Title: Propagation and interaction of topological invariants on embedded 4-valient spinets

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Abstract: The study of particle-like excitations of quantum gravitational fields in loop quantum gravity is extended to the case of four valent graphs and the corresponding natural evolution moves based on the dual Pachner moves. This makes the results applicable to spin foam models. We find that some braids propagate on the networks and they can interact with each other, by joining and splitting. The chirality of the braid states determines the motion and the interactions, in that left handed states only propagate to the left, and vise versa.

Braid Propagation and Interaction of (framed) 4-Valent Spinnets

Yidun Wan

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Budding-Minds: PI Grads Conference, 2007

OUTLINE

1. Motivations
2. Introduction
   - Embedded (framed) 4-valent spin-networks
   - Notation
   - 3-strand braids
3. Operations
   - Equivalence Moves
   - Reducibility of Braids
   - Evolution Moves
4. Braid Interaction
5. Braid Propagation
6. Some Discussion on Braid Interaction/Propagation
7. Conclusions and Future Works

Motivations

Road to Unification

- The lame beauty of Loop Quantum Gravity: Where is matter?
- Two philosophies of unifying gravity with matter:
  - Coupling matter fields with quantum gravity;
  - Emergent matter in quantum gravity (the one we take).
- Sundance's ribbonized Preon model sheds light on LQG with matter.
- Particle-like excitations of quantum gravitational fields in LQG exist on 3-valent spin-networks.
- However, 4-valent spinnets have true correspondance with 3-space, then what about the 4-valent spin-networks?

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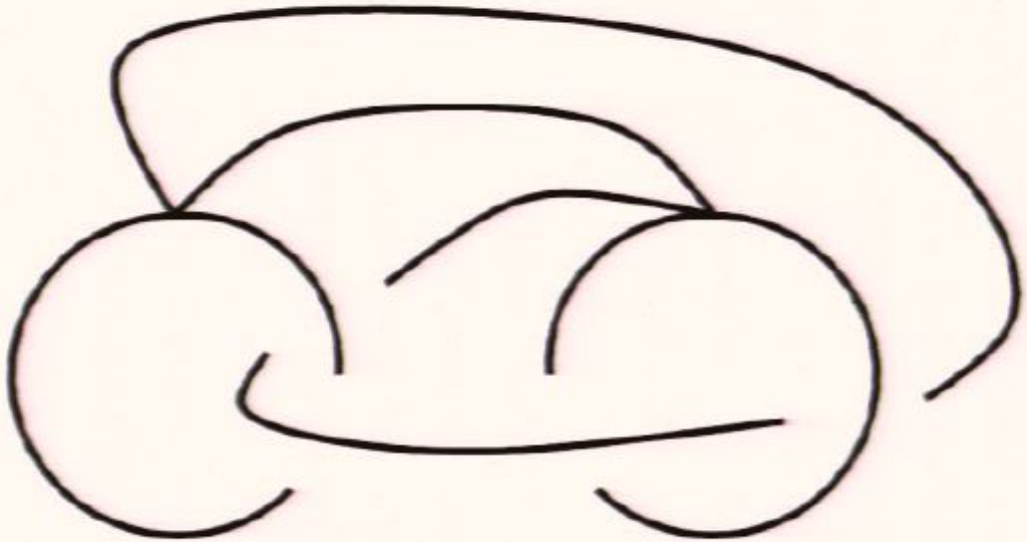

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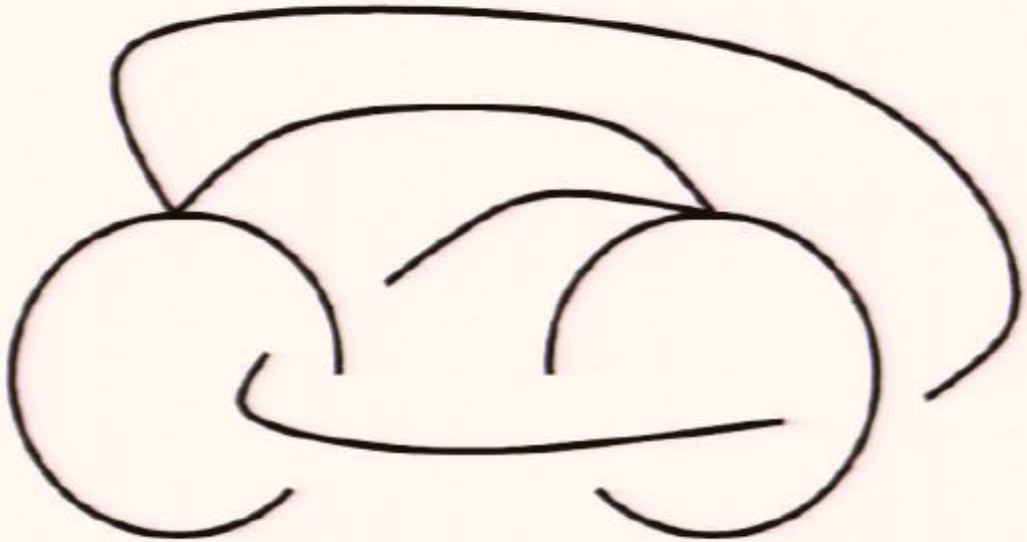

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Notation

Spheres and Tubes

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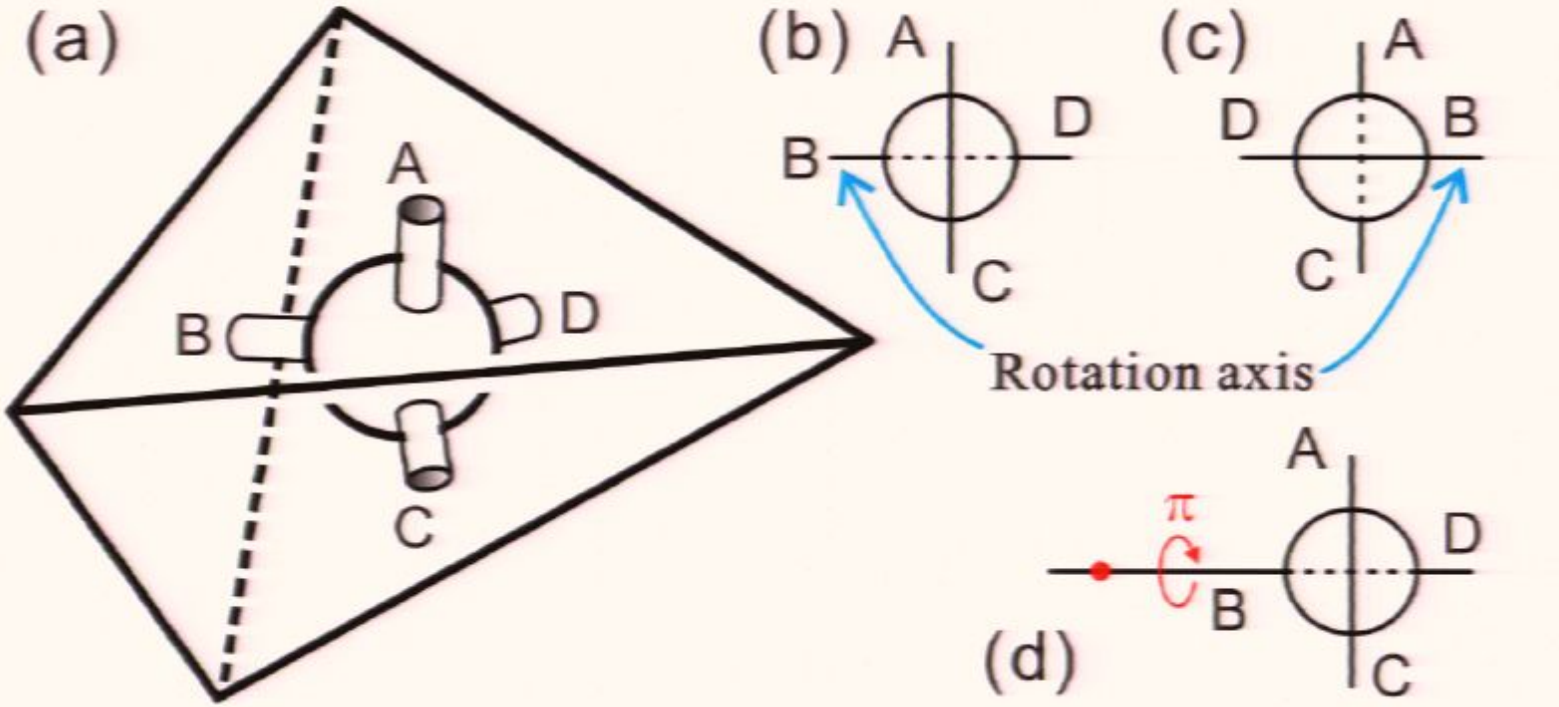

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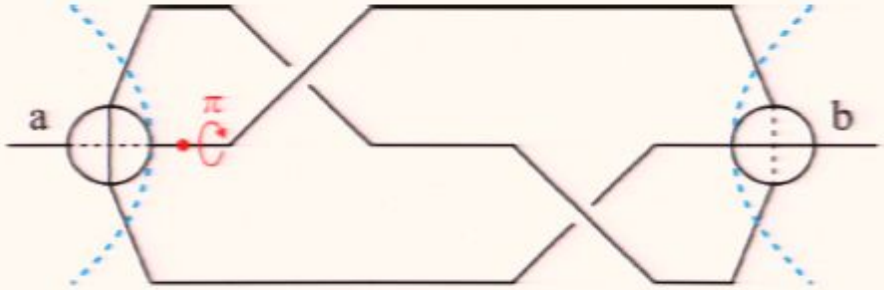

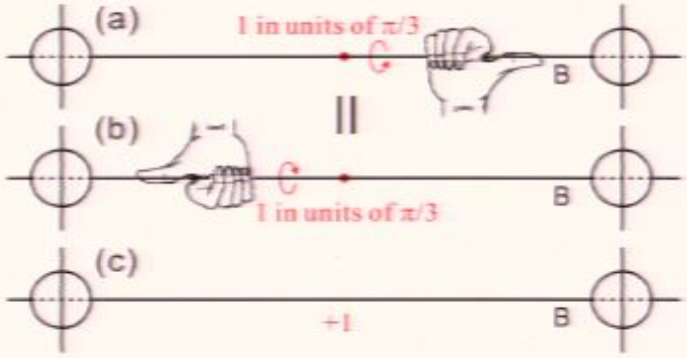

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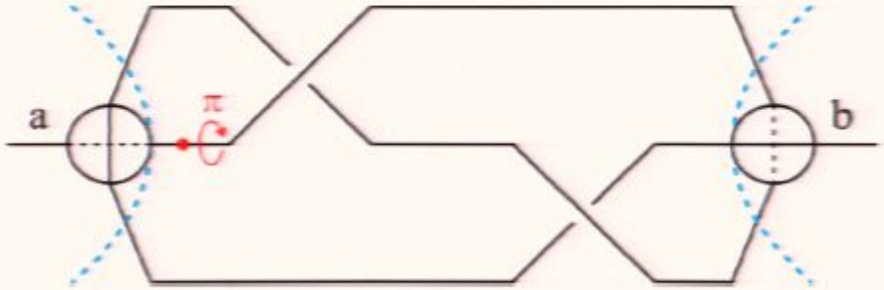

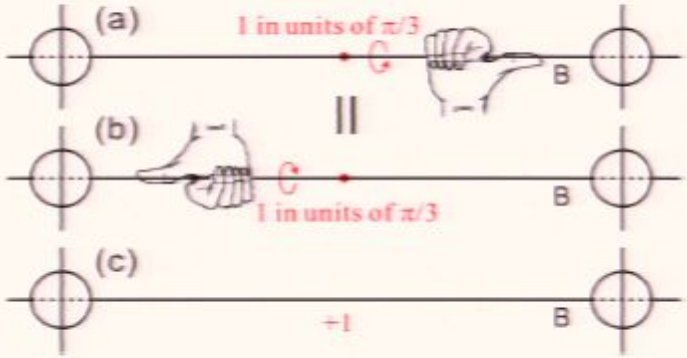

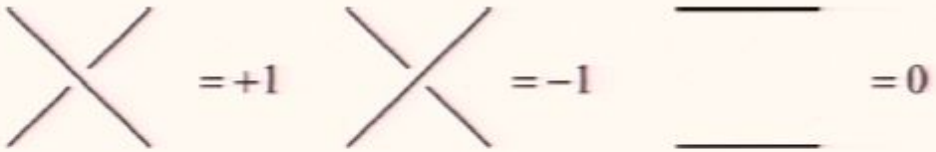

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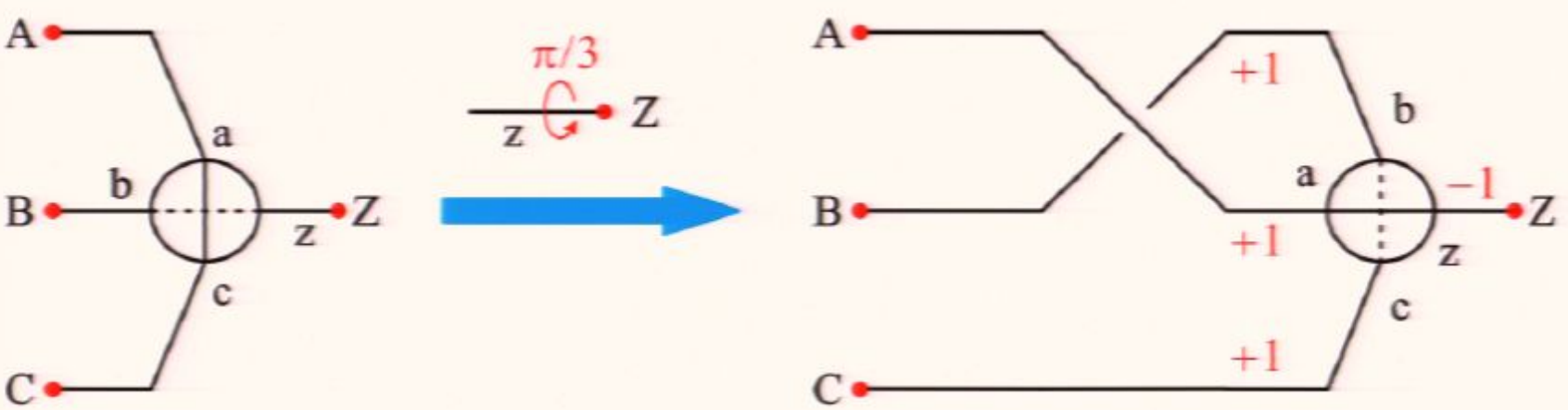

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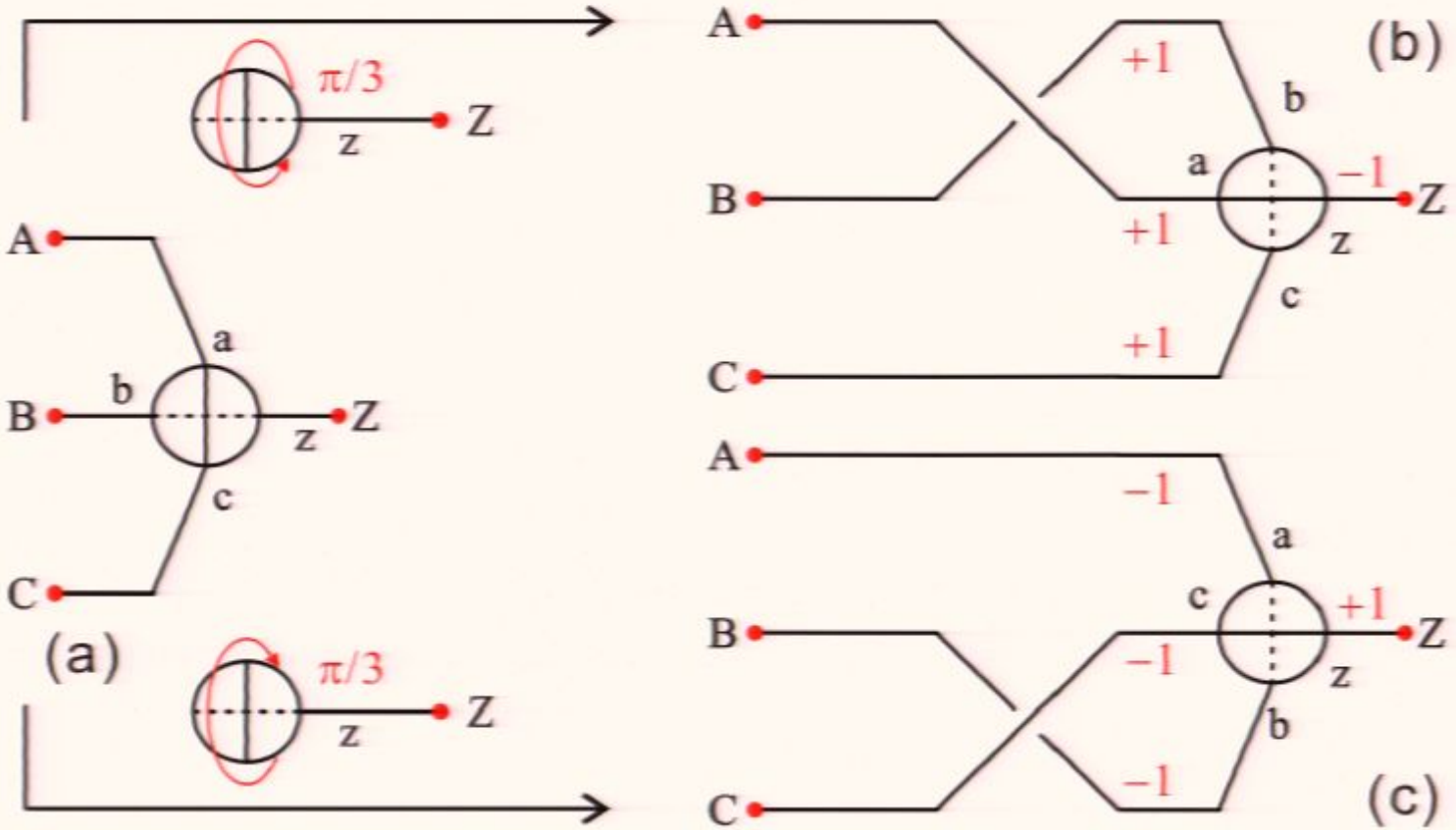

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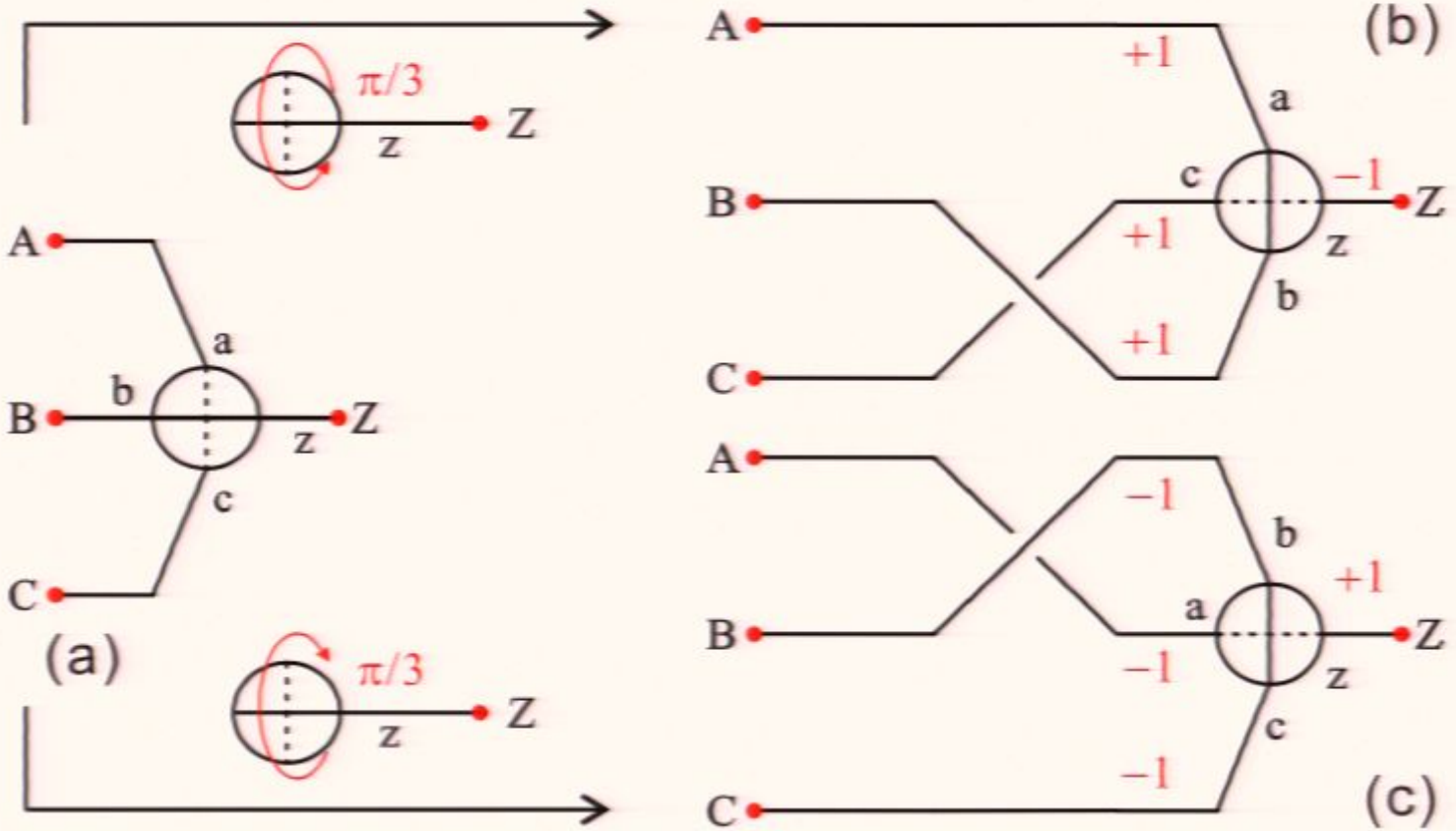

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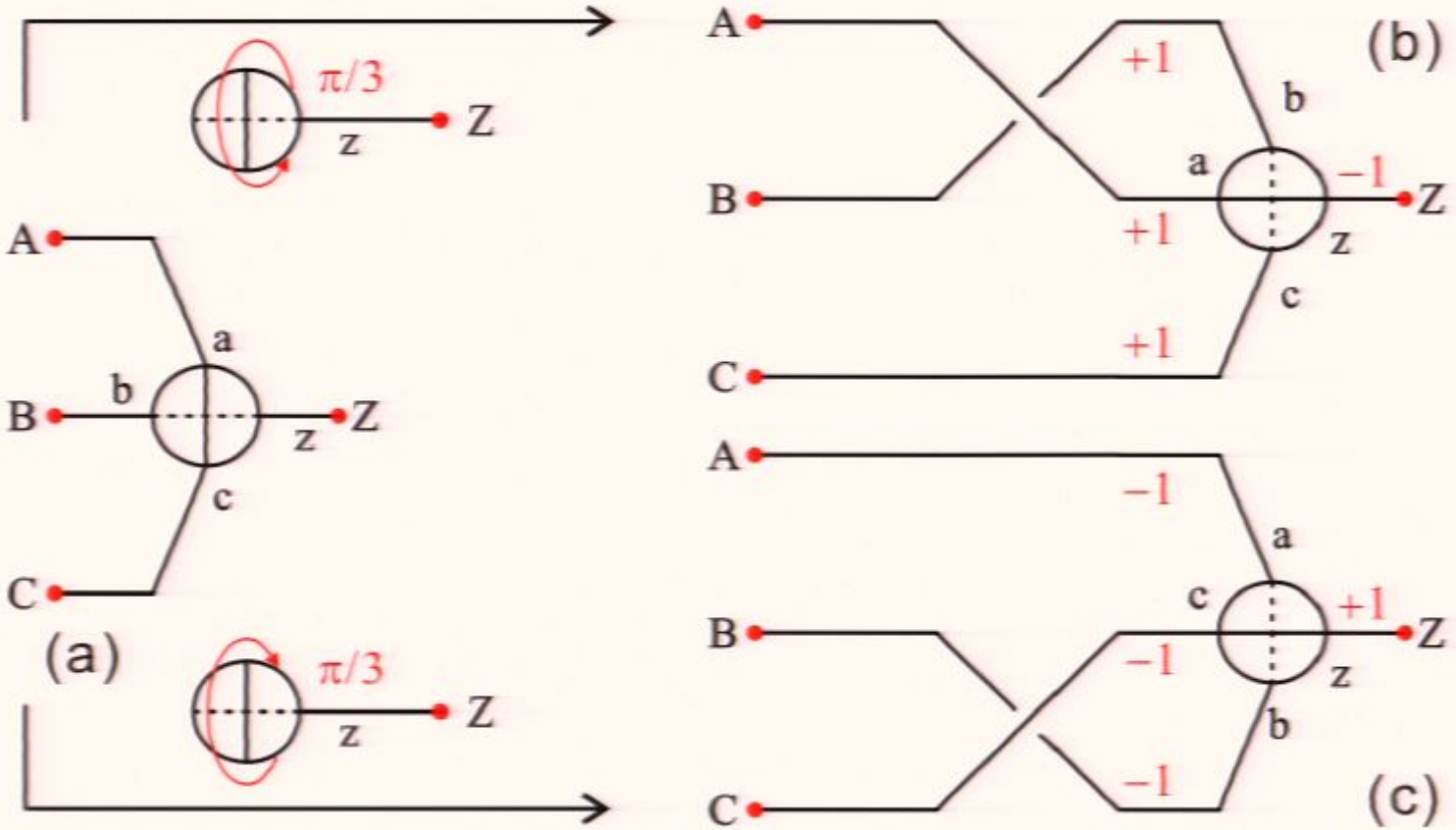

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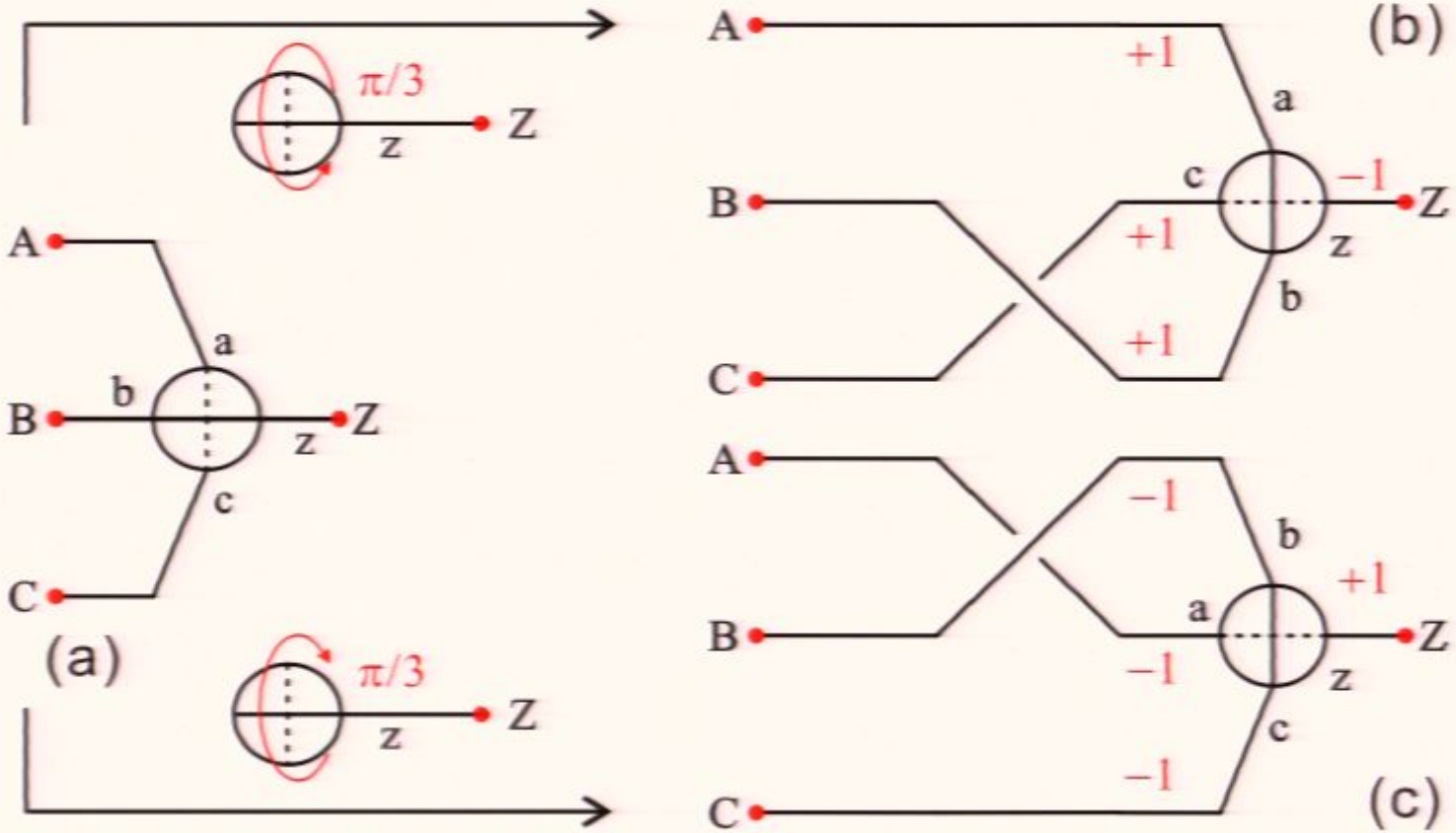

Translations

- Case 1
- Case 2

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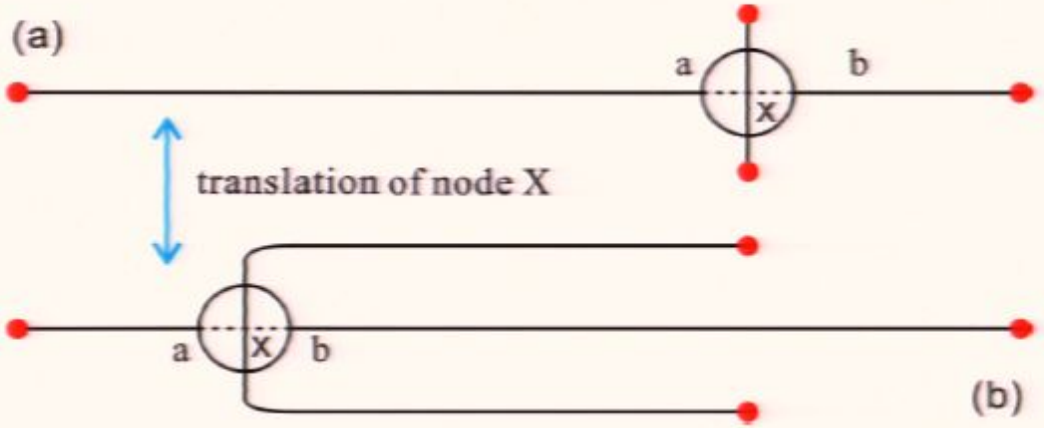

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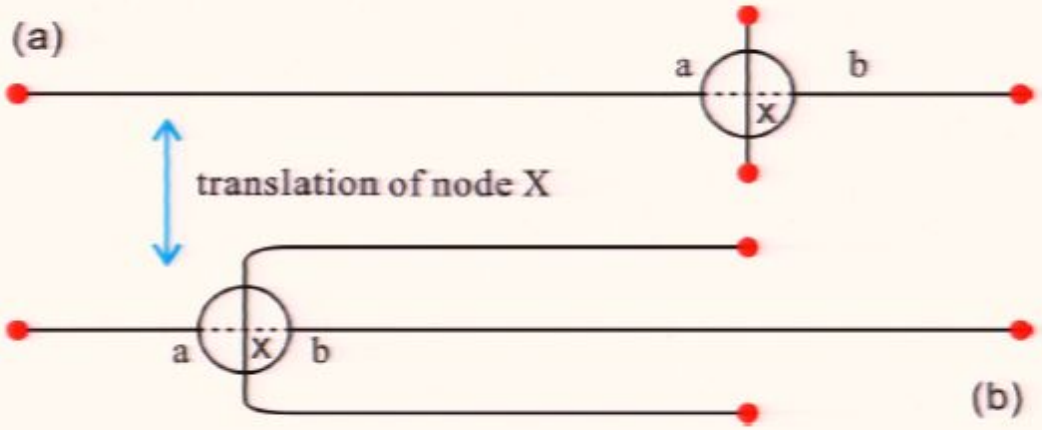

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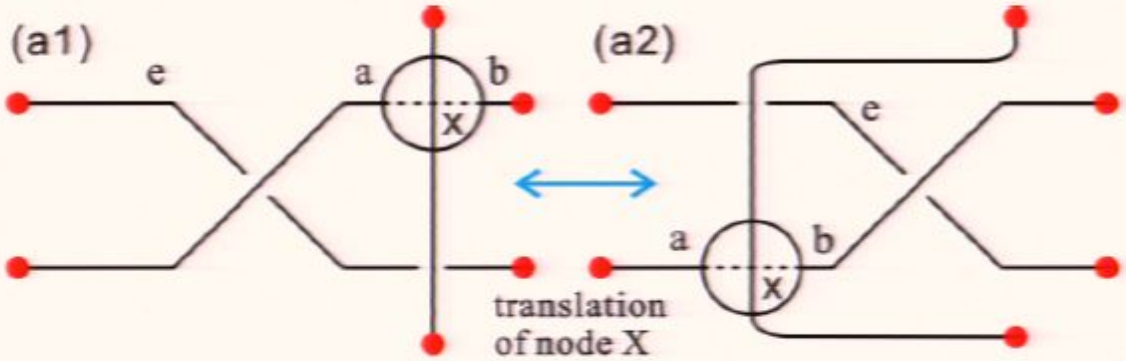

Effective twist: a conserved quantity

For a subdiagram,

- the effective twist is defined as

$$\Theta = \sum_{all\ edges} T_e - 2 \times \sum_{all\ Xings} X_i$$

- it is conserved under equivalence moves: rotations and translations.

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A braid is **(left) right (ir)reducible** if it is equivalent to a braid with fewer crossings by equivalence moves excerted only on its (left) right end-node.

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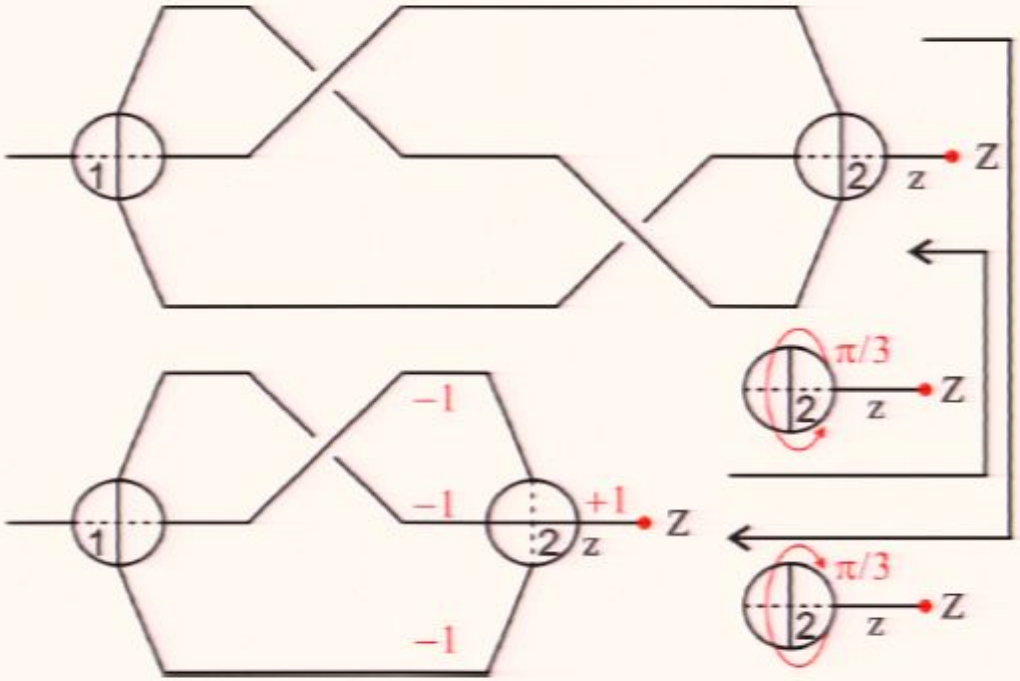

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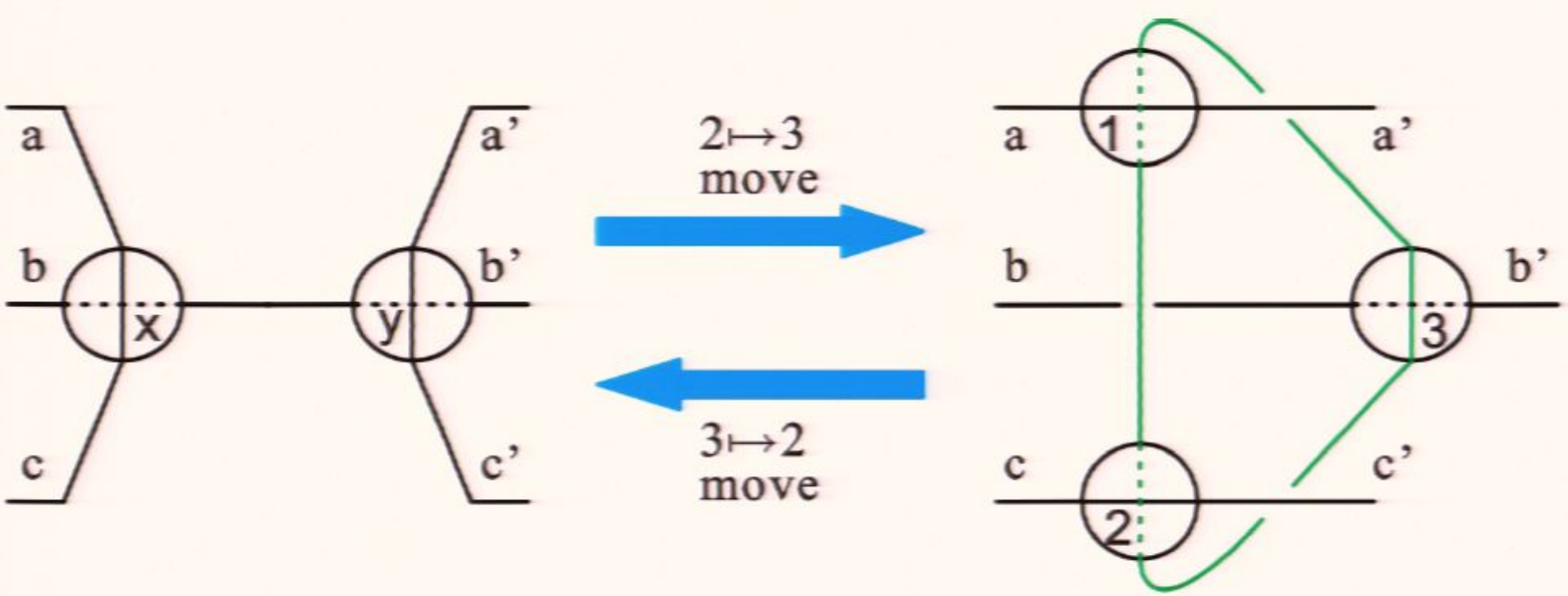

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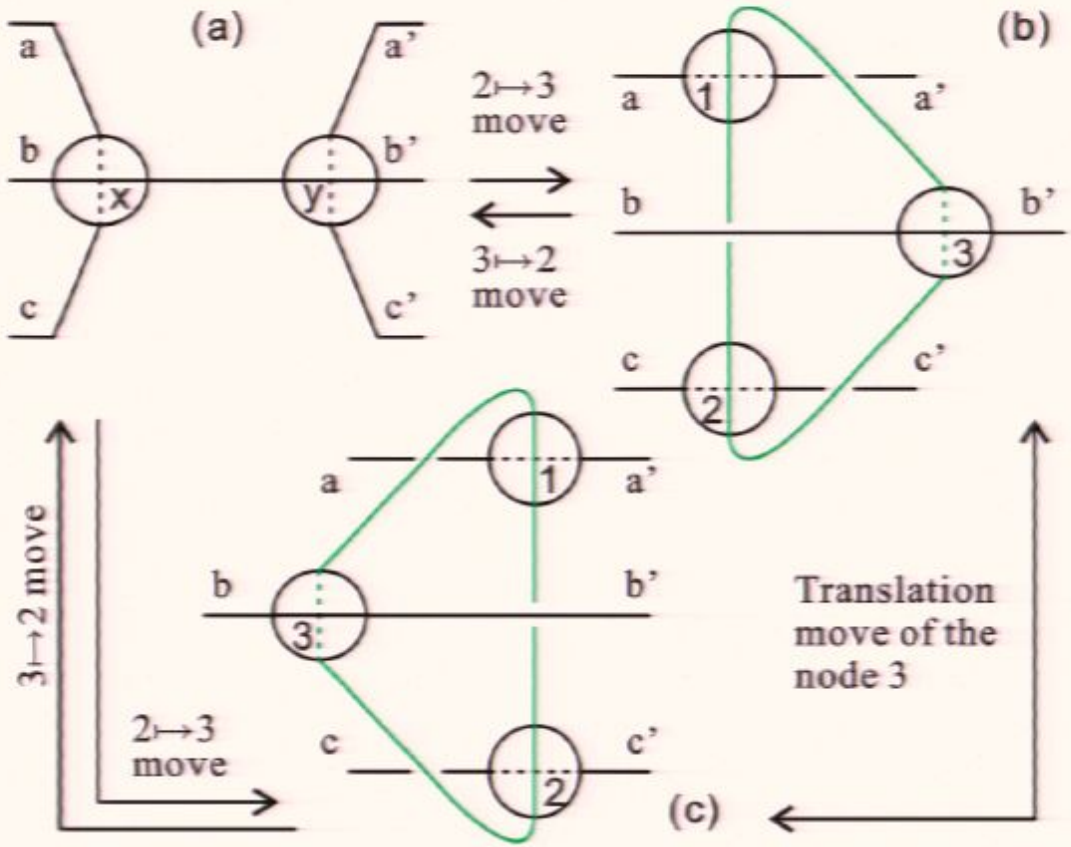

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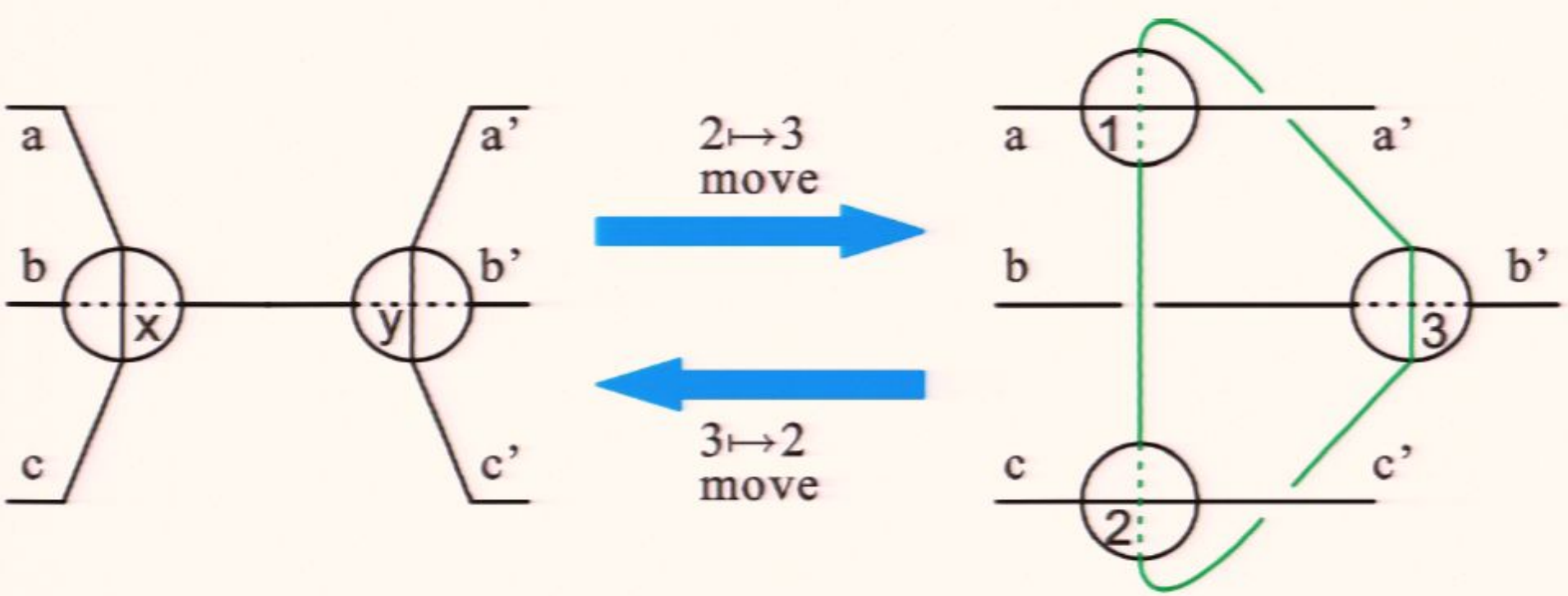

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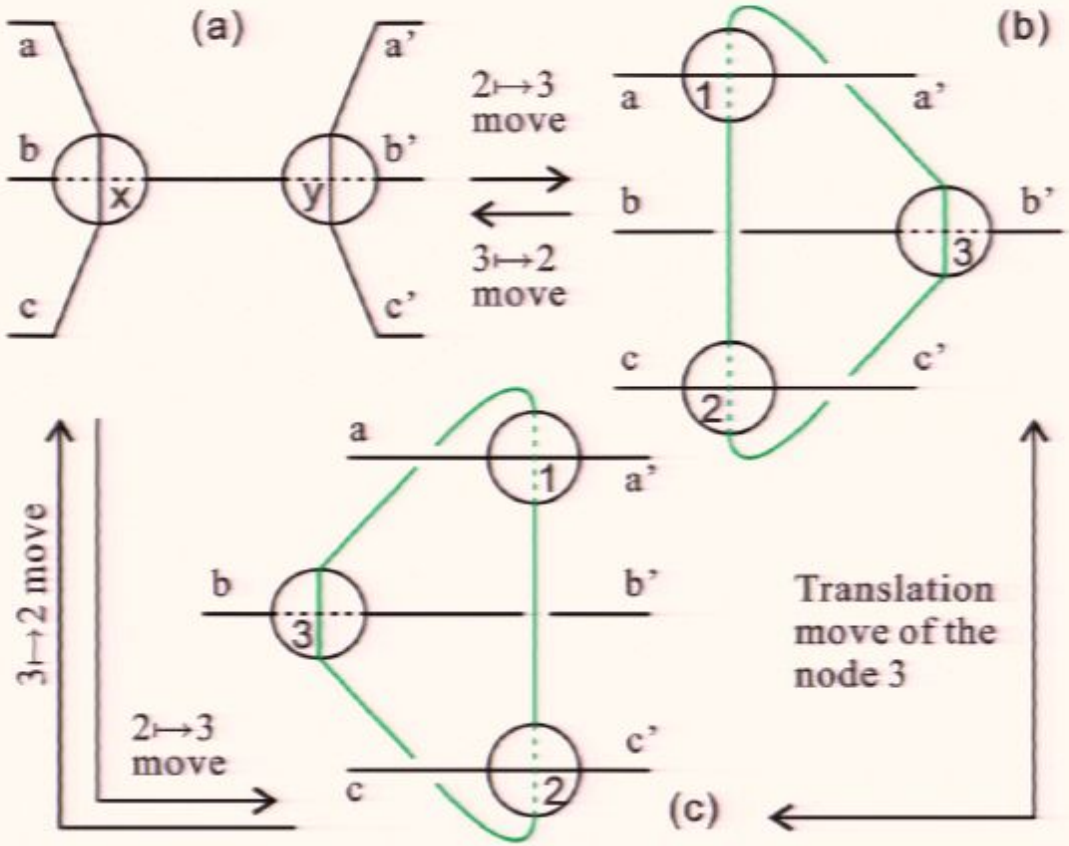

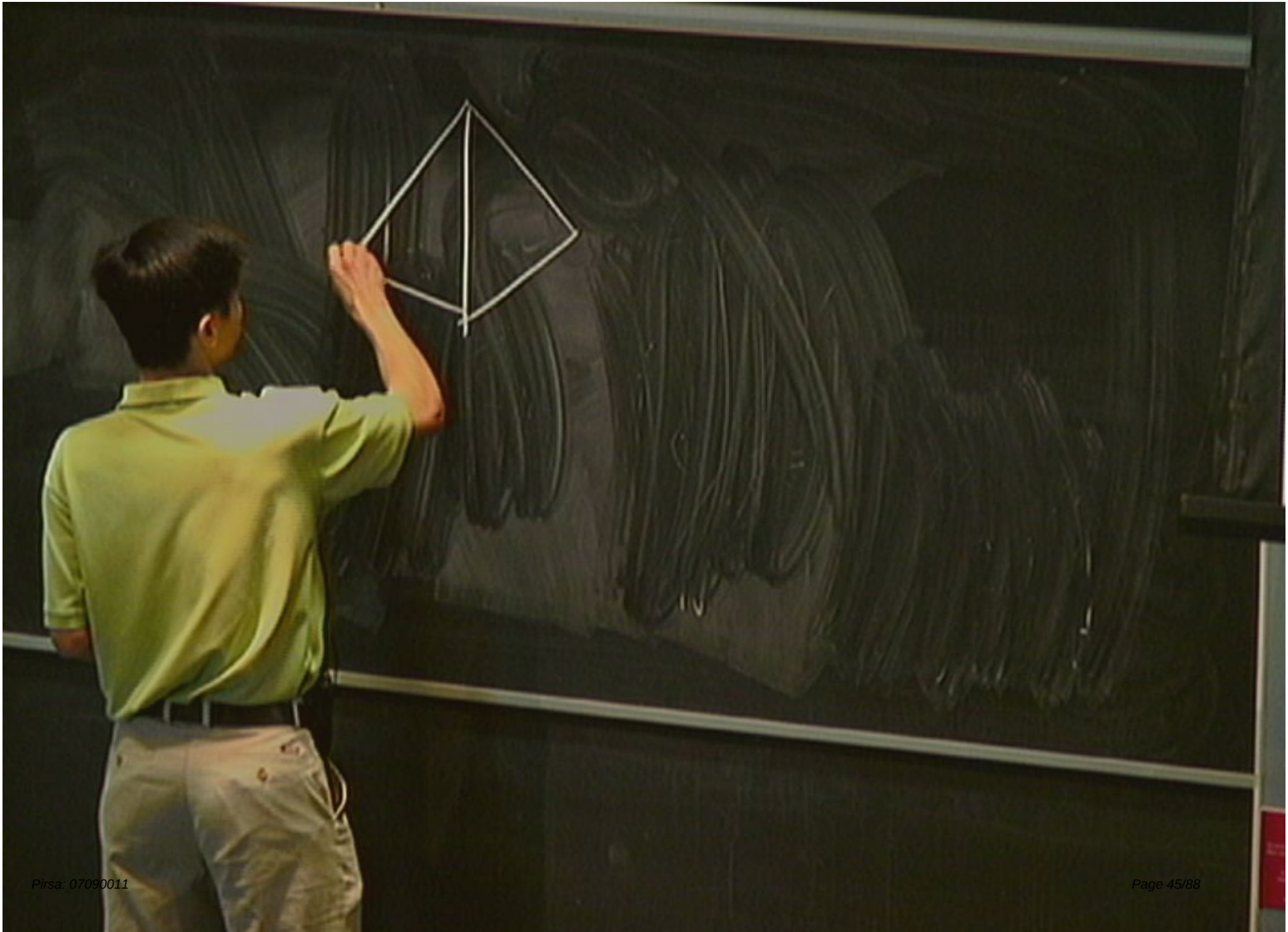

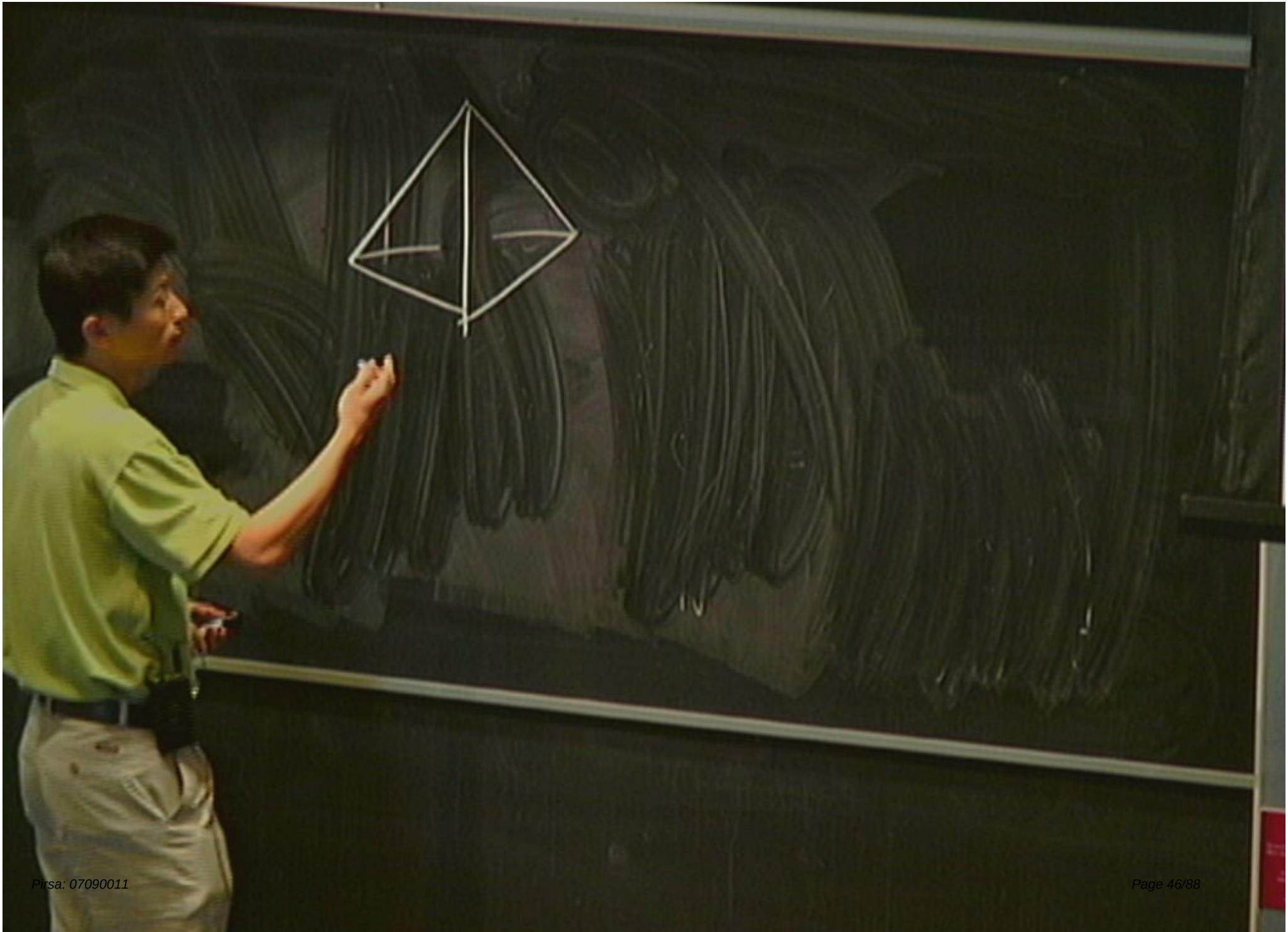

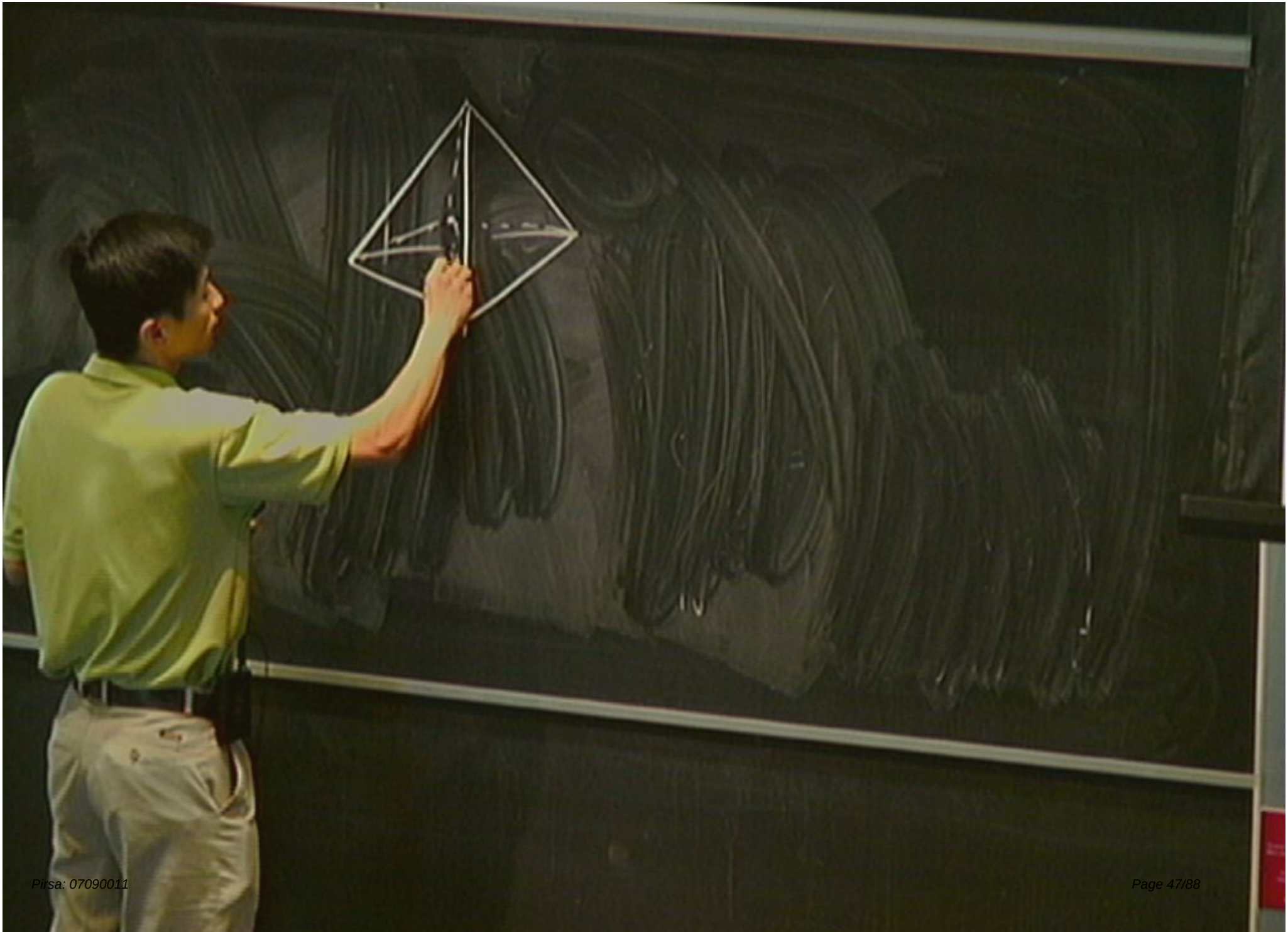

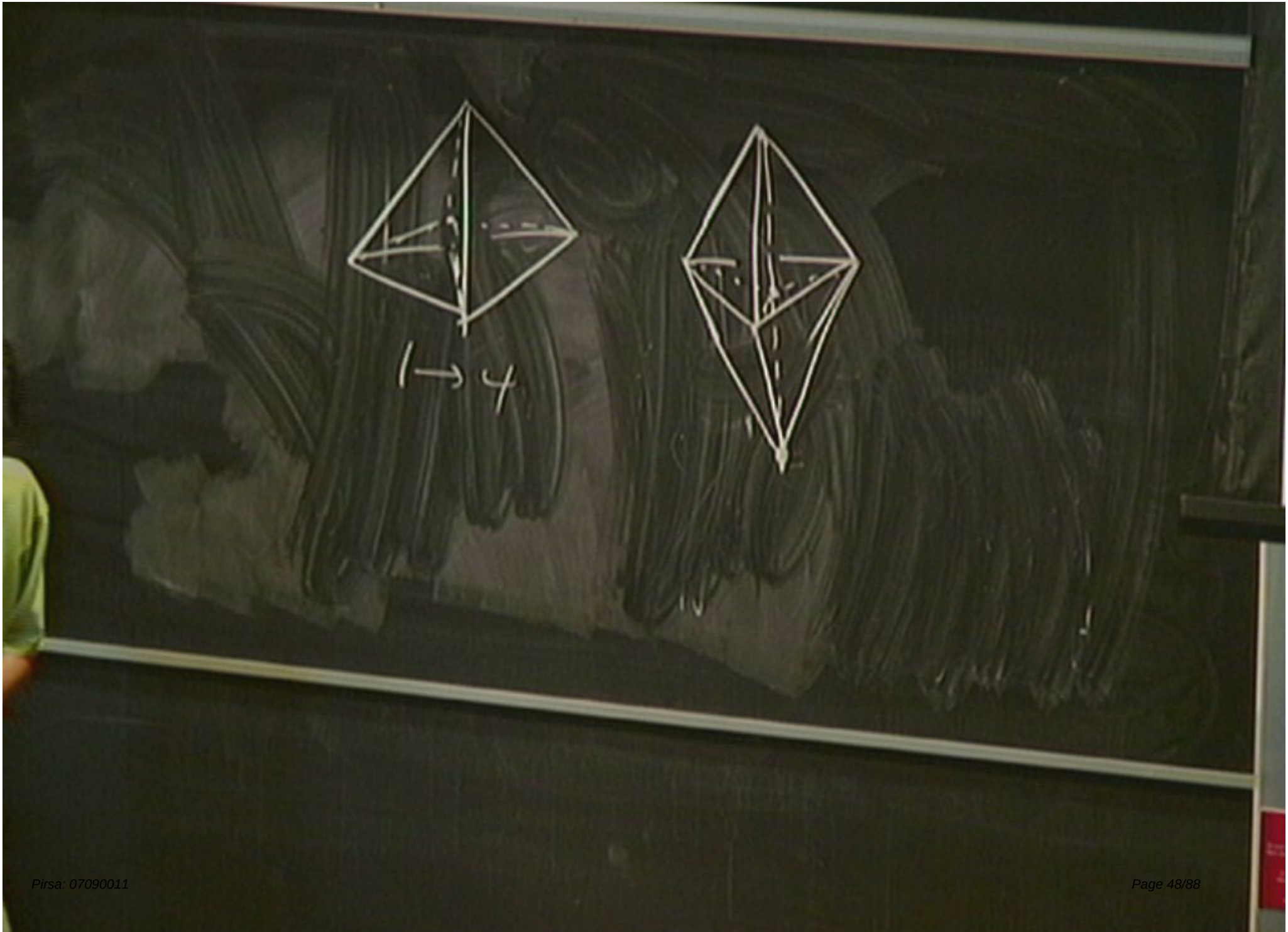
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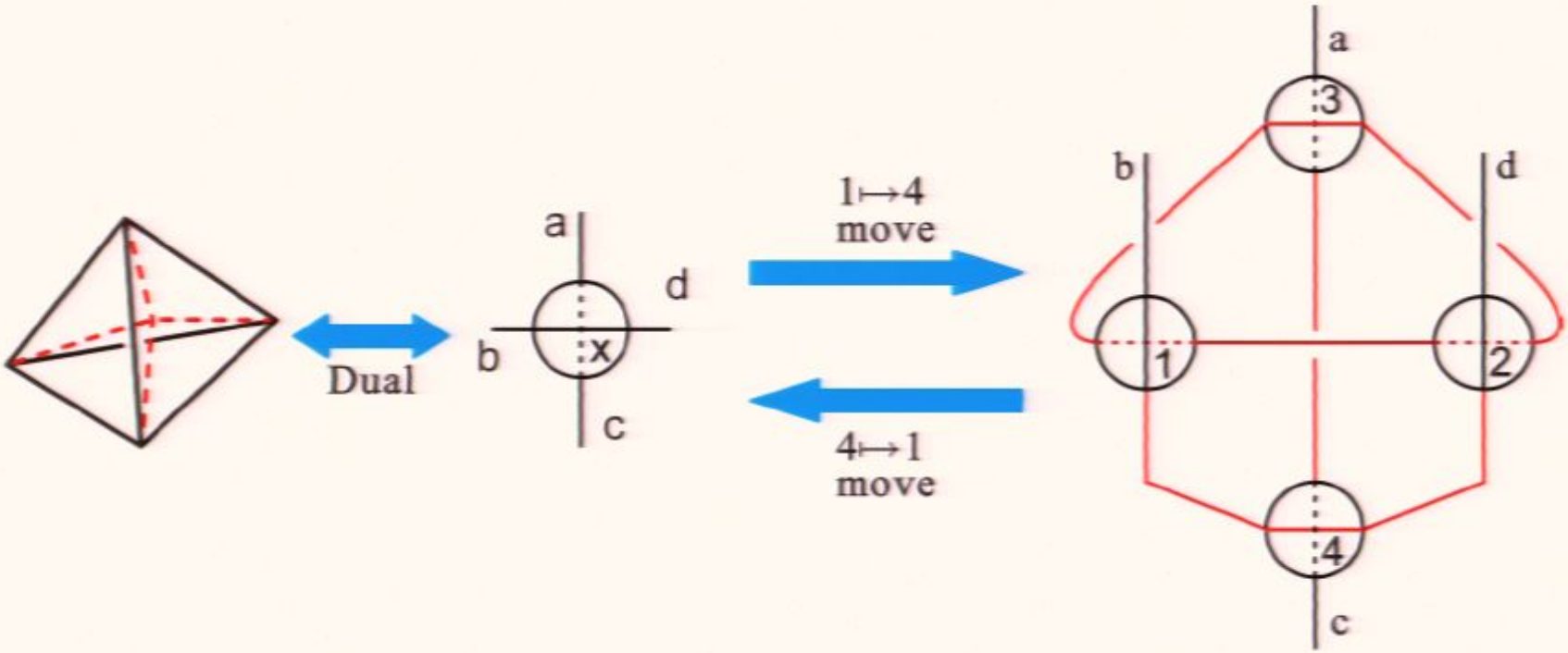

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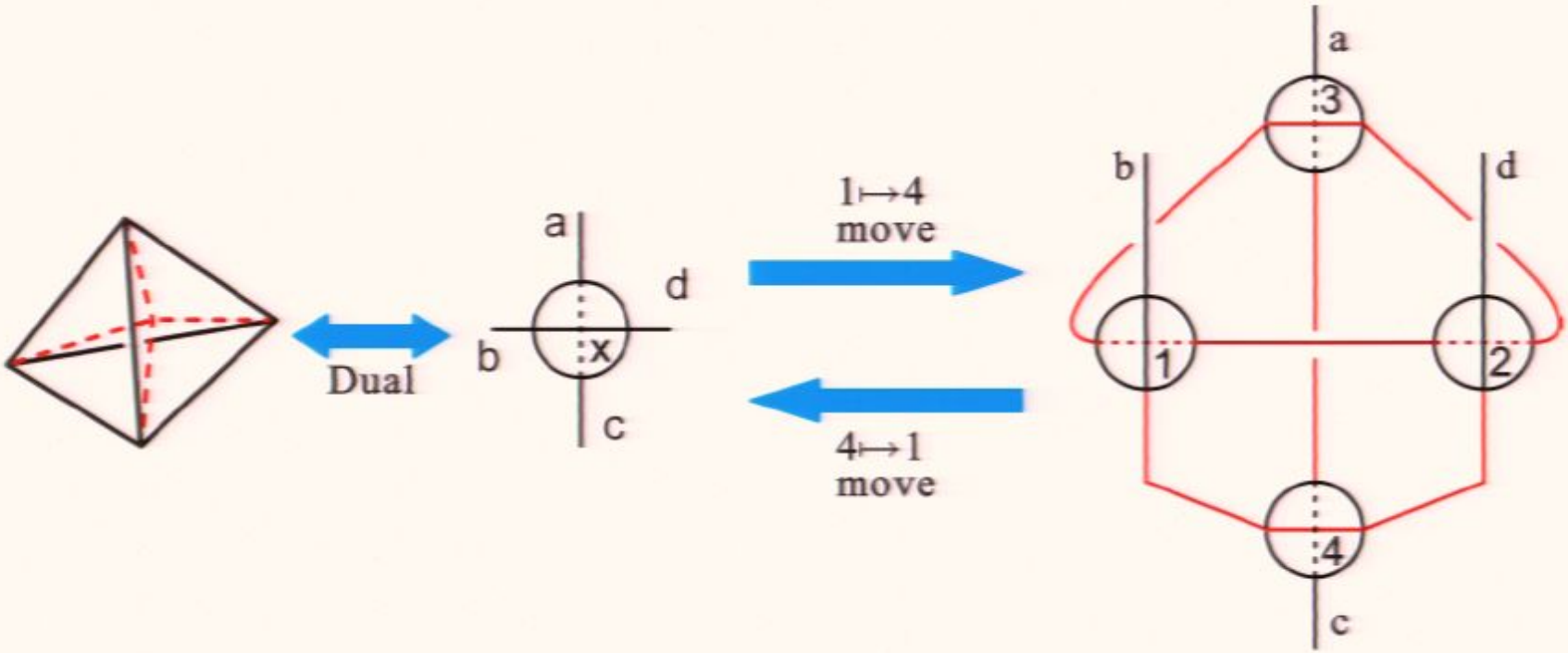

An Example of **Active Right-Interaction**

- Bingo!!! We got a new braid! Plus the conservation of twist!

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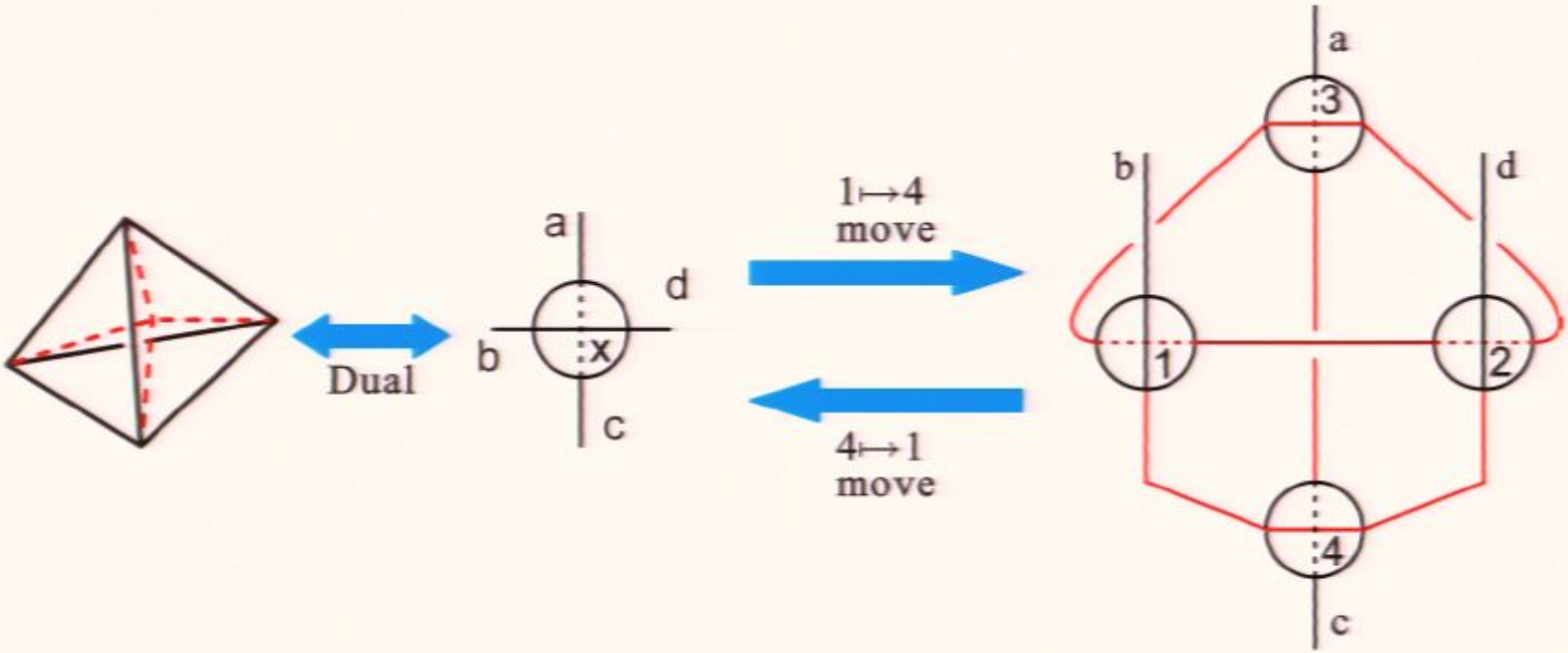

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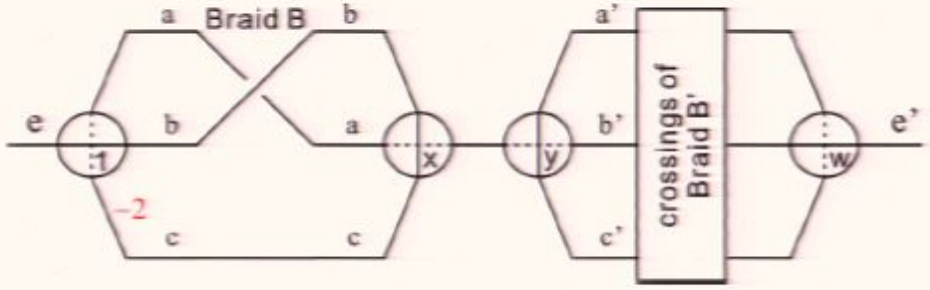

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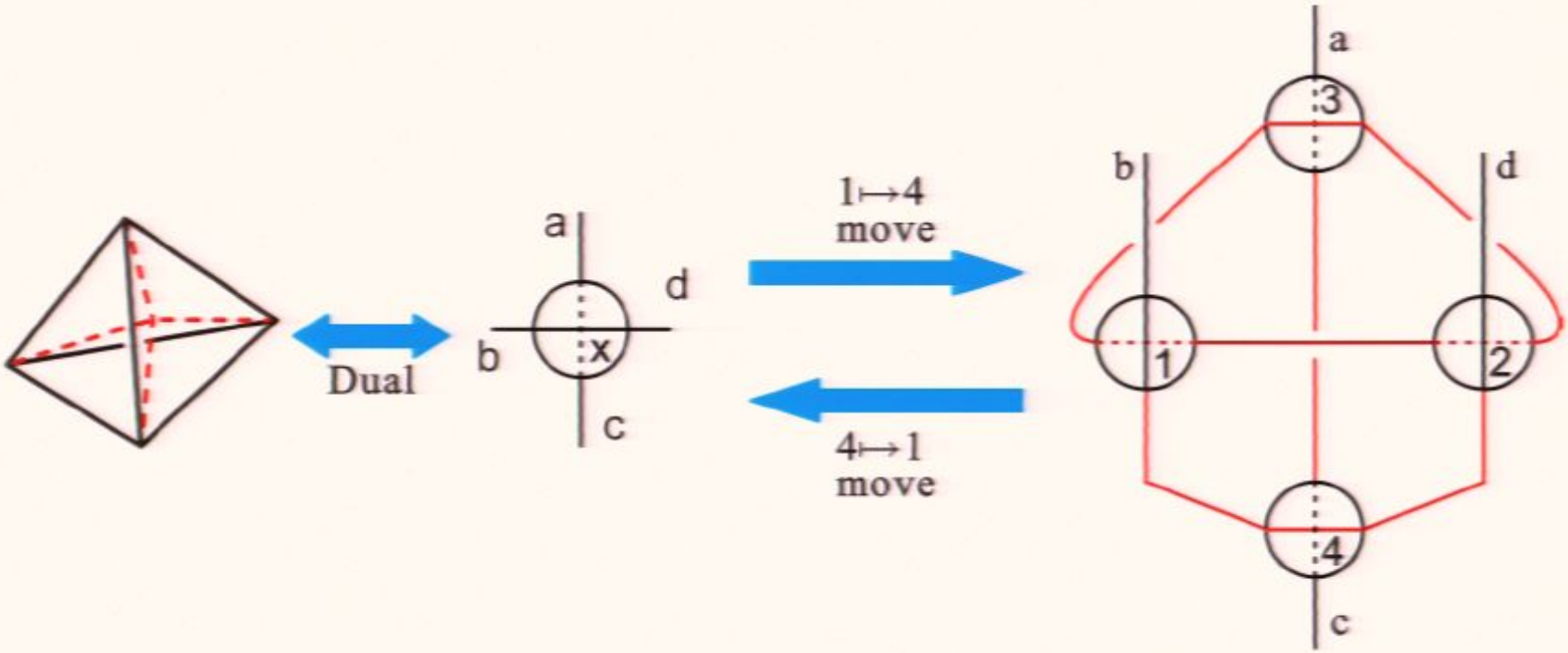

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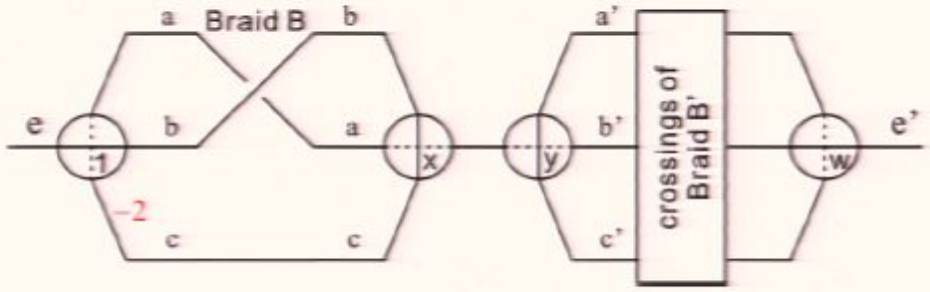

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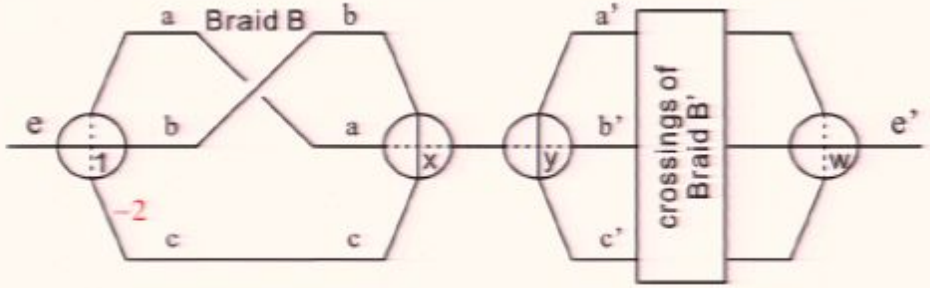
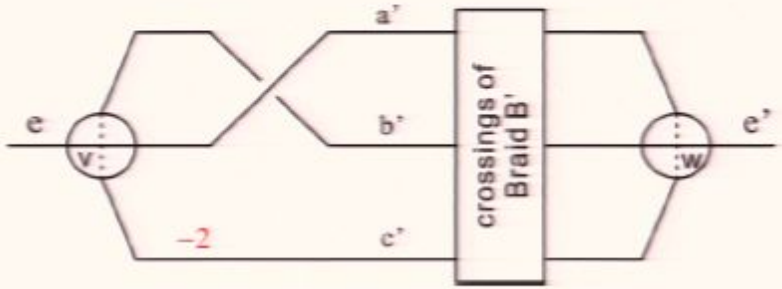


Evolution moves ⇕ Equivalence moves



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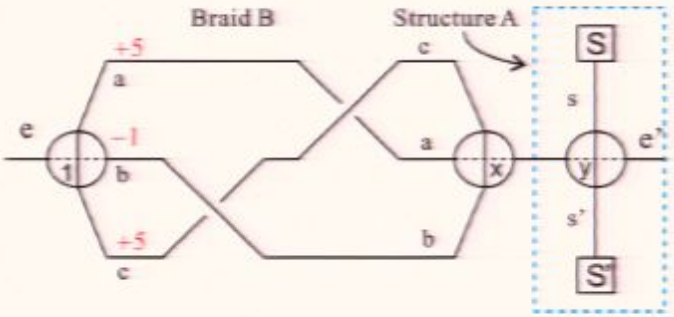

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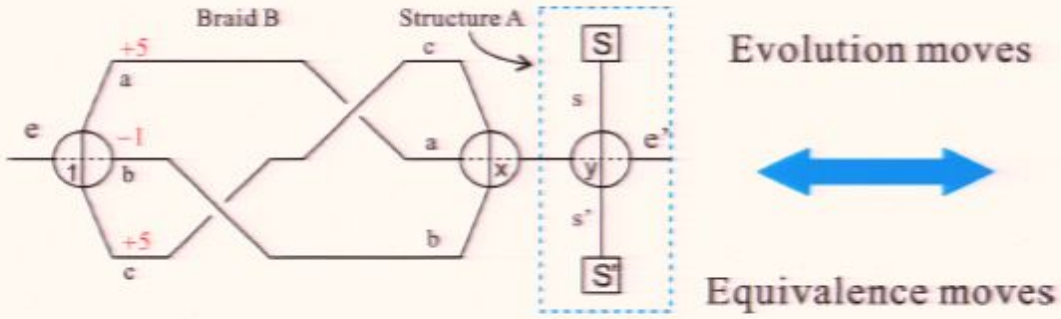

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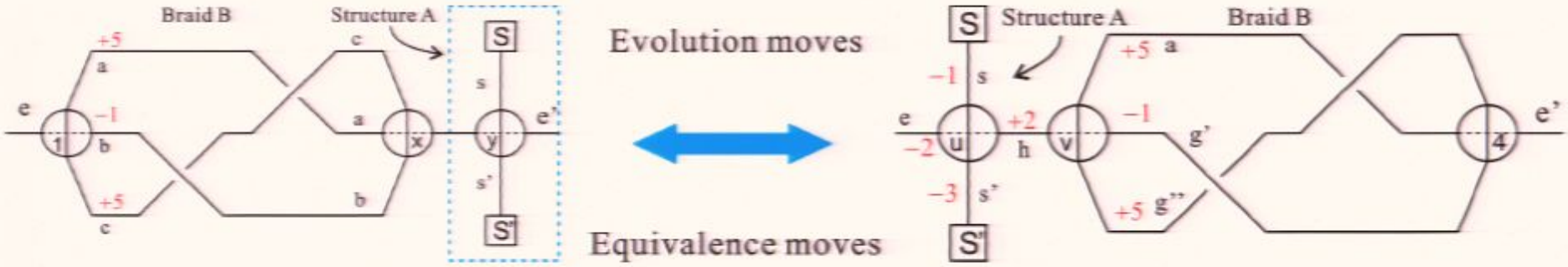

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- *A (left) right-irreducible braid is not **actively (left) right-interacting**.*
- *A irreducible braid is never **actively interacting**.*

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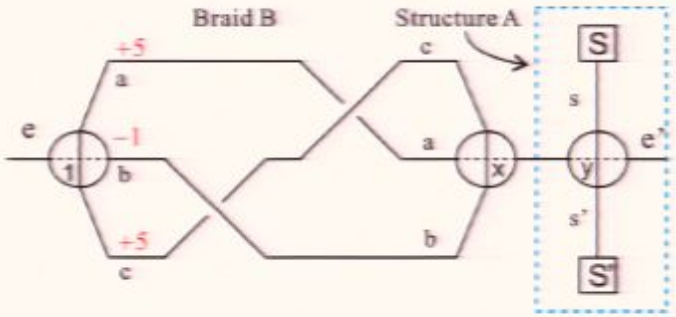

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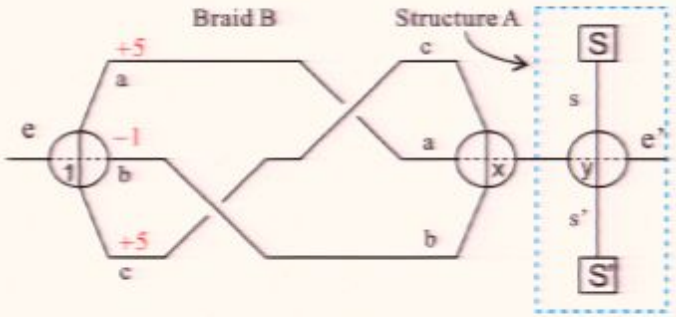

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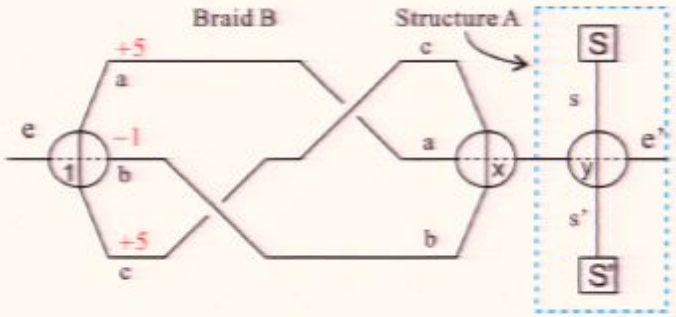

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5. Both propagations and interactions are chiral.
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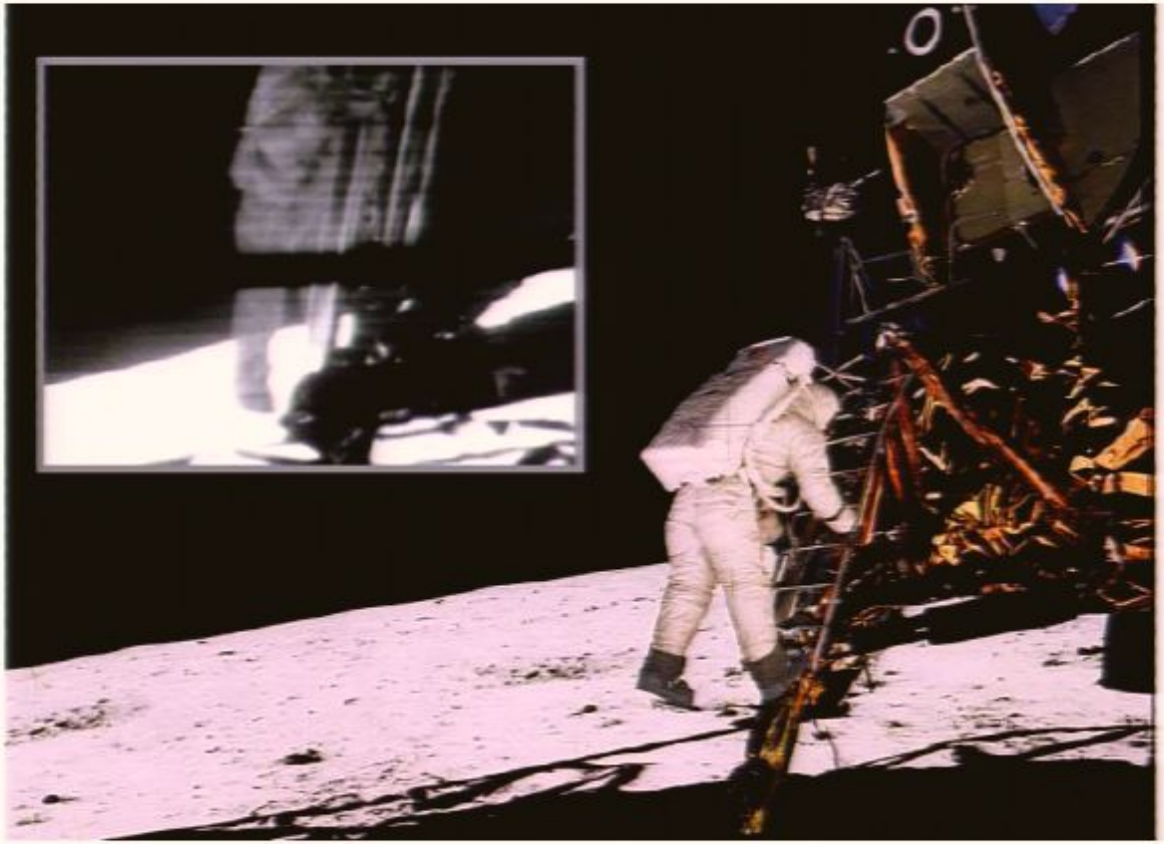

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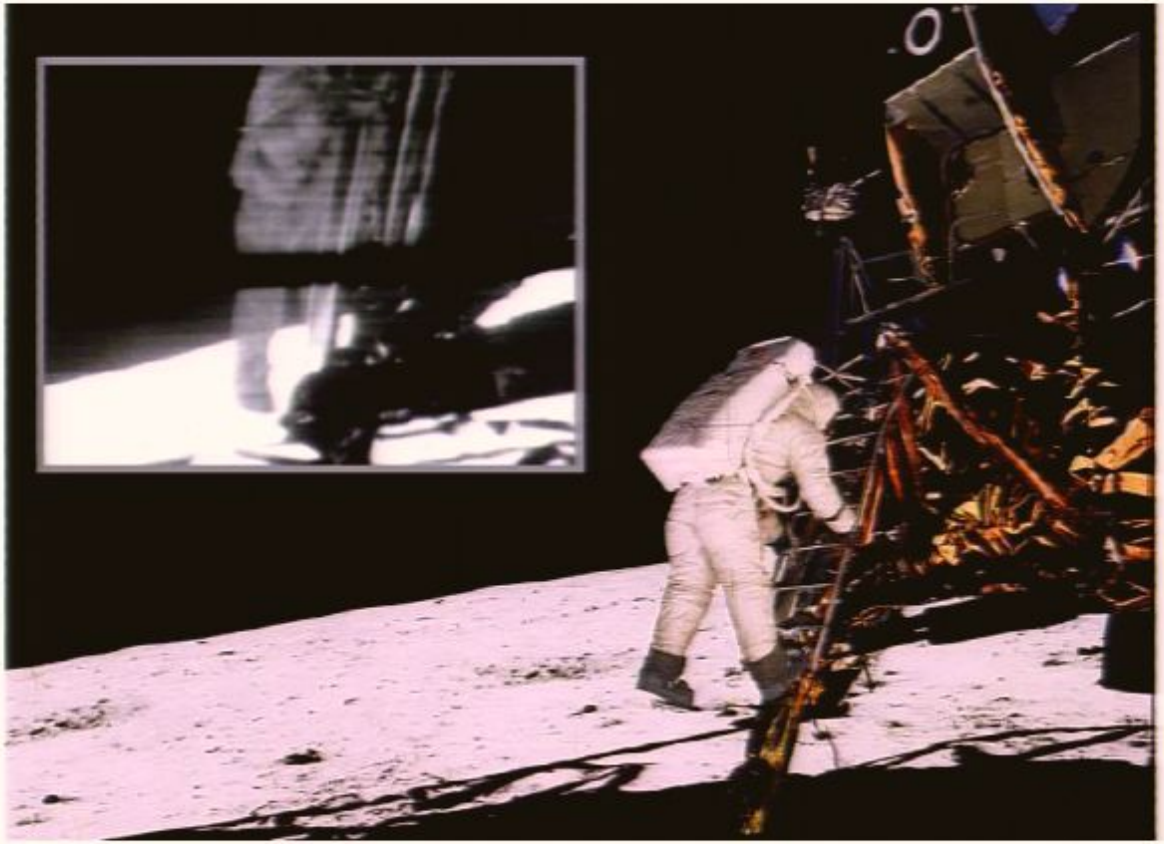

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