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Implications of diffeomorphism invariance for observables in gravity

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Physical observables in quantum gravity must be diffeomorphism-invariant. Such observables are nonlocal and hence do not obey the standard field-theoretic formulation of microcausality. I will show how to construct such 'gravitationally dressed' observables in perturbative gravity that become local in the weak gravity limit, and characterize gravitational corrections to microcausality. I will also derive bounds on how localized an operator's gravitational dressing can be. Based on arXiv:1507.07921 and 1607.01025 with Steve Giddings, and arXiv:1510.00672 with Don Marolf and Eric Mintun.