

Based on Feynman "A travelling field", on the electromagnetic radiation necessary and sufficient conditions

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In the Feynman Lectures on Physics Volume 18, section 4, to study the electromagnetic radiation field produced an ideal experiment, Feynman called the "A travelling field".

18-4 A travelling field

Now for the new consequences. They come from putting together all of Maxwell's equations. First, let's see what would happen in a circumstance which we pick to be particularly simple. By assuming that all the quantities vary only in one coordinate, we will have a one-dimensional problem. The situation is shown in Fig. 18-3. We have a sheet of charge located on the yz -plane. The sheet is first at rest, then instantaneously given a velocity u in the y -direction, and kept moving with this constant velocity. You might worry about having such an "infinite"

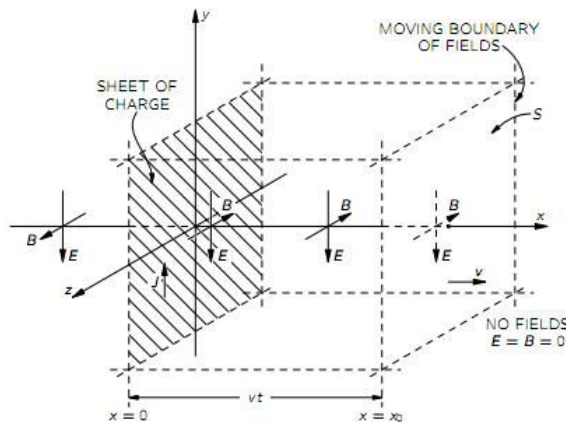


Fig. 18-3. An infinite sheet of charge is suddenly set into motion parallel to itself. There are magnetic and electric fields that propagate out from the sheet at a constant speed.

18-5

In Feynman discussed based on, further in-depth study of discussing the ideal experiment the electromagnetic wave radiation field formation conditions, can once again very clearly that: accelerating charge is generated electromagnetic wave radiation field is necessary but not sufficient condition; the source charge doing work on electromagnetic field is sufficient and necessary conditions for generating electromagnetic radiation field.

Feynman original discussion, can exist independently from the source charge "A travelling field", highlights are as follows:

1. The initial moment T_0 , in the vicinity of the YZ plane through the origin, there are two mutually approaching "infinite" surface charge sheet uniformly charged stationary, two surface charge sheet brought opposite polarity charge, charge density equal; and each space electromagnetic field strength at zero;
2. Thereafter, the process after a short time, until the moment T_1 , the positively charged surface of the charge sheet, (by external forces) along the Y -axis acceleration reaches a positive V ; and, after a certain time

to a moment T , surface charge sheet steady speed of V ; then, as shown in the X coordinate value is less than CT spatial range, uniform magnetic field induced B (direction is positive, negative Z), induced uniform electric field E (negative direction Y);

3. Later, to a moment T_2 , superimposed another pair exactly like surface charge sheet, however, in which the surface charge sheet with a positive charge, do $(-V)$ motion; then after a moment of T_2 , to a moment T' , in the X coordinate value is less than $C(T'-T_2)$ of the spatial extent of the electromagnetic field strength will be restored to zero (no longer continue to produce electromagnetic radiation field); however, the absolute value of $\{X$ coordinate greater than $C(T'-T_2)$ within less than $C(T'-T_1)\}$ spatial extent, there may be one independent of the source charge "A travelling field" (A travelling electromagnetic radiation field).

In recognition of Feynman theoretical perspectives, on the basis of the above, we can see: the entire (T_1, T_2) during the movement velocity V (surface charge sheet), continues to "the travelling field" supplement the radiant energy if the push force movement of the surface charge sheet referred to as F , obviously, the supplementary power:

$$F \cdot V = - \int \rho V \cdot E d\sigma \quad (d\sigma \text{ for surface element, } \rho \text{ for surface charge density})$$

Exclude electromagnetic radiation field starting build, and ending two corresponding short period of time, the entire (T_1, T_2) period, no charges accelerated motion, there is a charge for the electric field urging continued doing work, continuous supply of electromagnetic radiant energy!

Visible, and electromagnetic radiation field is always accompanied by: $F \cdot V = 0$; this is the necessary and sufficient conditions for formation of electromagnetic radiation field.

On the basis of discussions on the existing Feynman, and then continue further and can more clearly prove: even if there is a charge made to accelerate the movement, it may not produce electromagnetic radiation field.

Prove as follows:

①. When the surface charge sheet another positively charged, when $(-V)$ movement, acting on the two reverse movement of the surface charge sheet induced electric field force to zero;

②. If the external force is not removed, surface charge sheet the two reverse movements are bound to happen equal and opposite direction of accelerated motion;

③. According to the superposition principle, even if the two surface charge sheets produce the same as the "equal size, the opposite direction of the acceleration movement", it is also certain that no longer continue to radiate electromagnetic energy;

④. Therefore, the charge acceleration motion is a necessary but not

sufficient condition for the formation of the "A travelling field" (the electromagnetic wave radiation field).

QED.

The conclusions are as follows:

Charge accelerating is the formation of "A travelling electromagnetic radiation field" necessary but not sufficient condition; Charge urged electric field doing work $-F \cdot V \neq 0$, is sufficient and necessary conditions for the formation of the electromagnetic radiation field.

Further research and thinking:

In three steps Feynman discussed above, after which the first two steps to remove the external force F , will happen then?

The first possibility is - surface charge sheet movement in the opposite direction of movement of the self-inductance of its electrical field strength E of action, slow down to a lower speed value u , and then maintain the speed constant, and stop the external electromagnetic radiation field to add energy;

The second possibility is - surface charge sheet movement in the opposite direction of movement of the self-inductance of its electrical field strength E of action, slow down to a lower average speed value u , and around the average speed u , generating sustained and stable rate fluctuations (Energy between the "Charge mechanical energy" and charge a small neighborhood-wide "electromagnetic energy" conversion, conservation)-The average velocity u and charge motion corresponding fluctuations, it is likely, that the physical mechanism of de Broglie wave!

About herein implementation mechanism "The second possibility" is:

- ① After the removal of the external force F , moment, surface charge sheet movement in the role of self-induction electric field E , it will slow down;
- ②. As described in the ① "sports surface charge sheet deceleration," the movement of the surface charge sheet Neighborhood inductance generated magnetic field strength B will diminish ($dB / dt < 0$);
- ③. With ② said "self - inductance magnetic field strength B weakening," the charge sheet surface inductance neighborhood movement direction is reversed electrical field E ($E = -dB / dt$);
- ④. With ③ said, "surface charge sheet Neighborhood self - inductance electric field E direction of movement is reversed," Poynting vector direction along reverse; energy flow direction toward the surface charge sheet movement; self - inductance electrical field force E direction, and the direction of "surface charge sheet" consistent movement; promote movement of the surface charge sheet has been accelerated;
- ⑤. As described in the ④ "sports surface charge sheet is accelerated," the charge sheet surface neighborhood self - inductance generated magnetic field strength B will enhance ($dB / dt > 0$);

⑥. As described in the ⑤ "self - inductance the magnetic field strength **B** enhanced" movement "surface charge sheet" neighborhood self - inductance electrical field **E** direction is reversed ($\mathbf{E} = -d\mathbf{B} / dt$) again;
⑦. As described in the ⑥ "neighborhood of the surface charge sheet self - inductance electric field **E** is again reversed the direction of movement", repeat the process began ①; forming speed around the average speed u sustained and stable volatility.

This "①-⑦-①" mechanism cycle changes, applied on a single electron is free to move, that is to say: true motion in the form of electrons, can not be "uniform motion" in the strict sense; "quasi-uniform linear electron movement ", is accompanied by electromagnetic field fluctuations in the neighborhood (de Broglie wave) motion.