Quantum Entanglement and the Flow of Time Animations

Quantum Entanglement

By Mark Egdall 6/15/ 09

Based on Brian Greene's *The Fabric of the Cosmos*

5. Animation on Quantum Entanglement:

•The wave functions of two correlated photons travel in opposite directions.

- We don't know where each photon is *until it hits a detector*.

• Equal probability that left photon will *transmit* or *reflect* off polarized lens

• Same is true for right photon.

Note: Wave functions not rigorously depicted.

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- We don't know where each photon is *until it hits a detector*.

• Equal probability that left photon will *transmit* or *reflect* off polarized lens.

• Same is true for right photon.

→ But if one of the photons transmits, *the other does the opposite*. (And vice-versa.)

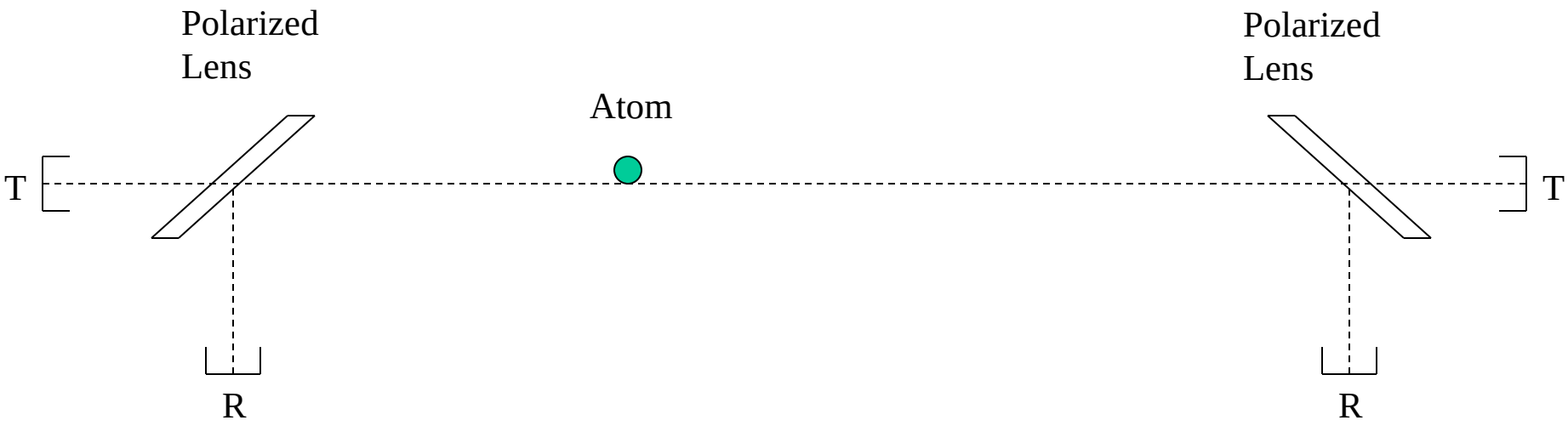
Note: Wave functions not rigorously depicted.

Quantum Entanglement - Example

Detectors

T – Transmission

R - Reflection



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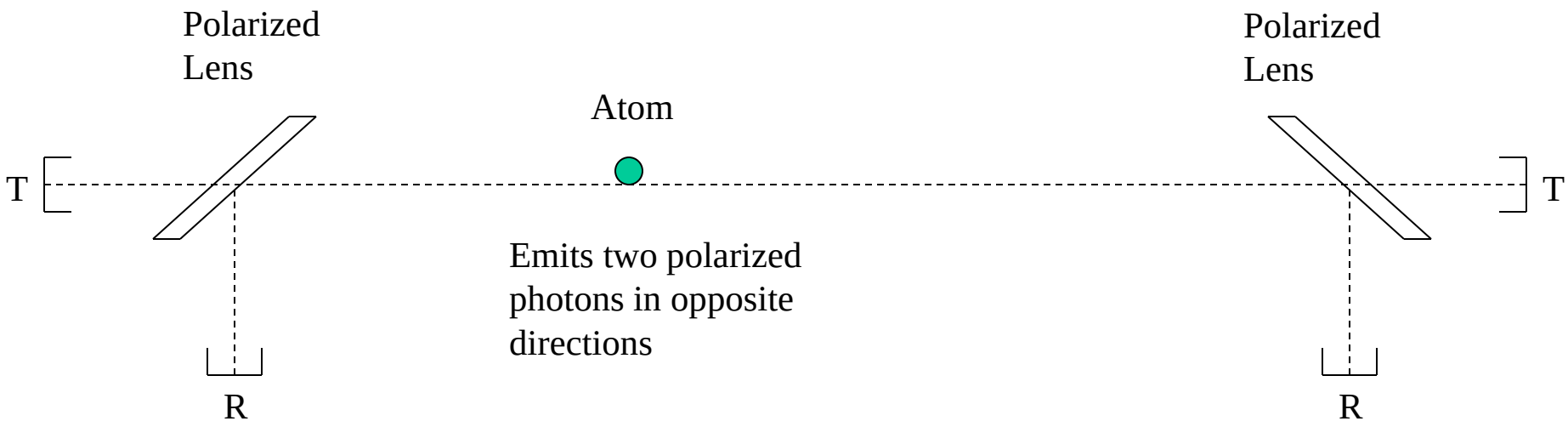

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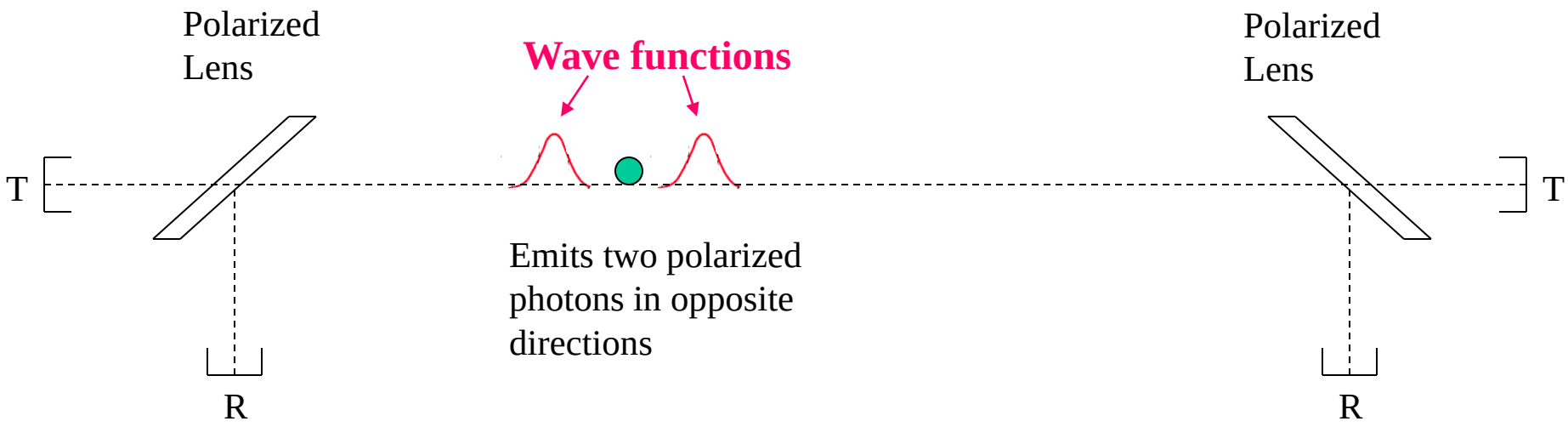

Wave functions not to scale

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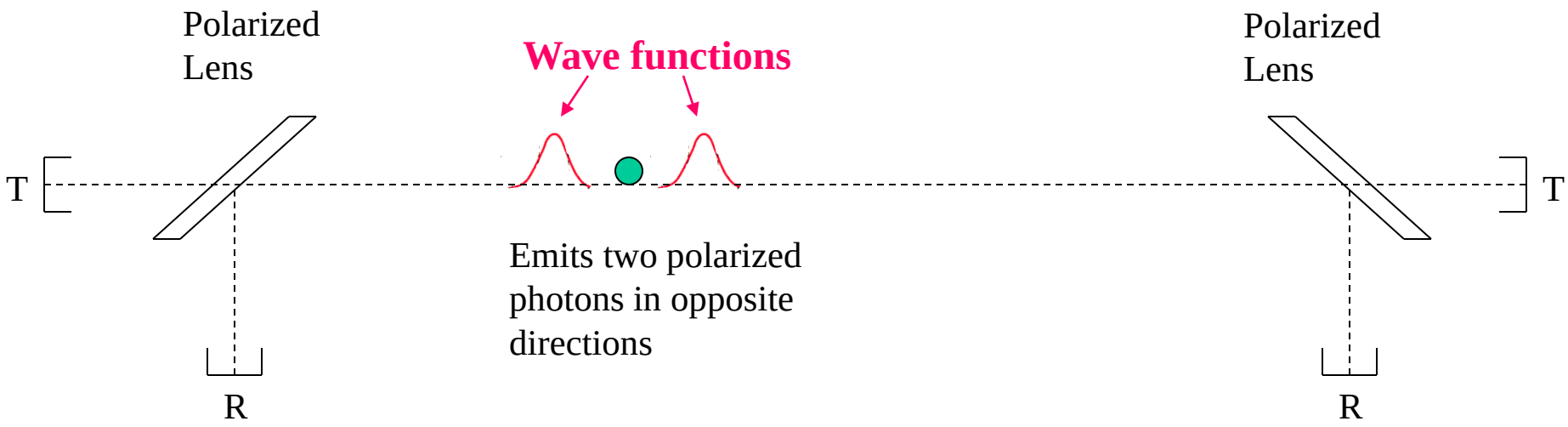

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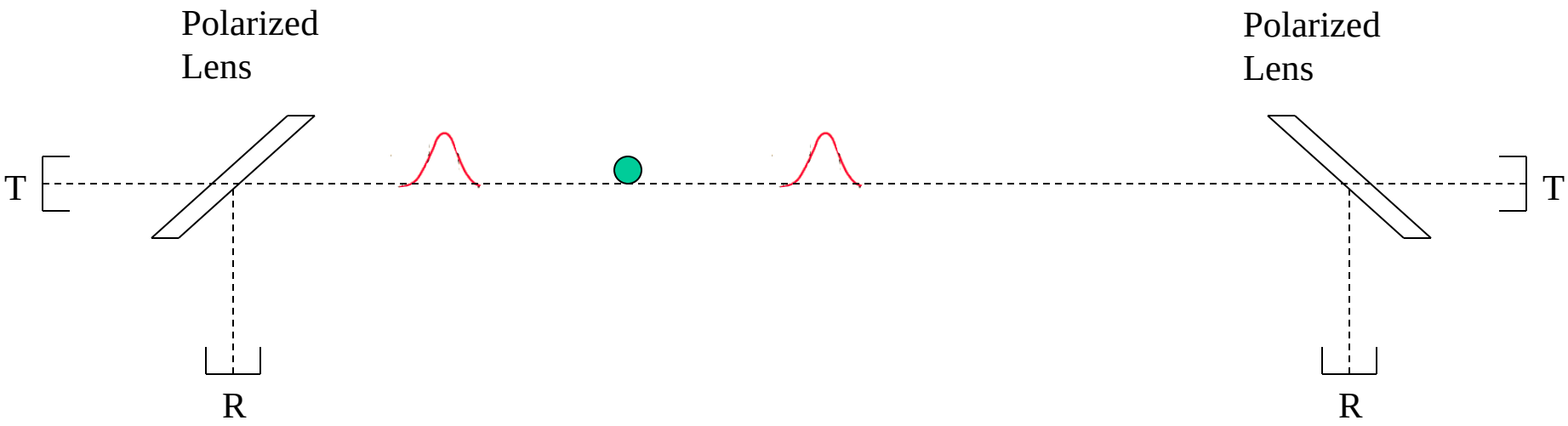

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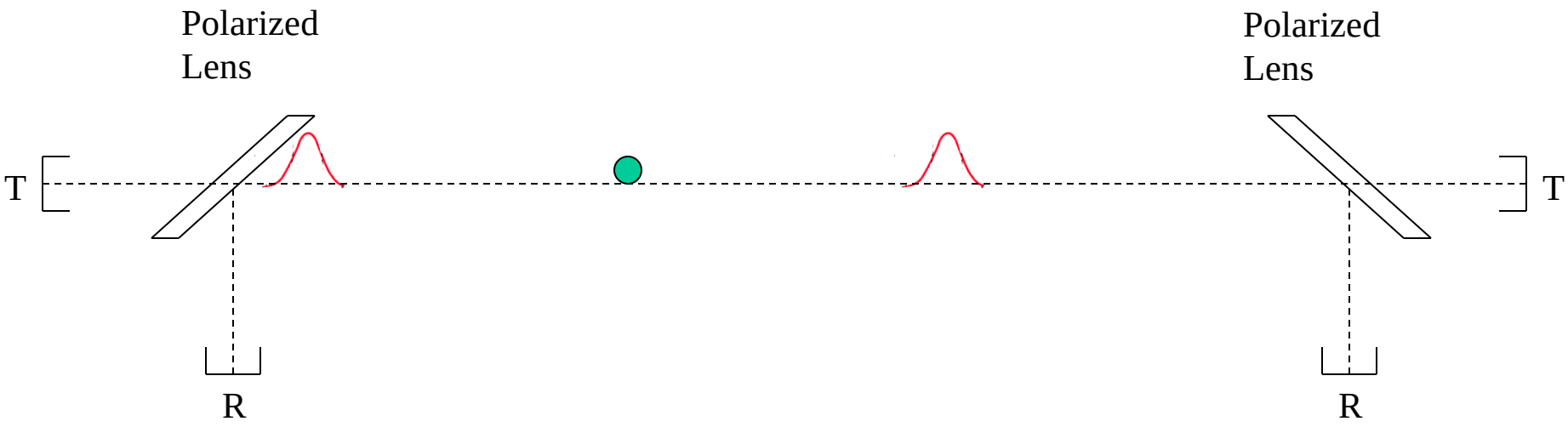

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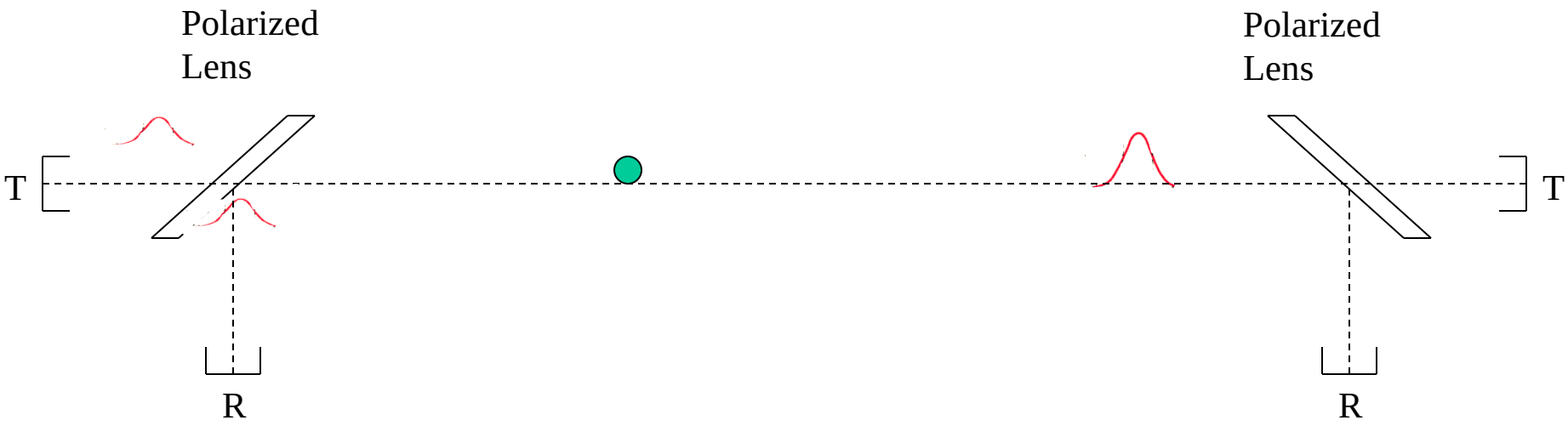

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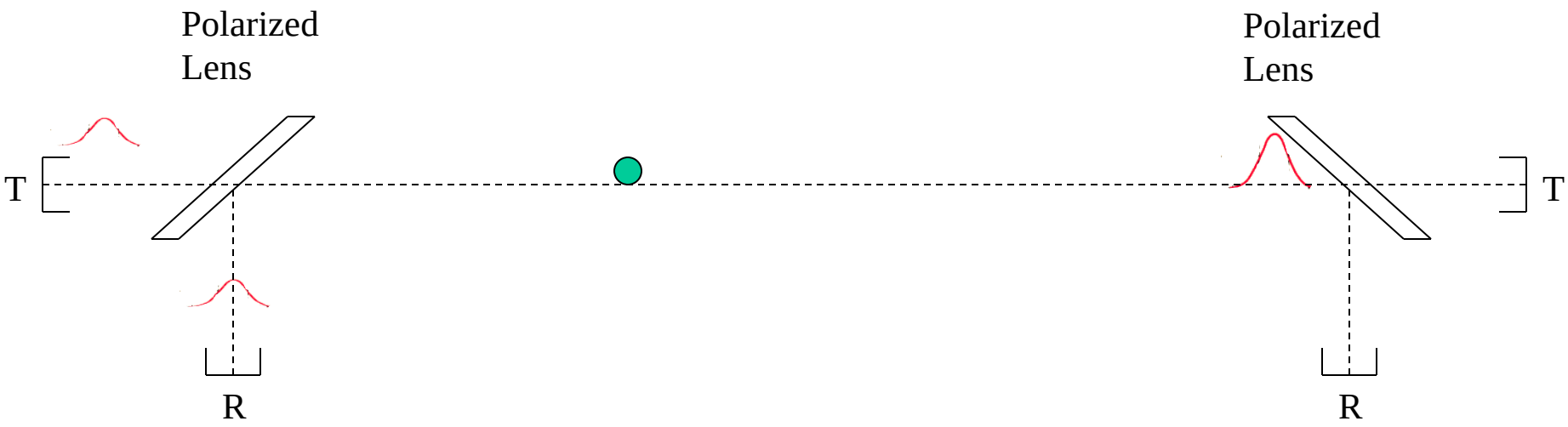

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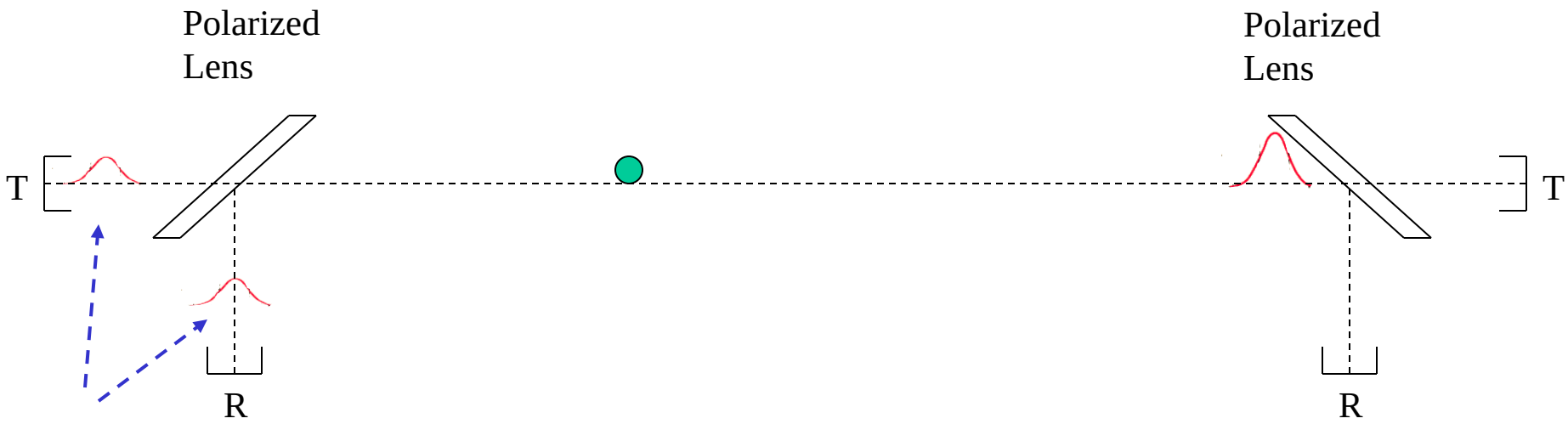

50/50 chance of reflection or transmission

- Actual choice is purely random and cannot be predicted

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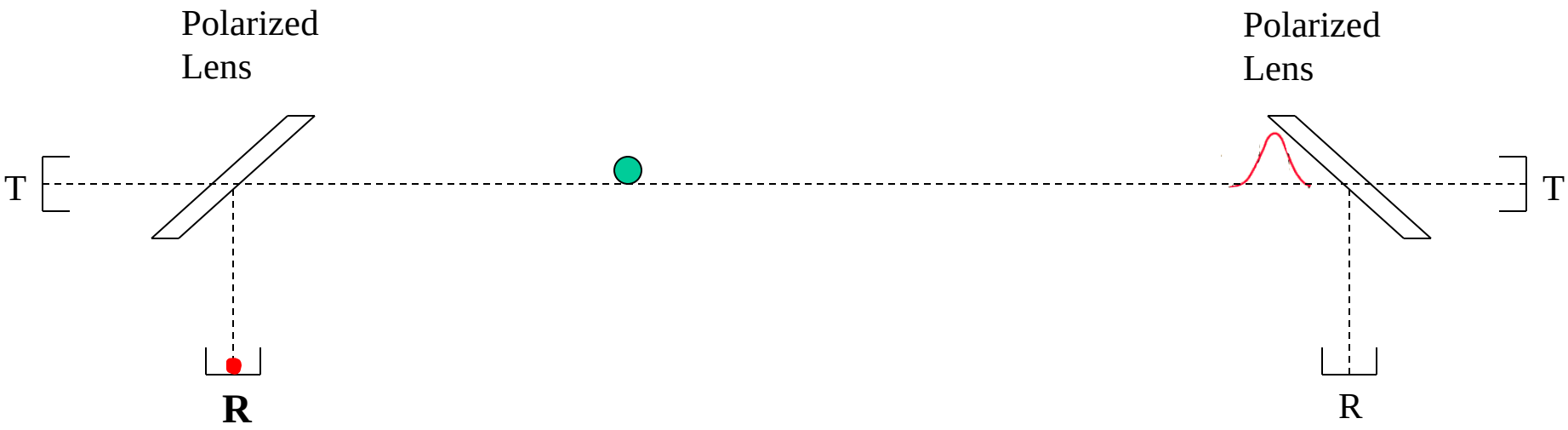

Wave functions collapse

Photon happens to be detected
- in *reflection*

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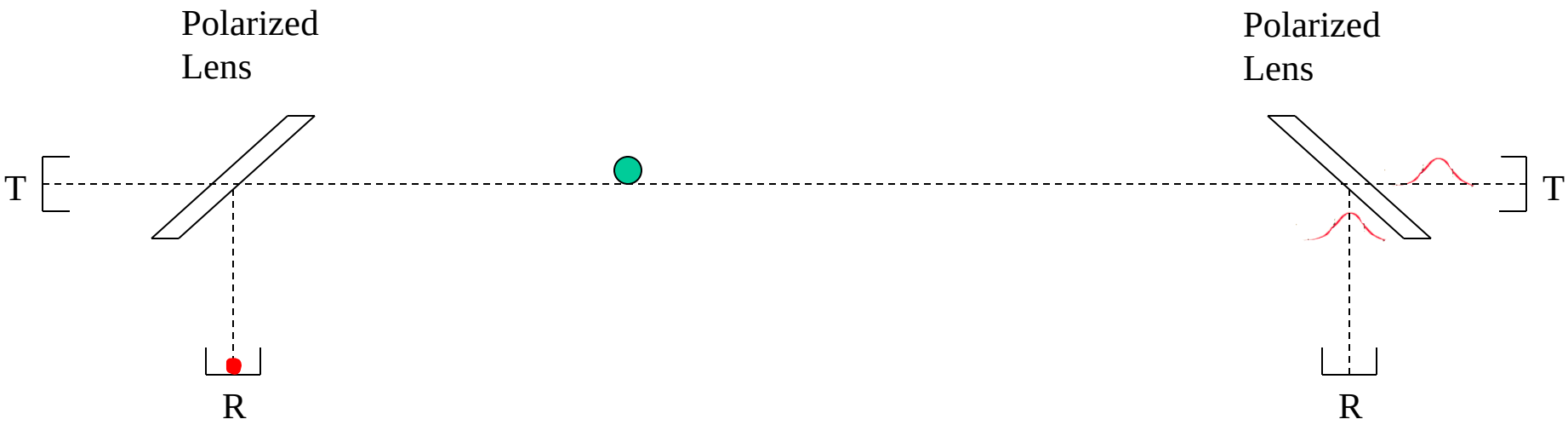

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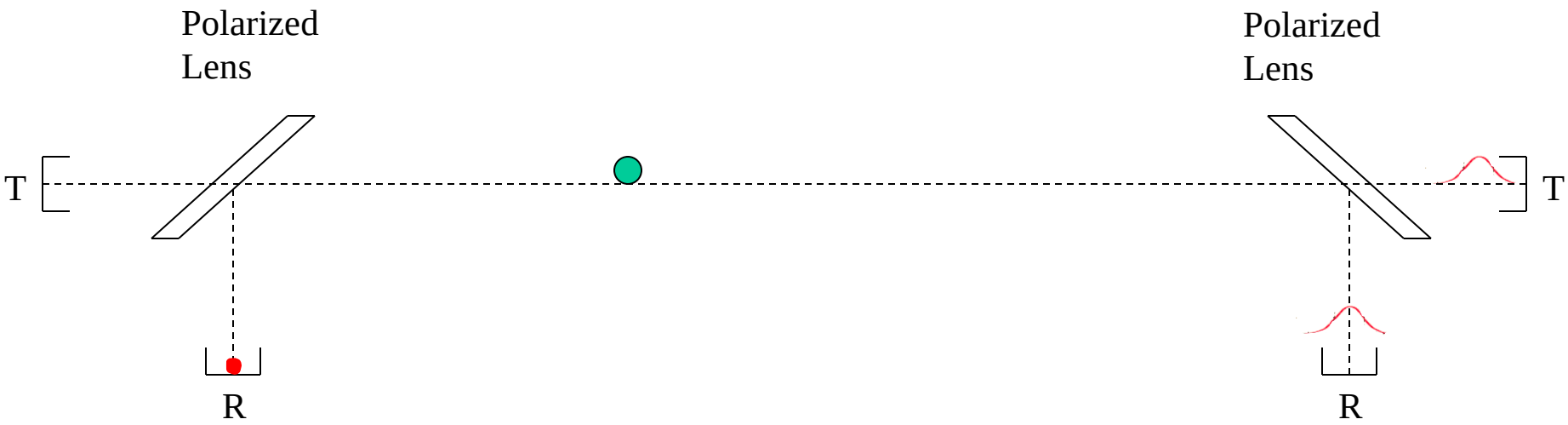

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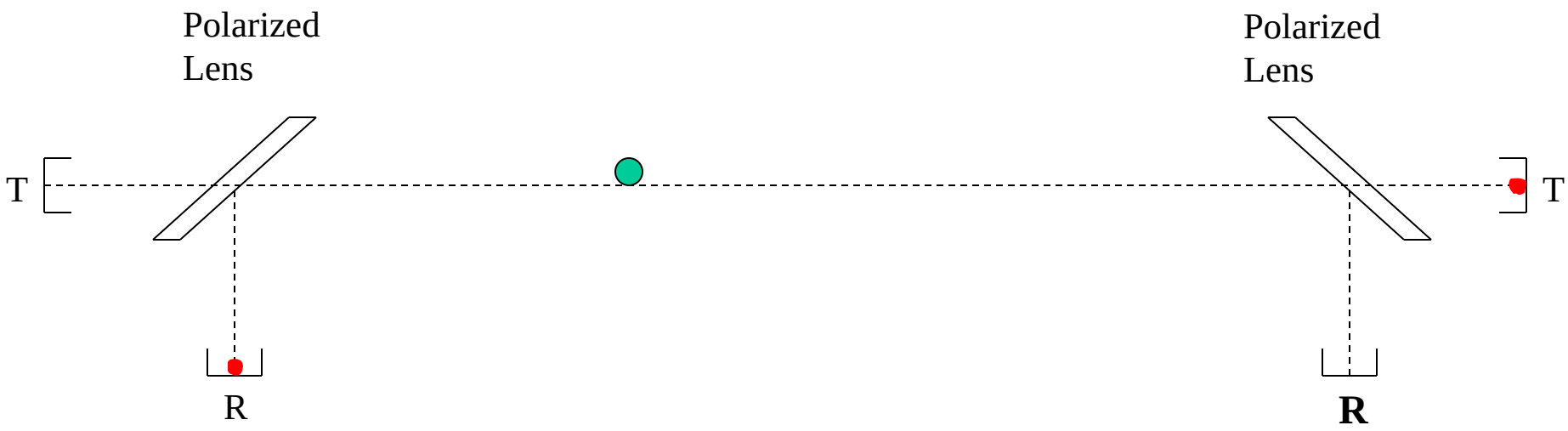

Wave functions collapse

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Right photon detected
- in *transmission*!

Quantum Entanglement - Example

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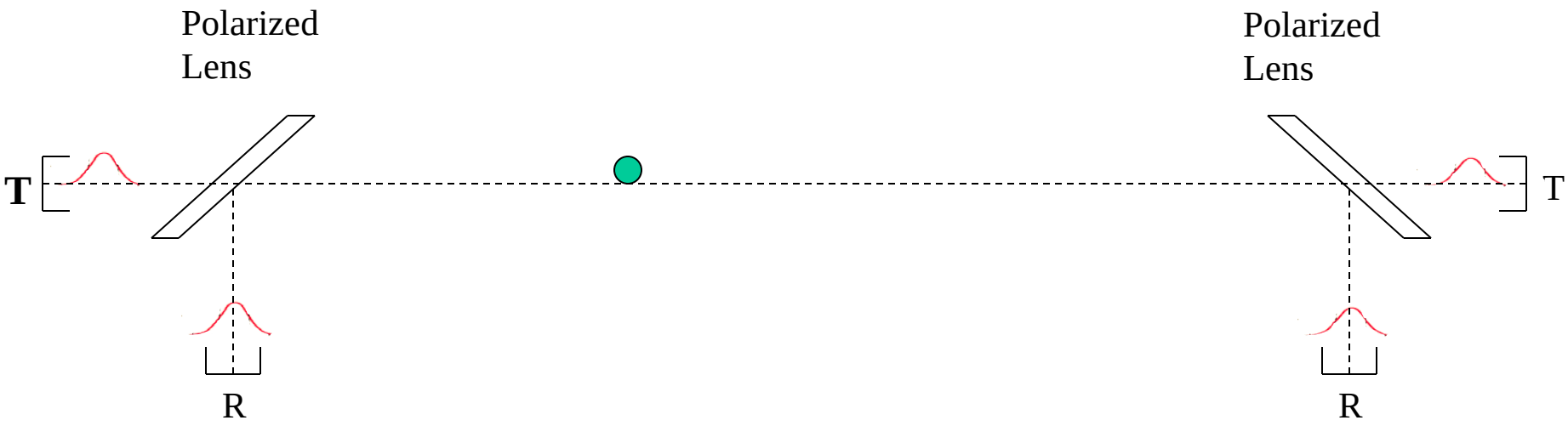
What if left photon happens to be detected – ***in transmission*** ?



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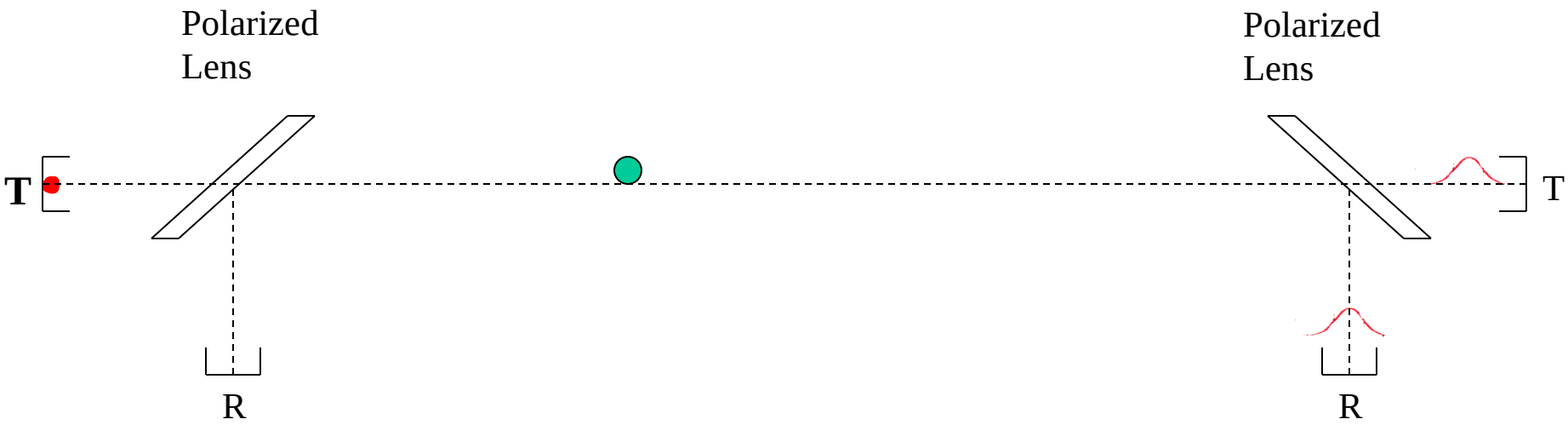

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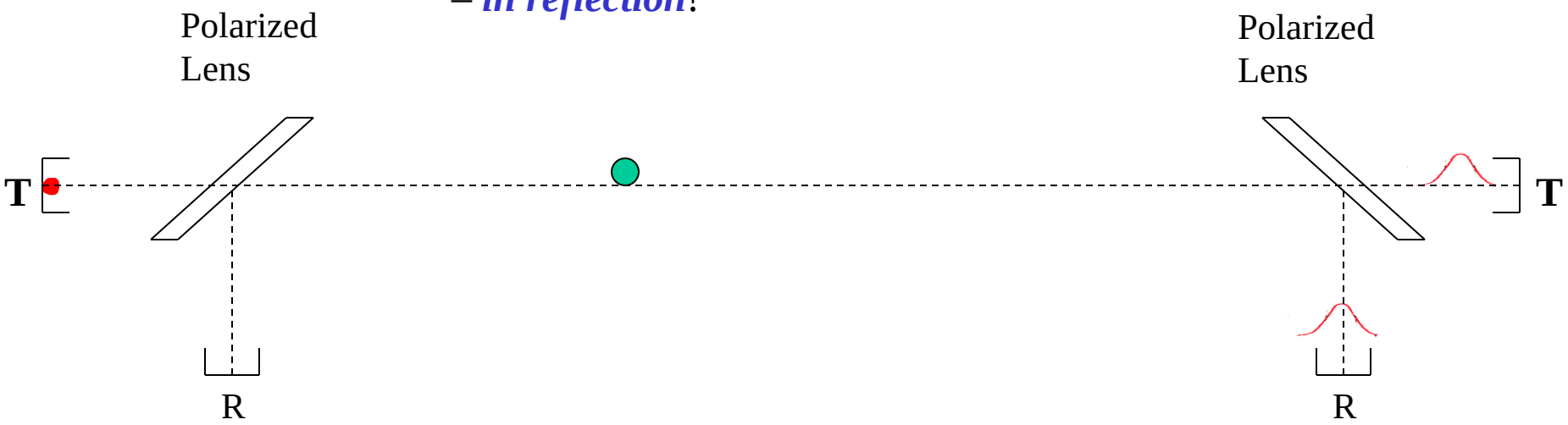

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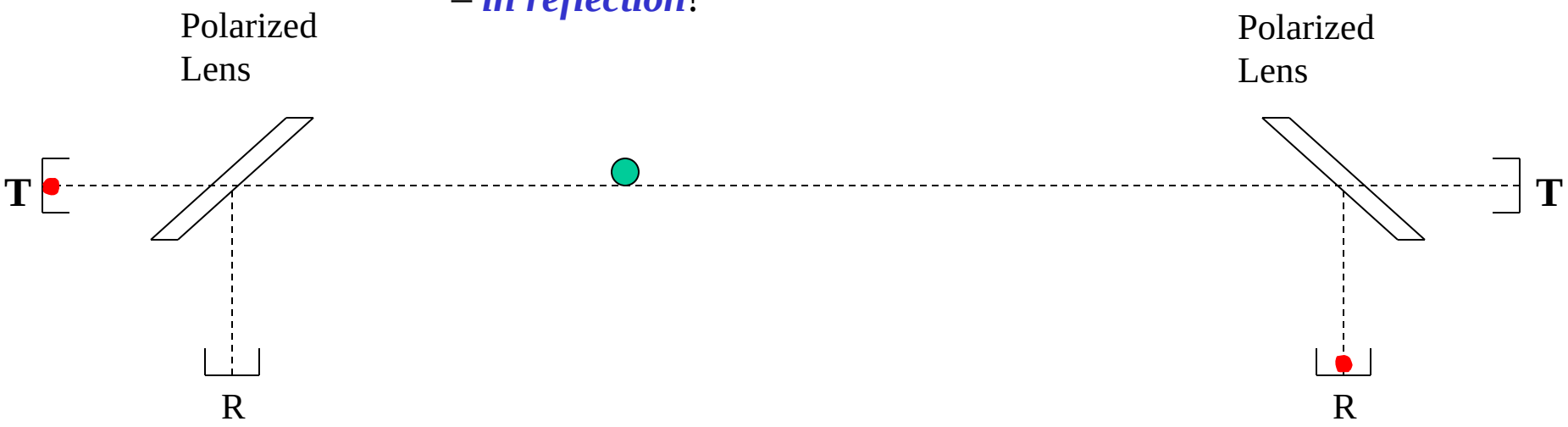

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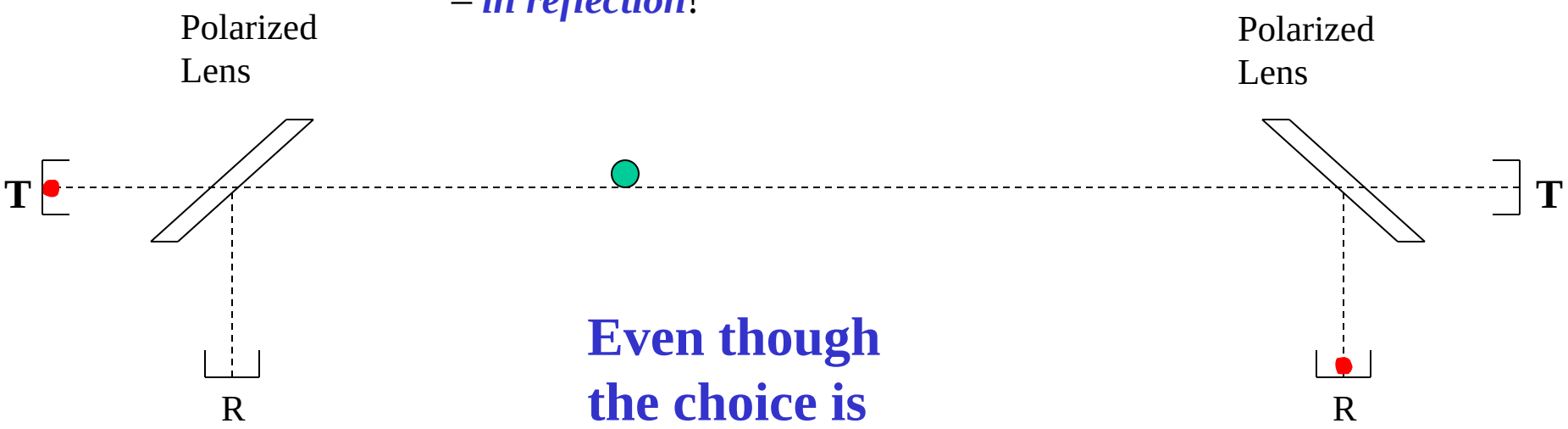


Even though the choice is random

Wave functions collapse

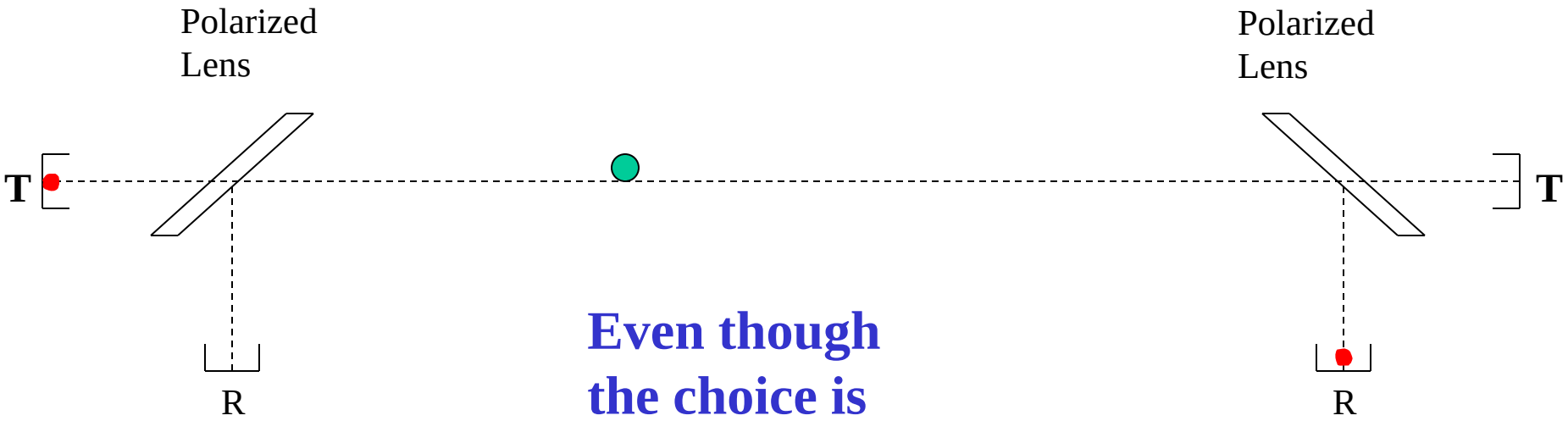
Photon detected - in *transmission*

Wave functions collapse

Photon detected - in *reflection*

Quantum Entanglement - Example

When confronted with 50/50 *random* chance of transmitting or reflecting off polarized lenses
- Both photons will always do the *opposite* thing!



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Wave functions collapse

Photon detected
- in *transmission*

Wave functions collapse

Photon detected
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Correlated Pairs

For the photon pair:

-The choice of reflection or transmission through the polarized lenses is *random*.

-We cannot predict whether a photon will transmit or reflect.

- We can only predict the odds or *probability* of a photon transmitting or reflecting.

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-The choice of reflection or transmission through the polarized lenses is *random*.

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- We can only predict the odds or *probability* of a photon transmitting or reflecting.

Yet whichever of these random events occurs for one photon:

- the opposite thing always happens to the other photon!

End of Animation