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Holographic observers for time band algebras (Suvrat Raju)

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Abstract: We study the algebra of observables in a time band on the boundary of anti-de Sitter space in a theory of quantum gravity. Strictly speaking this algebra does not have a commutant because products of operators within the time band gives rise to operators outside the time band. We show that in a state where the bulk contains a macroscopic observer, it is possible to design a coarse-grained version of this algebra with a non-trivial commutant, a resolution limited by the observer's characteristics. This algebra acts on a little Hilbert space that describes excitations above the observer's state and time-translated versions of this state. Our construction requires a choice of dressing that determines how elements of the algebra transforms under the Hamiltonian. At leading order in gravitational perturbation theory, and with a specific choice of dressing, our construction reduces to the modular crossed-product described previously in the literature.