

Three Simple Questions about Virtual Particle Pairs

Terry Bollinger

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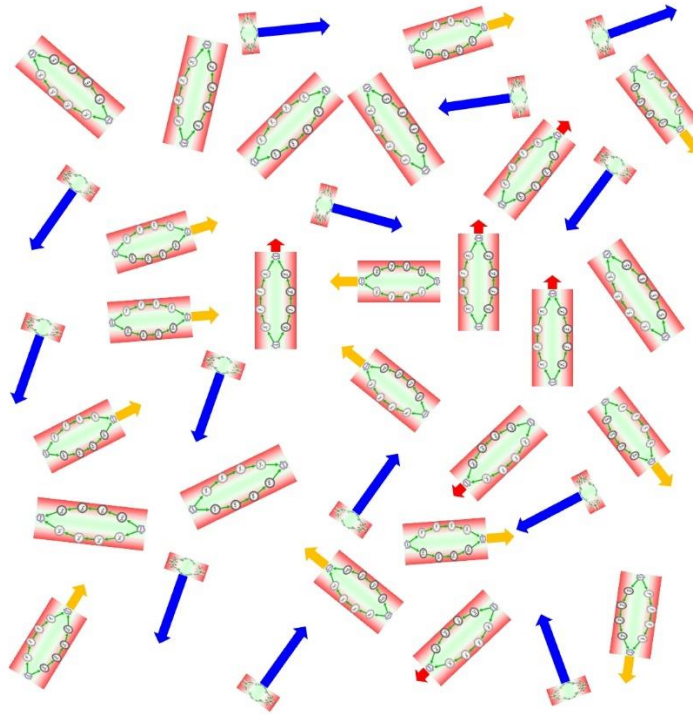


Figure 1. Special relativity requires an infinitely hot gas of virtual pairs from all possible inertial frames.

Don Lincoln, you noted at 4:04 in your Fermilab video [1] on virtual particles that “... *even with virtual particles, some of the usual rules apply. In this case, matter and antimatter particles appear in pairs.*” My apologies for violating the usual YouTube physics etiquette of never asking serious questions. My three questions are so simple that I hoped you might make an exception for a poor, bewildered computer scientist.

Producing a pair of virtual particles requires them, however briefly, to have equal and opposite momentums to achieve separation. That, in turn, requires them to originate at a point in space where their total momentum is zero.

Question #1: In what inertial frame is the virtual-pair origin point motionless?

Question #2: Since special relativity requires empty space to be identical from in frame of motion, won't every moving observer, regardless of speed, see pairs of virtual particles that are motionless in their frame and thus moving relative to any other frame?

Question #3: Since observers moving at close to lightspeed must observe virtual pairs similarly moving at close to lightspeed from any other viewpoint, how do you keep the indefinitely increasing relativistic energy of these fast-moving virtual particle pairs from forming an infinitely energetic gas that instantly incinerates the universe (Fig. 1)?

References

- [1] D. Lincoln, *What are virtual particles?* Fermilab (YouTube) 2024, 0417 (2024).
<https://youtu.be/ayQhNLqbTFk>