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Developing the wave equation for self-consistent metric oscillations in matter[1] DEEPEN GARG, Princeton University, ILYA DODIN, Princeton Plasma Physics Laboratory — Existing theories of gravitational-wave (GW)-matter coupling are not directly applicable to GWs that are inhomogeneous in space and have more general polarization than those in vacuum, thus leaving some important observable physical phenomena out of their scope. The standard approach to this problem has been to solve Einstein equations with matter and fields as source terms, but this has proven to be prohibitively cumbersome. We use an alternative, variational formulation [PRD 102, 064012 (2020)] to derive the gauge-invariant wave equation for collective oscillations of the self-consistent metric with a general polarization. We also propose a new nonlinear hereditary effect, the "gravitational ponderomotive effect." From a limiting case of our wave equation, we reproduce the Jeans instability on the same footing as vacuum GWs. Developing further on this equation, we also present corrections to the geometrical optics of GWs, which are of the same order as the GW-matter interaction term for near-vacuum waves.

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