Philosophy of QM 24.111

Fifth lecture,

14 Feb. 2005

A PUZZLE ABOUT LOCALITY

How does the Bell's Theorem definition of locality

outcome on left

outcome on right

setting on left

setting on right

state of particle pair

$$\mathrm{Prob}(x,y \mid \theta_L,\theta_R,\lambda)$$

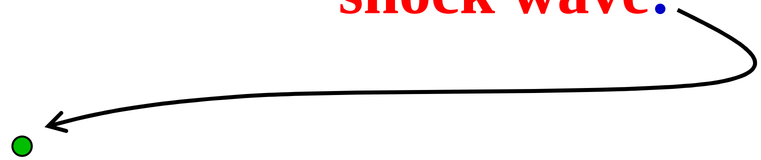
$$= \mathrm{Prob}(x \mid \theta_L,\lambda)\mathrm{Prob}(y \mid \theta_R,\lambda)$$

match up to

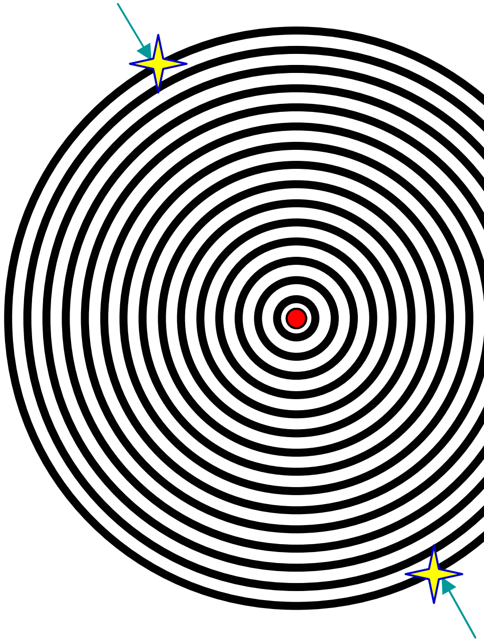
- our intuitive understanding of this notion;
- the kind of "locality" that features in special relativity?

SOME HYPOTHETICAL PHYSICS

Unstable particle; when it "explodes", it sends out a spherical shock wave:

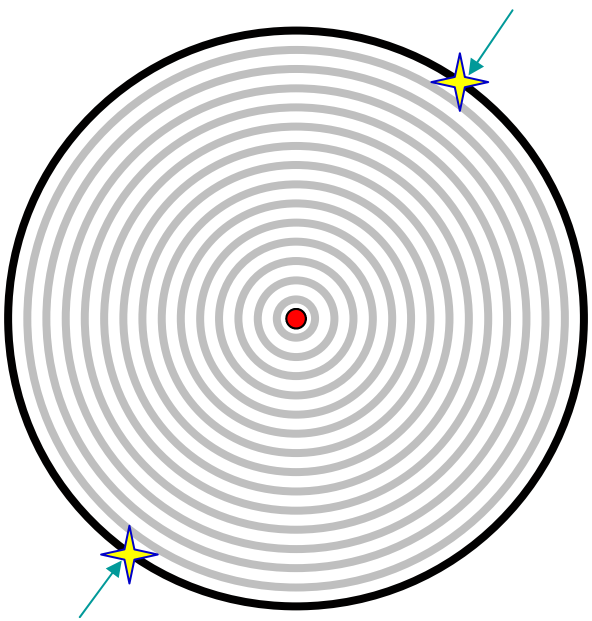


SOME HYPOTHETICAL PHYSICS



When the shock wave reaches a certain critical distance, two localized "flashes" appear on its surface, at opposite positions, with their axis randomly determined:

SOME HYPOTHETICAL PHYSICS



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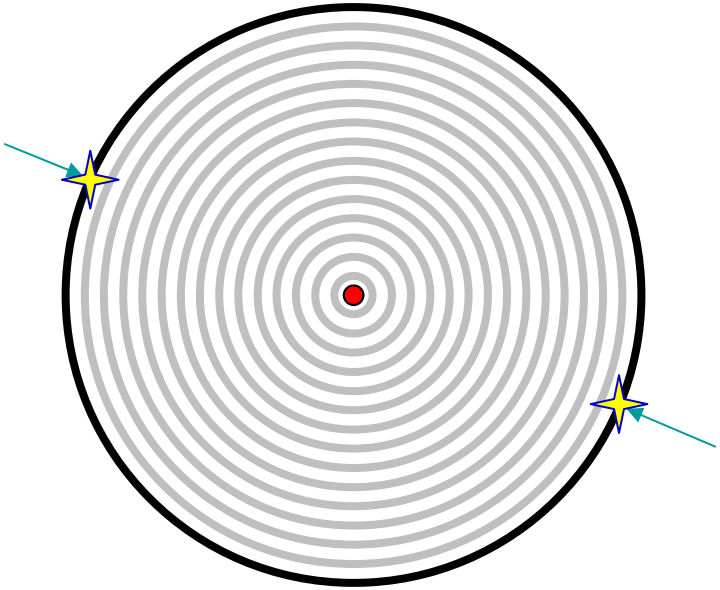

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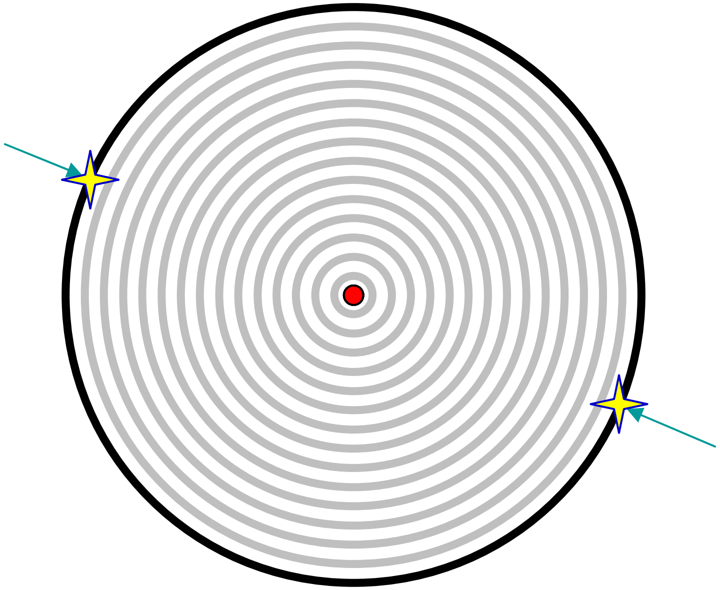

Bell-locality is violated in this example. Why?

Is our intuitive notion of locality (no “action at a distance”) violated?

Is special relativity violated?

WHAT SPECIAL RELATIVITY FORBIDS:

Five options:

Faster-than-light mass/energy transport

Faster-than-light information transfer

Faster-than-light signalling

Faster-than-light causation

Dynamical laws that are not Lorentz-invariant