

# *Gravitational Waves and One-dimensional Einsteinian Gas-Dynamics*

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**1. Introduction.** It has long been known [1] that Einstein's equations of general relativity possess certain approximate solutions representing so-called gravitational waves. By this is meant that the gravitational potentials corresponding to a zero distribution of matter are solutions of the classical wave-equation, the velocity of propagation being equal to that of light. It has been argued by BERGMANN [2] that waves of this kind are emitted whenever mass points undergo accelerations but the example he gives—referring to plane waves—contains no indication that the gravitational effect of mass points is taken into account. Exact solutions of Einstein's equations of wave-form are also known: EINSTEIN & ROSEN [3] find that there are no plane waves but that there are cylindrical waves. This curious result is interpreted in terms of the energy carried by the waves but this interpretation is suspect because the concept of energy is artificial in general relativity. To introduce it, non-tensor quantities have to be used. In an important paper A. H. TAUB [4] has examined the exact solutions of plane wave type and has shown that they are spurious because by a coordinate transformation the waves can be removed. His method depends on assuming *a priori* that the energy-tensor is zero except perhaps in singular regions. It may be however that there are distributions of matter that tend to zero with the lapse of time and that significant gravitational waves may then result. Such cases are not necessarily covered by TAUB'S method and this is one question that is examined in this paper. It will be said that a gravitational wave solution of Einstein's equations in their exact form is significant if it can be shown to lead to a zero energy-tensor and, at the same time, to a curved space-time. When the space-time attained is flat, and a coordinate-transformation can thus reduce it to the MINKOWSKI space-time of special relativity, the gravitational waves will be regarded as physically spurious.

At the time when TAUB carried out his investigation the method of reduction