[notation in a Slavic language]

Grunewald, 22 October 1906

Very esteemed Doctor,

This time also, I must again begin my letter with a request for forgiveness, because not much less than a quarter of a year has passed since I received yours. And yet I can assure you that I always had the best will to answer you, but nonetheless I never got to it. Now my lectures begin again this week, so I want and have to finally clear off my desk, as otherwise I will not get to it any more this year at all.

However, you ask me much more than I will probably ever be able to answer you. The problem

that you mention of the two electrons flying away from each other in a straight line, however simple it appears, is in fact extremely complicated as soon as the velocities of the electrons become high enough to be noticeable in comparison to the speed of light. And here the different electron theories also diverge from one another. Consequently, there is simply not an unequivocal answer to this today, not even in the form of differential equations.

But now to your main question: do the equations (I), (II), (III) form a "complete" system or not?

$$\left[(I)\ \frac{d\mathcal{E}}{dt} + v \cdot div\ \mathcal{E} = curl\ M, \quad (II)\ \frac{dM}{dt} = -curl\ \mathcal{E}, \quad (III)\ Vv\mu + \eta = 0\right]$$

To this I can only reply that for the time being and until further notice I <u>believe</u> that they form a complete system. My reasons are the following: 1) The circumstance

that you bring up, that v cannot be unequivocally calculated from $\mathcal{E}$ and M, is for me not decisive, because it would demand too much. For a point in time (t_0), v is of course to be viewed as given, naturally in such a way that (III)[1] is satisfied. Since v is given, the electromagnetic field after the passage of time dt is calculated from (I) and (II), and from this, with the help of (III), one then also finds v at time $t_0 + dt$. Granted, I am not at all able to prove that this is really always unequivocally possible. 2) In view of the difficulty of working out such a proof in general terms, what will be most advisable, in order to be able to move forward, is to begin by treating special cases of which it is easy to get an overall view. This has in fact been done, especially by Herglotz and Sommerfeld, and they have found no contradictions up to now,[2] but rather on the contrary, decidedly positive results.

[1] Translator's note: "Like (I) also" is added and crossed out.
[2] Translator's note: "Up to now" is squeezed in at the end of the line and may have been added after the rest of the sentence.

I am convinced, however, that if that (I), (II), (III) system were incomplete, this would have to quickly show itself in such simple problems, through indeterminacies and contradictions. So long as these remain absent, this is a positive sign in my view.

I am absolutely not an enthusiast of rigid, spherical electrons, but I am doubtful whether this theory can be gotten around by uncovering internal contradictions in it. I have so far not come across any. If you should succeed in finding such, even if only in one concrete case, that would be extremely important and interesting.

Now to conclude, one more thing that should have come at the beginning: my best good wishes for the thriving of the young physicist whom you have given the world, and for a happy course of your married life! Give my regards to your wife, although I have not met her. With the best of greetings, your devoted M. Planck