MAXWELL EQUATIONS AND INERTIAL TRANSFORMATIONS

B. Buonaura

Liceo Scientifico “C. Columbo”
Marigliano, Napoli, Italy
E-mail:bbuonau@tin.it

Received 3 March 2004; revised 21 May 2004

The inertial transformations of the space and time variables have recently been shown to provide a viable alternative description of relativistic phenomena. In the present paper we find the inertial transformations of a force by starting from Newton’s law. This allows us to write also the inertial transformations of the electric and magnetic fields. Relative to a moving frame, the Maxwell equations assume a novel velocity-dependent form.

Key words: special relativity, Maxwell equations, conventionality.

1. INTRODUCTION

In the last few years there has been a revival of interest in the foundations of relativistic physics. Conferences [1] and books [2,3] have been devoted to the most controversial issues. Among other problems, one should remember that according to Poincaré [4], Reichenbach [5], Mansouri and Sexl [6] the clock synchronization in inertial systems is conventional and the choice of the invariance of the one-way velocity of light made in the TSR was based only on simplicity. Following this line of thought, Selleri showed that a suitable parameter $e_1$ can be introduced to allow for different synchronizations in the transformations of the space and time variables [7]. The TSR is obtained for a particular nonzero value of $e_1$. In this way an infinite set of theories empirically equivalent to the TSR was developed.

The inertial transformations [8] are particular transformations of the space and time variables, obtained for $e_1 = 0$, alternative to the
Lorentz transformations, introduced for overcoming the conventionality of the relativistic synchronization of clocks, according to which it is not possible to measure the one way velocity of light.

In these transformations one assumes the existence of a privileged inertial system $S_0$ in which:

- Space is homogeneous and isotropic.
- Time is homogeneous.
- The usual Maxwell equations hold.
- The velocity of light has the same value $c$ in all directions.
- Clock synchronization is achieved with Einstein’s method.

Other properties of $S_0$ will be specified later. Let $S$ be an arbitrary inertial system in a state of rectilinear uniform motion along the $+x_0$ axis of the system $S_0$ with velocity $V$. The inertial transformations from $S_0$ to $S$ are [7]:

$$x = (x_0 - Vt_0)/R, \quad y = y_0, \quad z = z_0, \quad t = Rt_0,$$

(1.1)

with

$$R = \sqrt{1 - \beta^2}, \quad \beta = V/c.$$  

(1.2)

The inverse inertial transformations are

$$x_0 = Rx + Vt/R, \quad y_0 = y, \quad z_0 = z, \quad t_0 = t/R.$$  

(1.3)

According to these inertial transformations the geometrical structure is that of the three dimensional Euclidean space. Furthermore, the absolute simultaneity conception has to be adopted.

In $S_0$, a particle with rest mass $m_0$ has

- momentum: $p_0 = \frac{m_0 u_0}{\sqrt{1 - u_0^2/c^2}}$;  

(1.4)

- total energy: $E_0 = \frac{m_0 c^2}{\sqrt{1 - u_0^2/c^2}}$.  

(1.5)

During its motion, the particle satisfies Newton’s equations of motion:

$$F_0 = dp_0/dt_0.$$  

(1.6)

The force $F_0$ performs on a particle whose position is shifted by $d\mathbf{r}_0$, the elementary work

$$dL_0 = F_0 \cdot d\mathbf{r}_0.$$  

(1.7)

This implies a variation $dE_0$ of the particle energy in the time interval $dt_0$ and therefore the existence of a power:

$$\frac{dE_0}{dt_0} = F_0 \cdot \mathbf{u}_0.$$  

(1.8)