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Gravitational waves in Friedman-Lemaitre-Robertson-Walker cosmology, material perturbations and the Huygens principle

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We analyze propagation equations for the polar modes of gravitational waves in cosmological space-times. We prove that polar gravitational waves must perturb the density and non-azimuthal components of the velocity of material medium of the Friedman-Lemaitre-Robertson-Walker space-times. Axial gravitational waves can in⊠uence only the azimuthal velocity. The whole gravitational dynamics reduces to the single "master equation" that has the same form as for axial modes. That allows us to conclude that the status of the Huygens principle is the same for both axial and polar modes of gravitational waves. In particular, this principle is valid exactly in radiation spacetimes with the vanishing cosmological constant, and it is broken otherwise.

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