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Elastic shocks in relativistic rigid rods and balls. (English) [Zbl 1472.74124](#)

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Summary: We study the free boundary problem for the ‘hard phase’ material introduced by *D. Christodoulou* [Arch. Ration. Mech. Anal. 130, No. 4, 343–400 (1995; [Zbl 0841.76097](#))], both for rods in $(1 + 1)$ -dimensional Minkowski space-time and for spherically symmetric balls in $(3 + 1)$ -dimensional Minkowski space-time. Unlike Christodoulou, we do not consider a ‘soft phase’, and so we regard this material as an elastic medium, capable of both compression and stretching. We prove that shocks must be null hypersurfaces, and derive the conditions to be satisfied at a free boundary. We solve the equations of motion of the rods explicitly, and we prove existence of solutions to the equations of motion of the spherically symmetric balls for an arbitrarily long (but finite) time, given initial conditions sufficiently close to those for the relaxed ball at rest. In both cases we find that the solutions contain shocks if and only if the pressure or its time derivative do not vanish at the free boundary initially. These shocks interact with the free boundary, causing it to lose regularity.

MSC:

[74J40](#) Shocks and related discontinuities in solid mechanics

[35Q75](#) PDEs in connection with relativity and gravitational theory

[76E20](#) Stability and instability of geophysical and astrophysical flows

Keywords:

[elasticity](#); [shocks](#); [wave equation](#); [free boundary](#); [relativity](#); [relativity](#); [differential equations](#); [wave motion](#)

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