Transverse Contractions of Moving Bodies.

D. Bramanti

Via Vecchia Fiesolana 40, 50016 San Domenico di Fiesole (Firenze), Italia

(ricevuto il 3 Giugno 1977; manoscritto revisionato ricevuto il 3 Gennaio 1978)

Summary. — One of the most important theoretical consequences of the principle of relativity, i.e. the absence of transverse Lorentz-Fitzgerald contractions in moving bodies, has never been subjected to direct experimental tests. The existing indirect evidence of this absence is discussed, and a simple experiment for testing it directly and with high accuracy is proposed. Some implications of a possible non-null result of this experiment are also pointed out.

1. — Introduction.

In his book on the theory of relativity Møller writes what follows: «In view of the far-reaching consequences of the special principle of relativity, it is quite remarkable how few direct tests of this principle have actually been performed » (1). In fact, it even appears that one of its first and most important theoretical consequences, i.e. the absence of transverse Lorentz-Fitzgerald contractions of moving bodies (2), has never been subjected, so far, to any direct test at all.

The transverse contraction is absent also from the nondragged-ether theories by Lorentz (3) and by Ives (4), since, from the experimental point of view, they are perfectly equivalent to special relativity. In fact, Lorentz' theory is

(2) C. Møller: The Theory of Relativity (Oxford, 1972), p. 37, eqs. (2.10) and (2.11).
(4) H. E. Ives: Phil. Mag., 36, 392 (1945).
based on the hypothesis that all kinds of force depend on the velocity in the same way as electromagnetic forces: this hypothesis can also be deduced in a straightforward manner from the principle of relativity and, although from the theoretical point of view it is not fully equivalent to that principle, it is sufficient to derive all the same known experimental consequences. The same is true for Ives' theory, practically based on the hypothesis that the rates of all kinds of clock depend on the velocity in the same way as that of an ideal light clock.

Instead of simply accepting the principle of relativity and, therefore, neglecting the possibility of transverse contractions, we think it is necessary to analyse the problem also independently of this principle and of Lorentz' and Ives' hypotheses.

The simplest way to proceed might be the following: consider a gyroscope rotating with angular speed \( \omega_0 \) and with total inertial mass \( m_0 \) (which also includes the contribution from the gyroscope rotational energy). Apply to a point on its axis of rotation an accelerating force parallel to \( \omega_0 \) until the translational velocity reaches the value \( \mathbf{w} \), also parallel to \( \omega_0 \). Then assume that the angular momentum \( I\omega \) is conserved during the acceleration. Since the moment of inertia \( I \) is proportional to \( m_0 r_{\perp}^2 \), where \( r_{\perp} \), orthogonal to \( \mathbf{w} \), is the transverse dimension of the gyroscope, we must have

\[
(1) \quad m_0 \omega_0 \omega_w = m_0 \omega_0 r_{\perp0} \omega_0.
\]

Now, if \( m \) and \( \omega \) depended on \( \mathbf{w} \) in the same way as in Einstein, in Lorentz and in Ives theories, that is if

\[
(2) \quad m_w = \frac{m_0}{\sqrt{1 - w^2/c^2}},
\]

where \( c \) is the speed of light, and if

\[
(3) \quad \omega_w = \omega_0 \sqrt{1 - \frac{w^2}{c^2}},
\]

we would get from (1)

\[
(4) \quad r_{\perp w} = r_{\perp0},
\]

which would mean that transverse Lorentz-Fitzgerald contractions would not exist. Conversely, if they do exist, eqs. (2) and (3) cannot be both valid exactly.

Since eq. (4) has never been tested directly, in order to find some evidence for the existence or nonexistence of transverse contractions, we may look for how well (2) and (3) are supported by available experimental data. Equation (2) is supported by a large number of experiments made with particles widely different in mass, charge, spin, types of internal energy, etc., but not