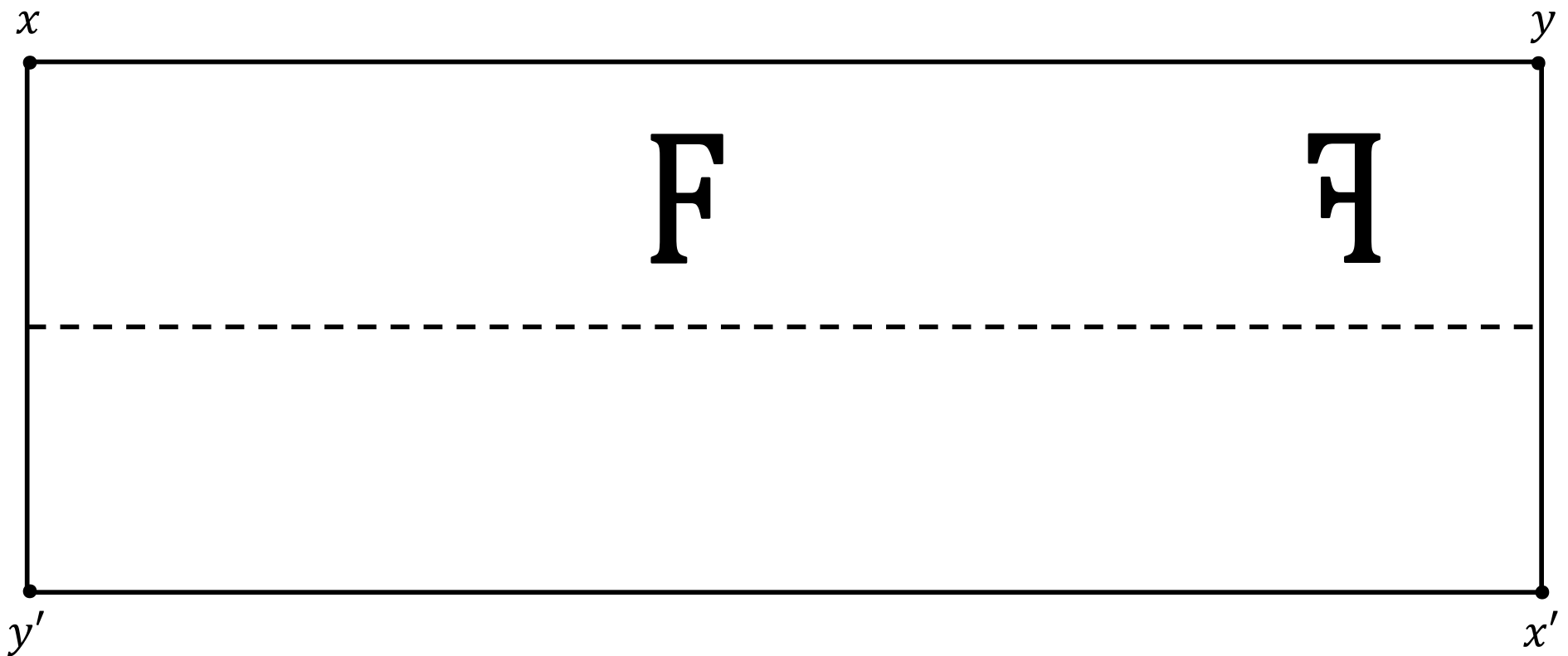
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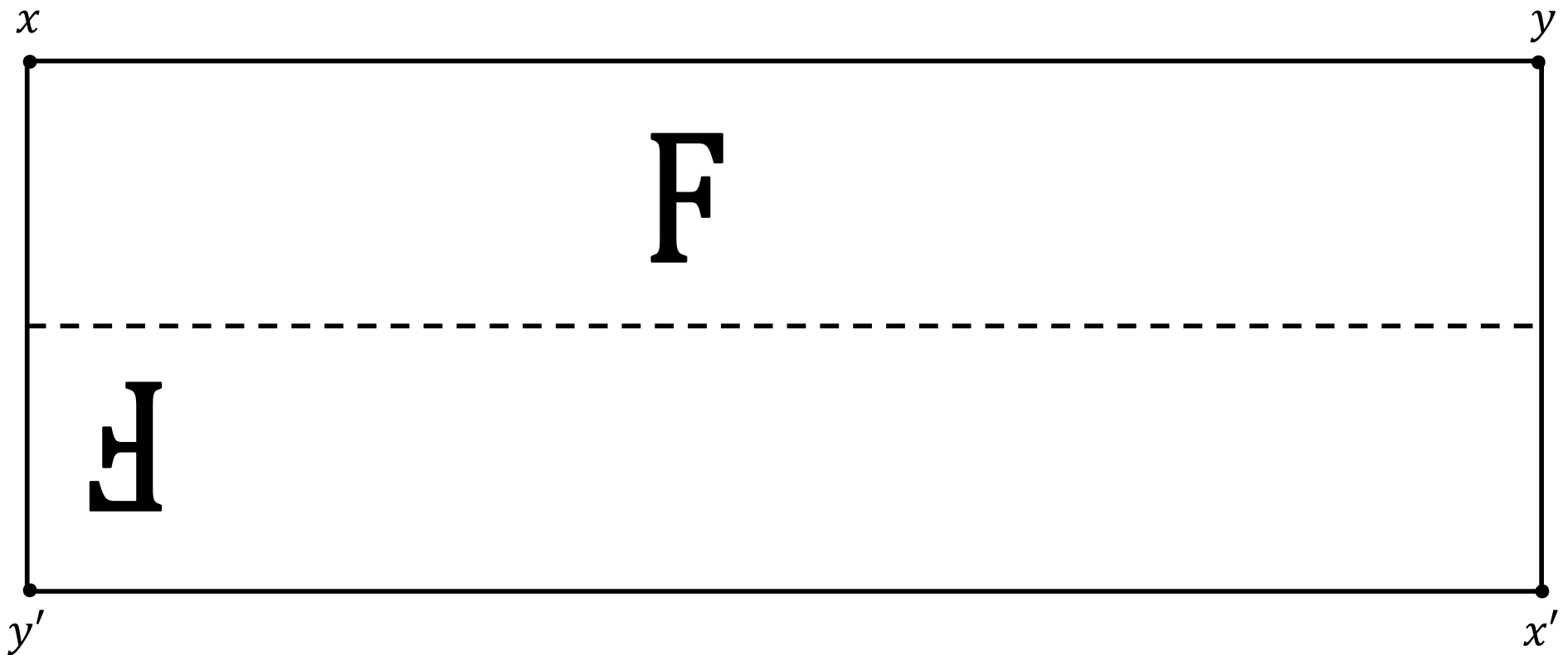
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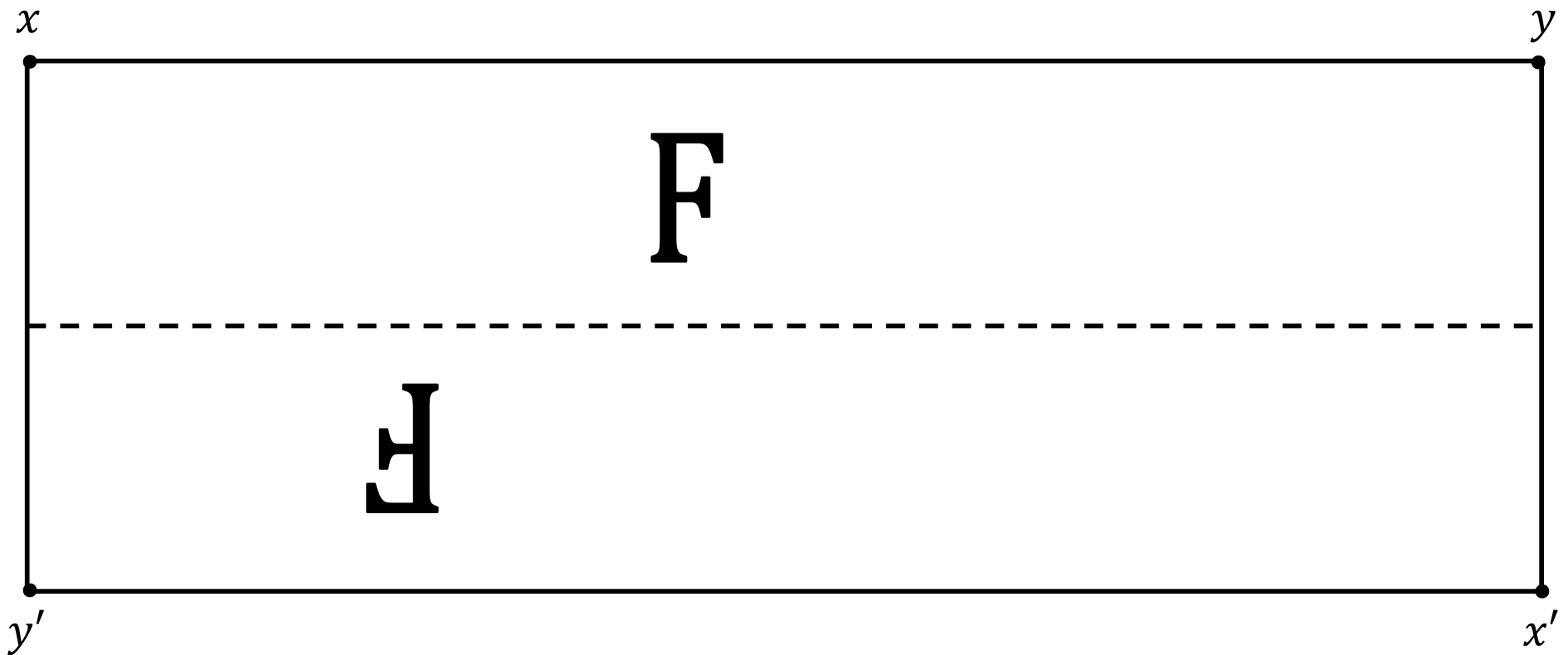
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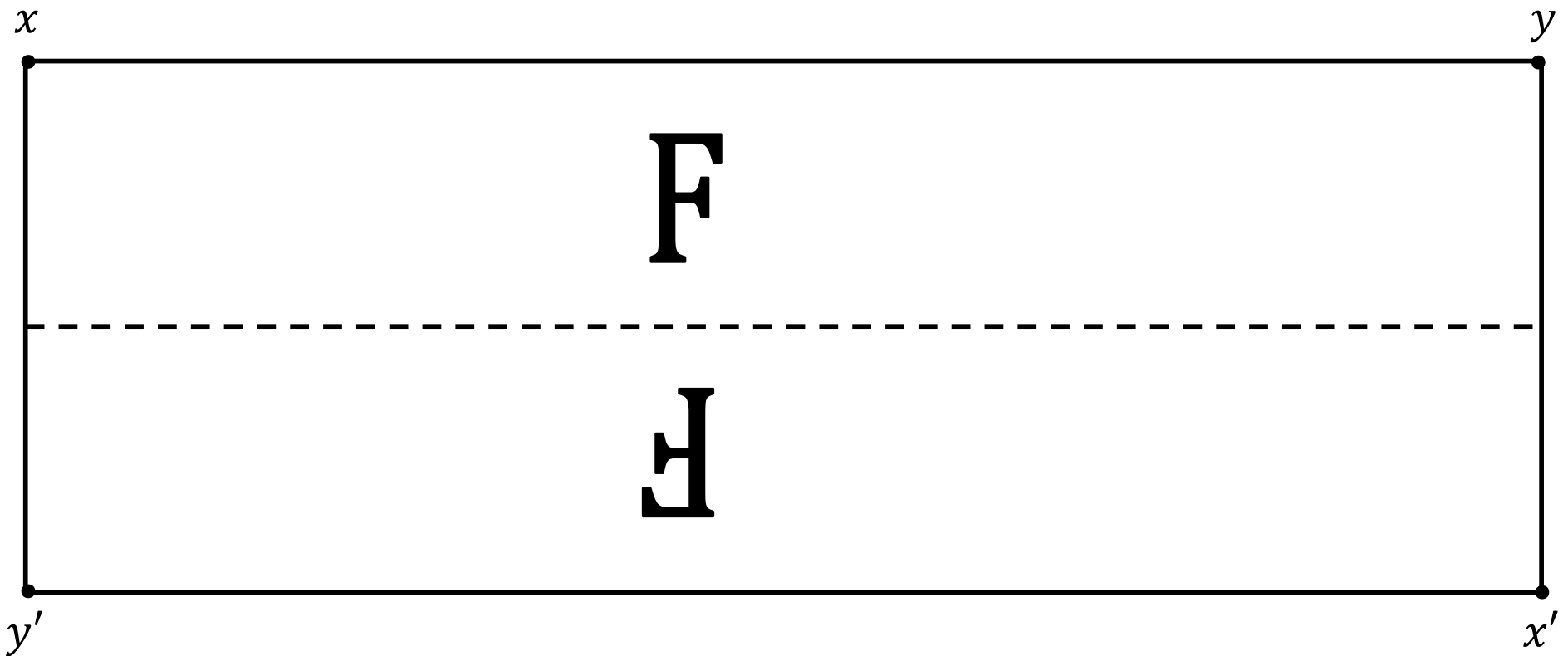
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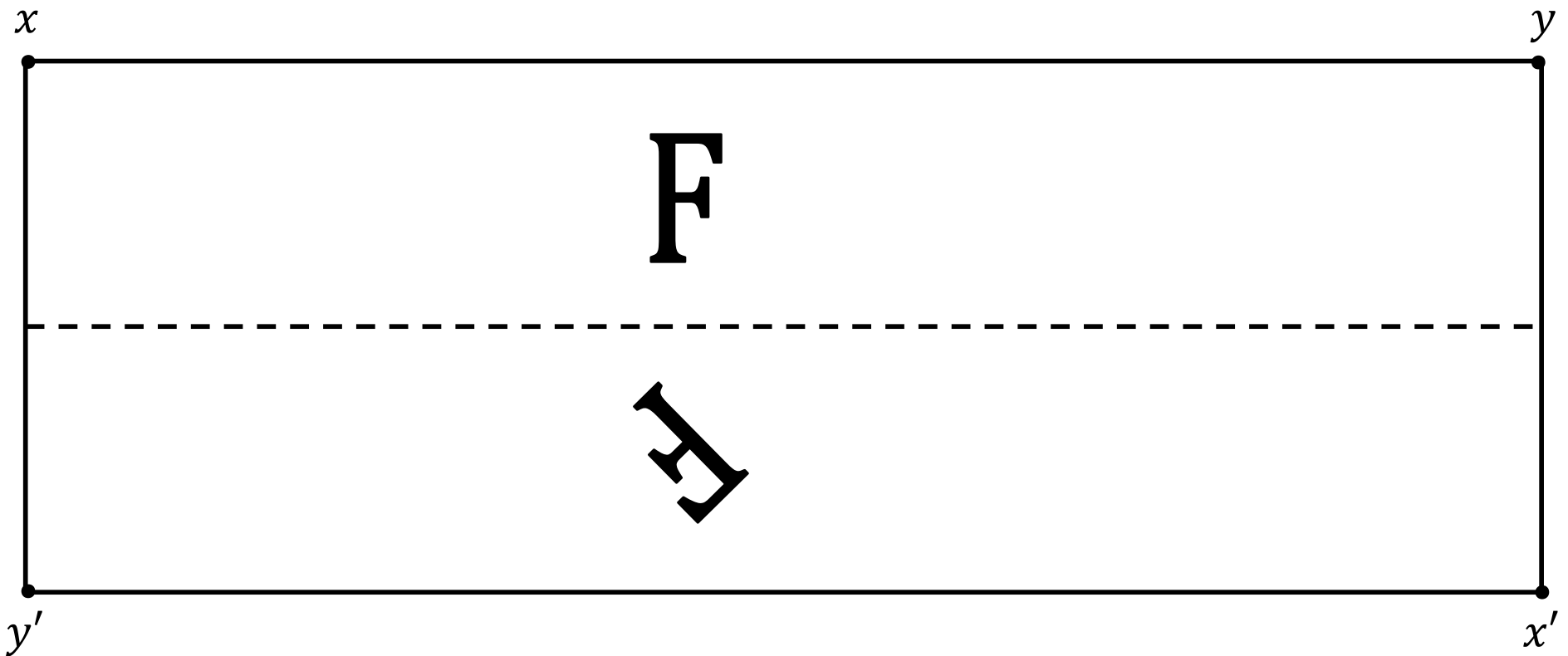
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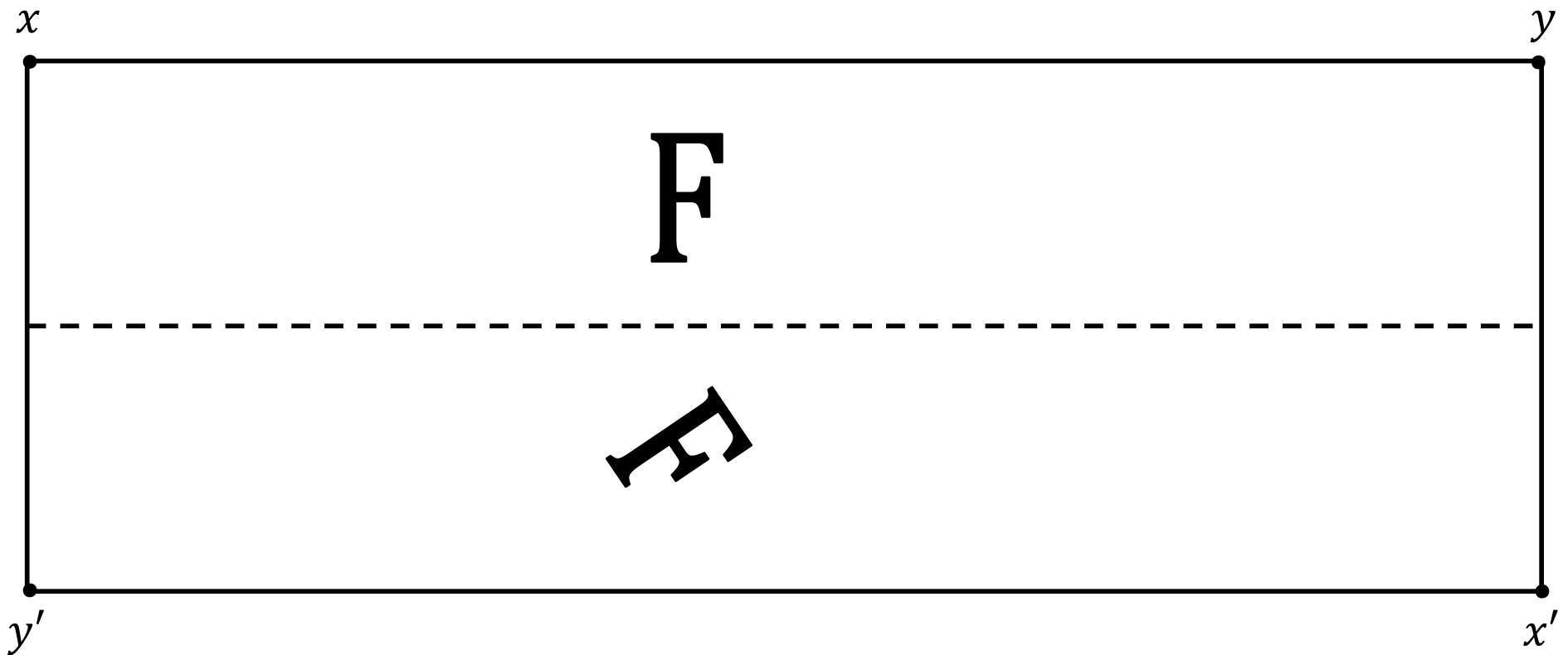
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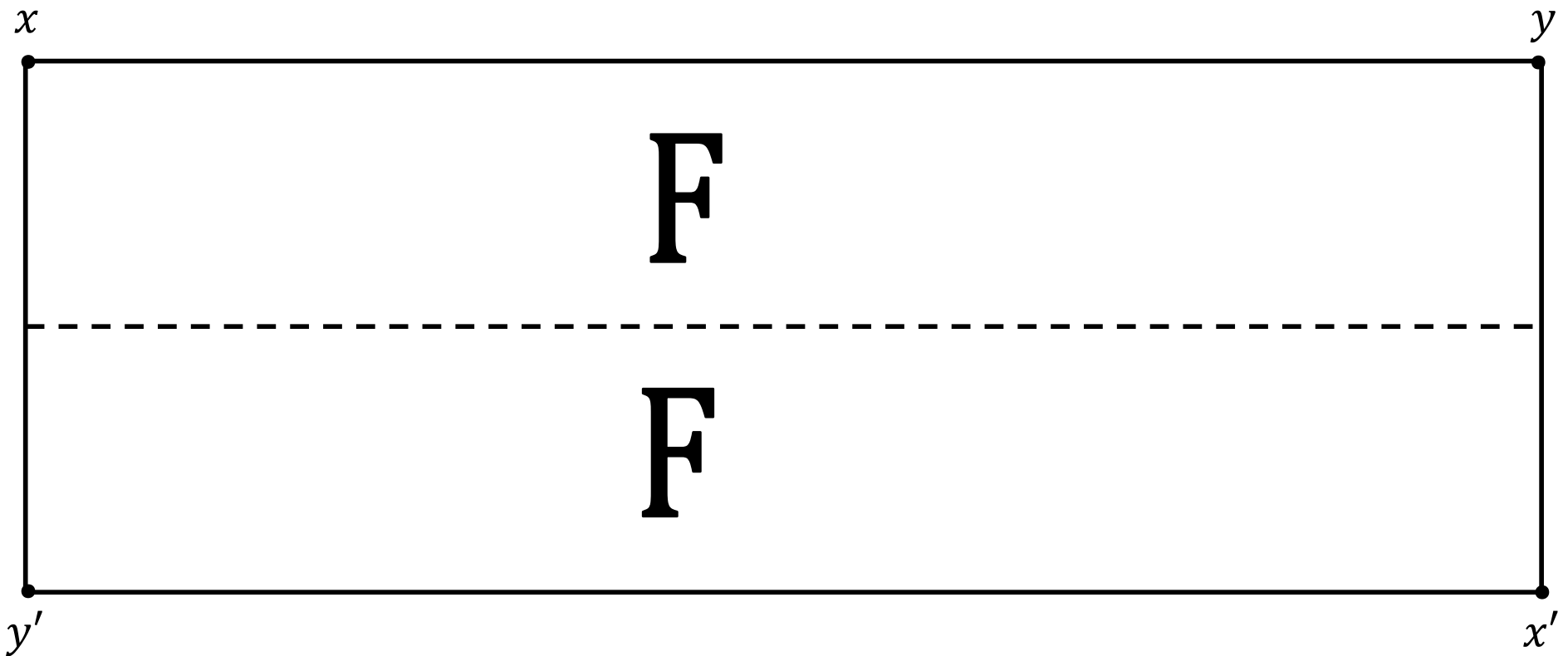
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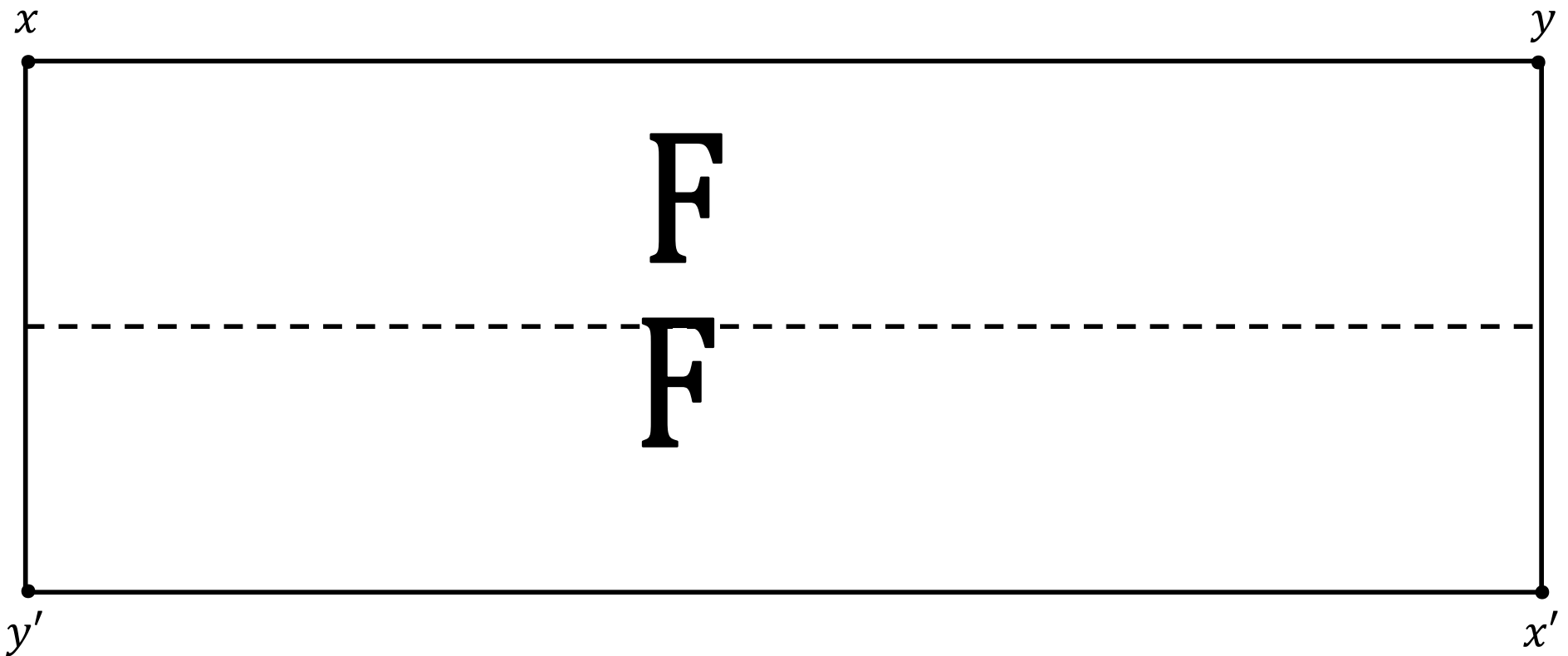
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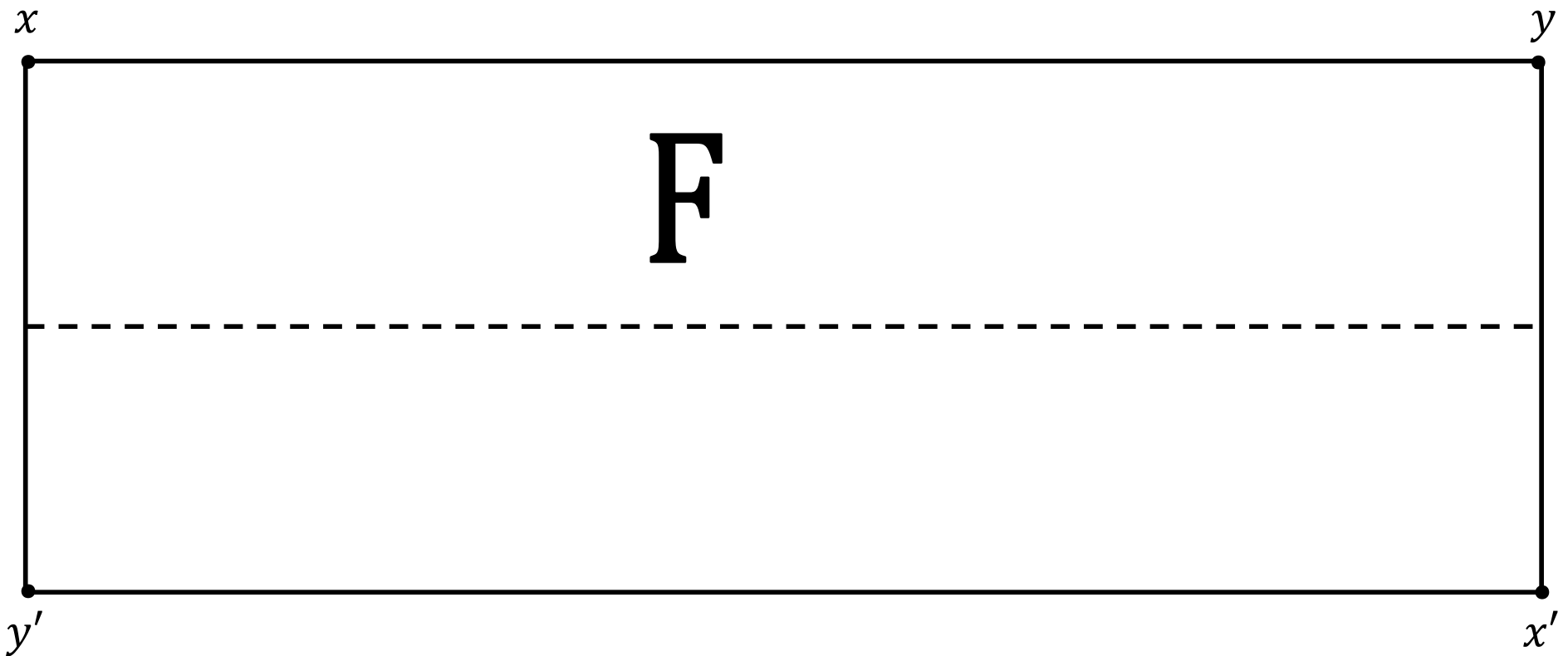
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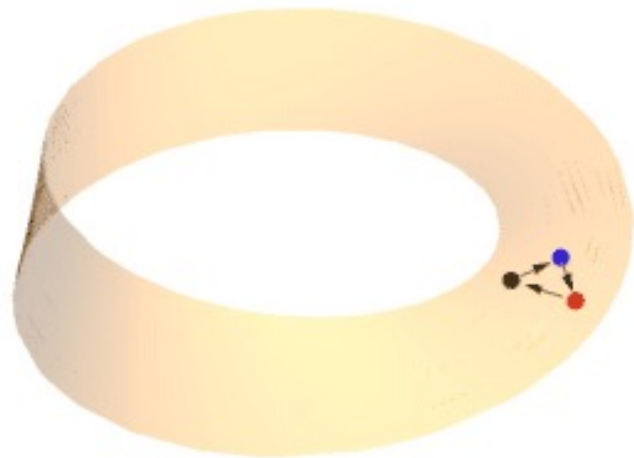


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Modified definition:

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.

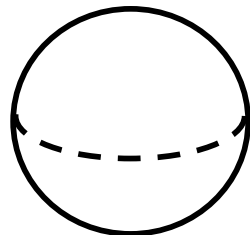
- An object is said to possess ***handedness*** (chirality) just when it and its mirror image are incongruent counterparts.

F



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

E



spherical cow

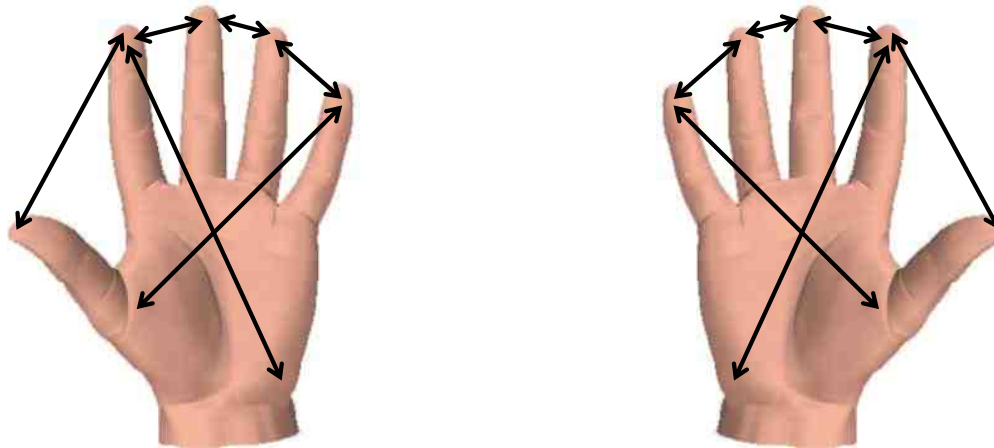


2. Kant's Argument for Absolute Space



"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

F F

- 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.

THE QUICK BROWN FOX JUMPED OVER THE LAZY DOG.

- 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?

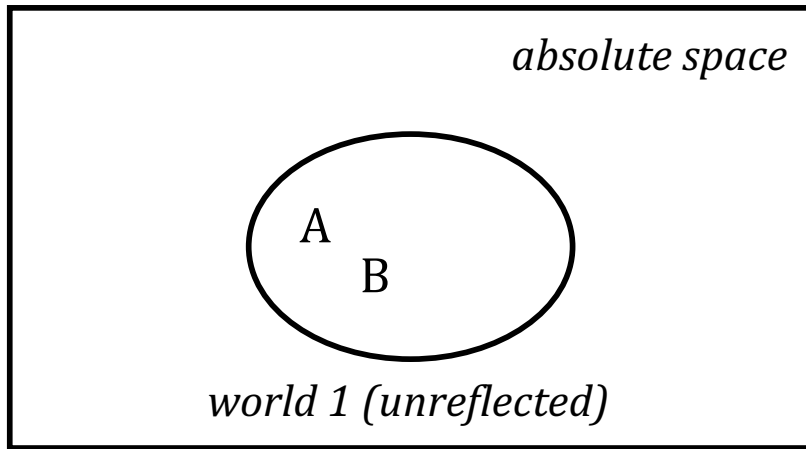
THE QUICK BROWN FOX JUMPED OVER THE LAZY DOG.

.GOD YSAJ EHT ЯEVO DEPMUJ XOF WWOЯB KИUQ EHT

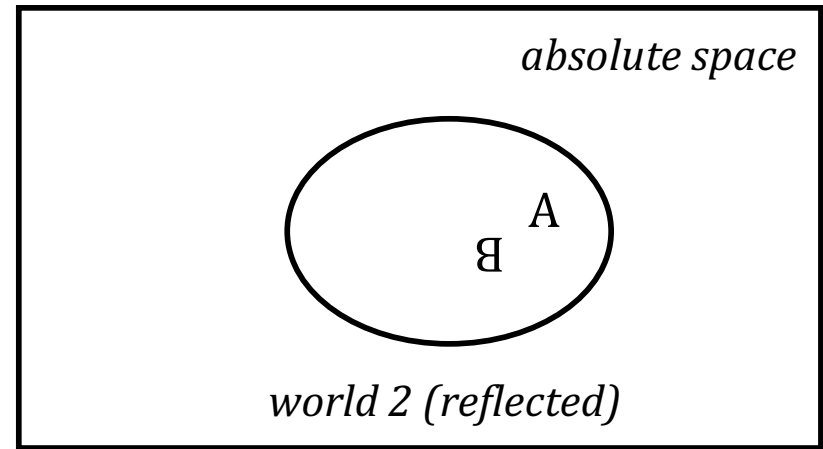
- Since F and its mirror image share all relational properties in these sentences, a relationist will not be able to distinguish them.
- Absolutist intuition: Aren't F and its mirror image \bar{F} distinct, independent of their relations to other objects?

Relationist's Reflection Argument

- Suppose: Absolute space exists.
- Then: The following two universes must be possible:



Universe 1

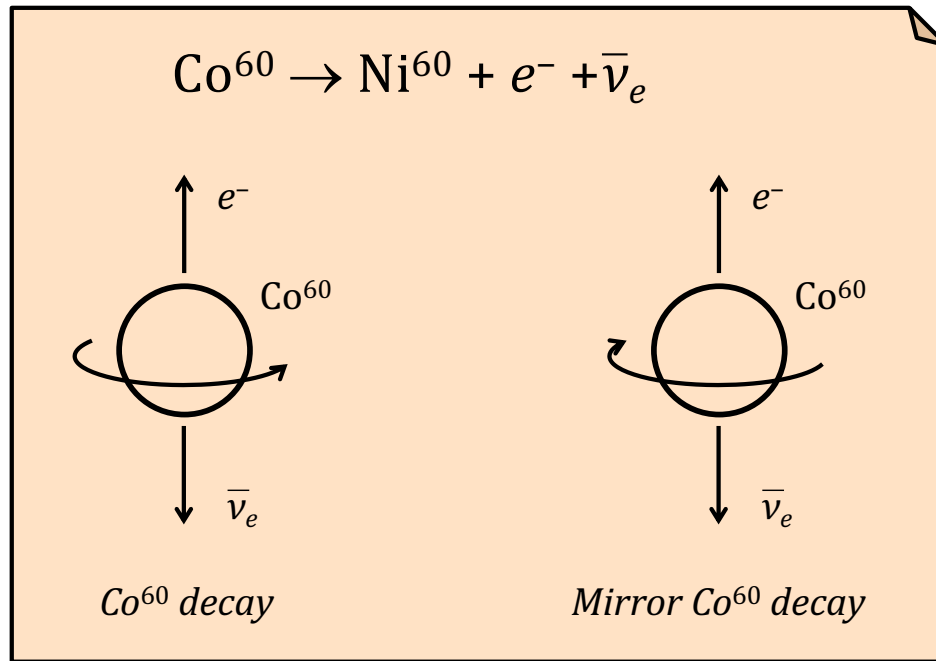


Universe 2

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



Spock



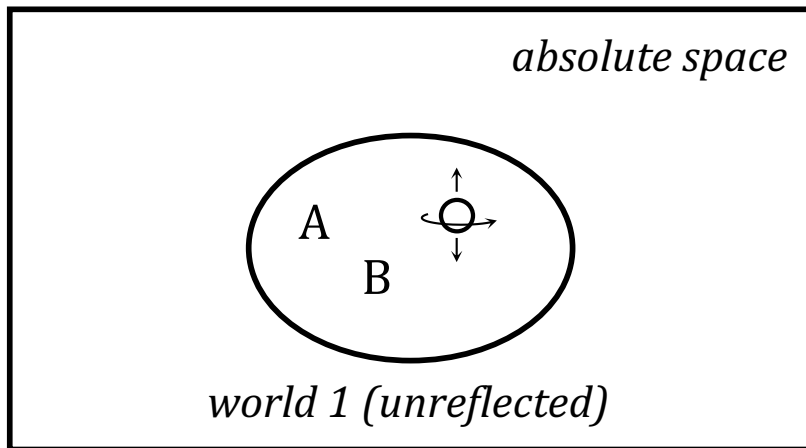
Mirror Spock



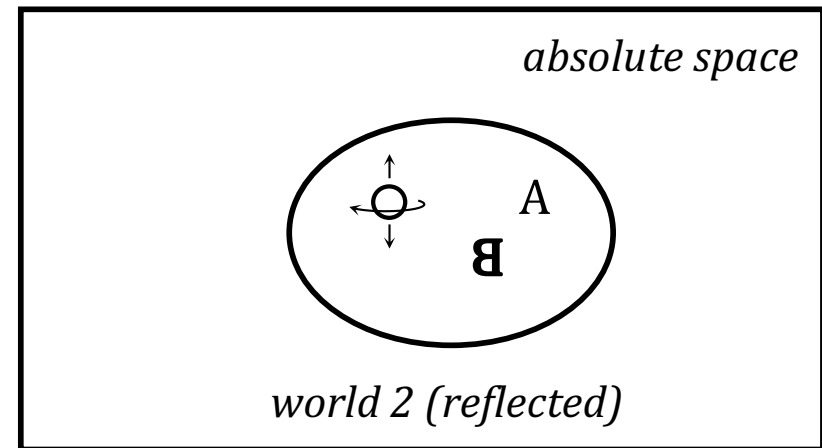
*Chien-Shiung Wu
(1912-1997)*

- 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 (*i.e.*, "parity").

Designed, run by C-S Wu. 1957 Nobel prize to Lee & Yang (men). 1978 Wolf prize finally to Wu.



Universe 1



Universe 2

- *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.*



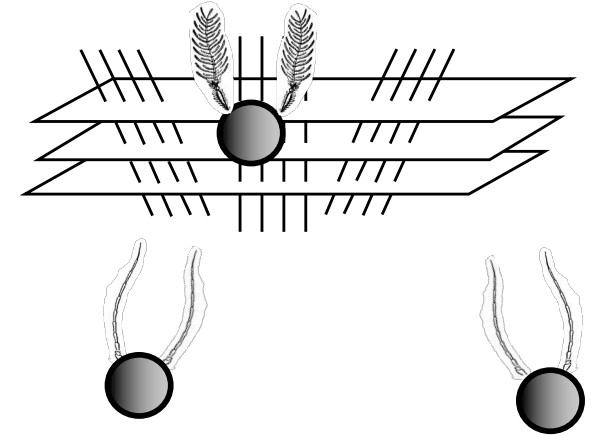
Let it be imagined that the first created thing were a Co^{60} decay process, then it must necessarily be either a right-handed Co^{60} decay process, or a left-handed Co^{60} decay process... *and* there's a law-like physical difference between the two!

- Can a relationist both *ground* the distinction between right- and left-handed processes and *explain* why one is more probable than the other?
 - (a) Claim that the difference is *intrinsic*: Co^{60} decay processes possess an intrinsic monadic (non-relational) property that *both* determines their handedness *and* their weak-force-governed behavior.
 - (b) Claim the difference is *extrinsic*:
 - What determines whether the first created Co^{60} decay process is right- or left-handed is its relation to all subsequent Co^{60} decay processes.
 - 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)

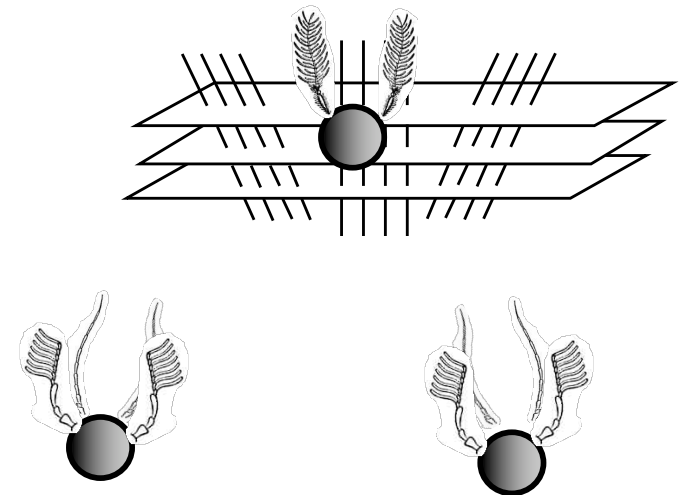
- What explains Newton's First Law? How does a force-free object know to move inertially?

- 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)?