

Title: The origin of arrows and time I

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URL: <http://pirsa.org/16060108>

Abstract:

Claim

- ▶ Maxwell's time-symmetric electrodynamics provides us with no predictions in the absence of an additional assumption.

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- ▶ Maxwell's time-symmetric electrodynamics provides us with no predictions in the absence of an additional assumption.
- ▶ This assumption renders the theory time-asymmetric.

Maxwell's equations

- ▶ Two constraint equations (at each point)

$$\nabla \cdot E = 4\pi\rho \qquad \nabla \cdot B = 0$$

- ▶ Two evolution equations (at each point)

$$\frac{\partial B}{\partial t} = -c(\nabla \times E) \qquad \frac{\partial E}{\partial t} = c(\nabla \times B) - 4\pi J$$

- ▶ The Lorentz force law gives the back-reaction of the field on the charges.

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- ▶ Two constraint equations (at each point)

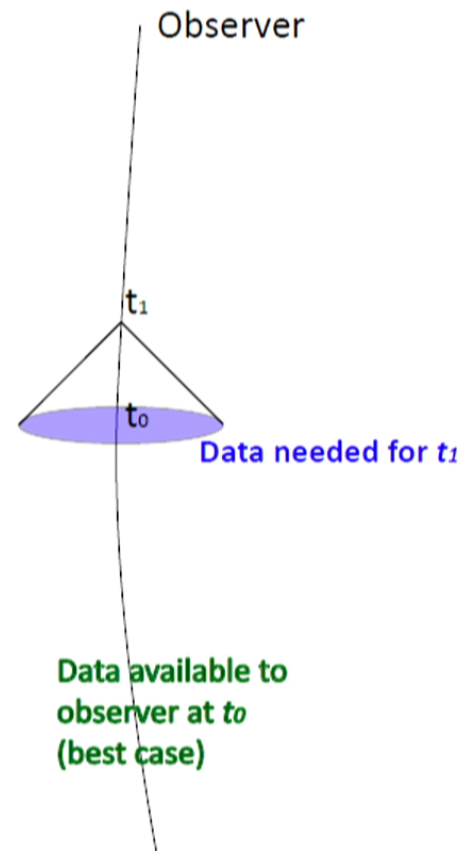
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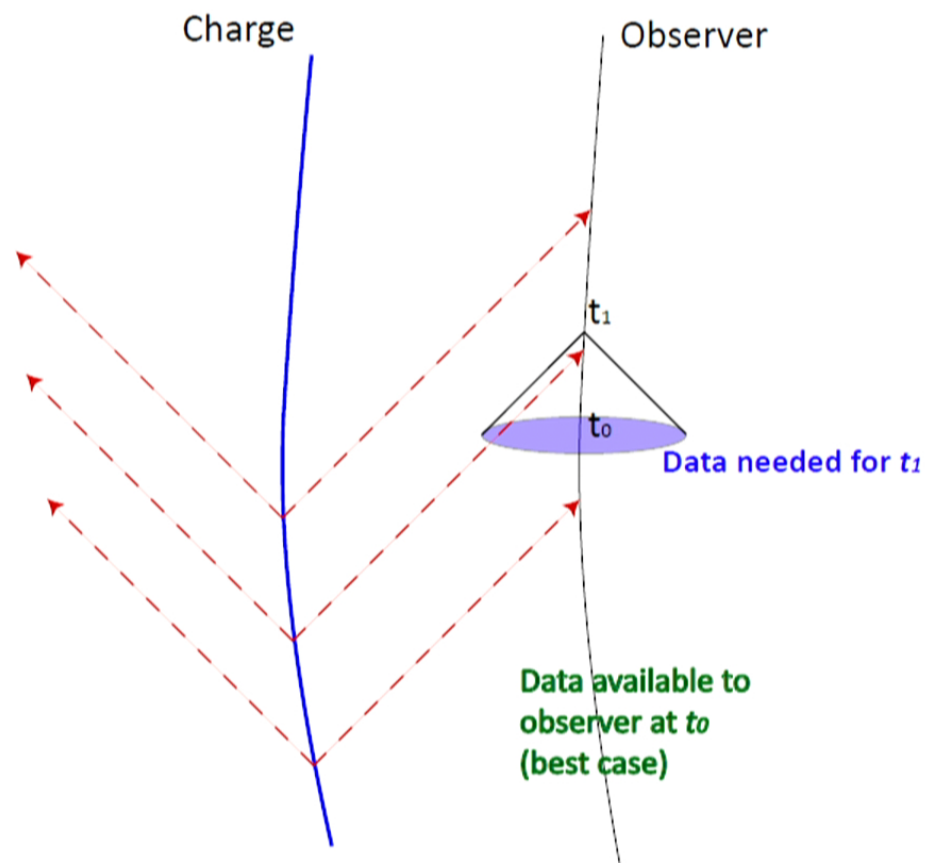
$$\frac{\partial B}{\partial t} = -c(\nabla \times E) \qquad \frac{\partial E}{\partial t} = c(\nabla \times B) - 4\pi J$$

- ▶ The Lorentz force law gives the back-reaction of the field on the charges.
- ▶ On the face of it, we can make predictions and test the theory by specifying E, B, ρ and J along a spacelike hypersurface.

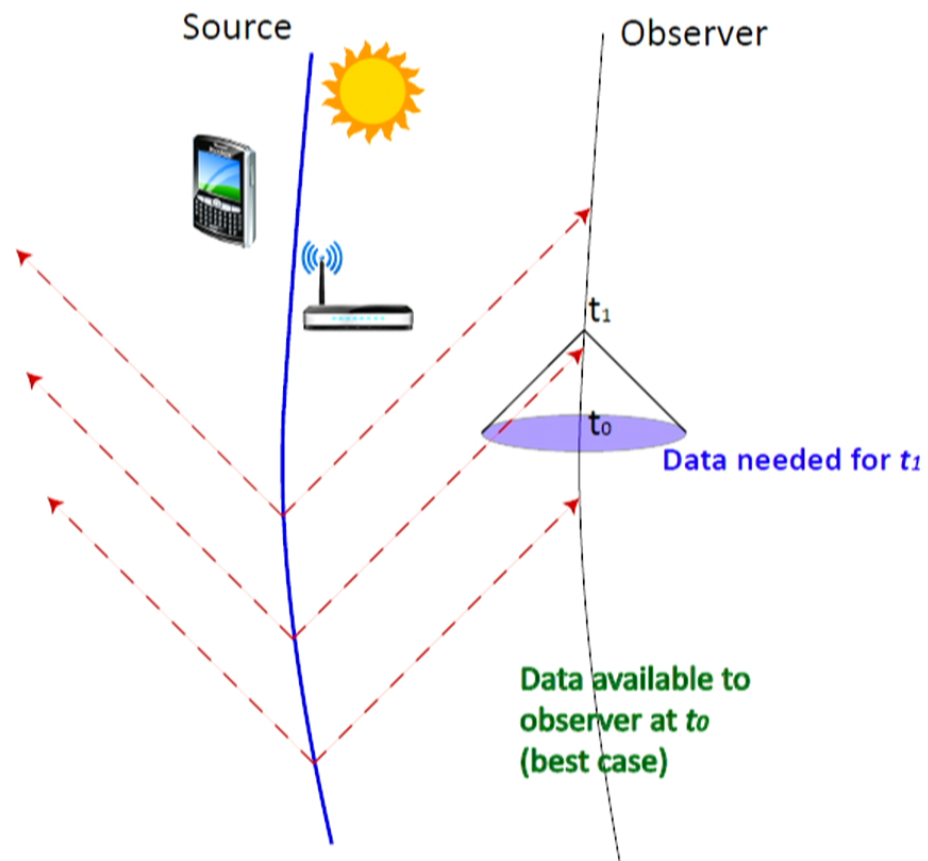
Paradox



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- ▶ All radiation is retarded radiation from massive charged objects. The behavior of these objects can be predicted by their prior behavior, which is visible in our past lightcone.
- ▶ There is no source-free radiation coming in from the past.

Upshot

- ▶ All radiation is generated by sources in the past. This is a *time-asymmetric* assumption, and it is essential to the predictive value of electrodynamics.
- ▶ A corollary is that the field at any given time is entirely a function of the past history of the charge distribution. The field degrees of freedom are in principle superfluous.
- ▶ The electrodynamics we actually use is essentially the (time-symmetric) Wheeler-Feynman absorber theory, without the absorber.