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Causal evolution of probability measures

The causal structure of a spacetime $\mathcal{M}$ is usually described in terms of a binary relation $\preceq$ between events called the casual precedence relation. In my poster I will present a natural extension of $\preceq$ onto the space $\mathcal{P}(\mathcal{M})$ of (Borel) probability measures on $\mathcal{M}$, designed to rigorously encapsulate the common intuition that probability can only flow along future-directed causal curves.

Using the tools of the optimal transport theory adapted to the Lorentzian setting, one can utilize thus obtained notion of "causality between probability measures" to model a causal time-evolution of a spatially distributed physical entity in a globally hyperbolic spacetime. In the poster I will define what it means that a time-dependent probability measure $\mu_t \in \mathcal{P}(\mathcal{M})$ evolves causally. I will also explain how such an evolution can be understood as a "probability measure on the space of worldlines". Moreover, some preliminary results concerning the relationship between the causal time-evolution of measures and the continuity equation will be highlighted.

[1] M. Eckstein, T. Miller, Ann. Henri Poincaré 18(9), 3049–3096 (2017), doi:10.1007/s00023-017-0566-1

[2] T. Miller, J. Geom. Phys. 116, 295–315 (2017), doi:10.1016/j.geomphys.2017.02.006

[3] M. Eckstein, T. Miller, Phys. Rev. A 95, 032106 (2017), doi:10.1103/PhysRevA.95.032106