Global Lorentzian geometry from lightlike geodesics: What does an observer in (2+1)-gravity see?

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We show how an observer could measure the non-local holonomy variables that parametrise the flat Lorentzian 3d manifolds arising as spacetimes in (2+1)-gravity. We consider an observer who emits lightrays that return to him at a later time and performs several realistic measurements associated with such returning lightrays: the eigentime elapsed between the emission of the lightrays and their return, the directions into which the light is emitted and from which it returns and the frequency shift between the emitted and returning lightray. We show how the holonomy variables and hence the full geometry of these manifolds can be reconstructed from these measurements in finite eigentime.

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