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The geometry of dissipative evolution equations

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Arnol'd pointed out that Euler's equations for an inviscid incompressible fluid can be seen as geodesic equations on the manifold of volume-preserving maps, when endowed with the ambient L^2 metric. On the opposite, overdamped, end of fluid dynamics, a density driven two-phase flow in a porous medium can be interpreted as a gradient flow of the potential energy with respect to a metric that models viscous dissipation on the level of Darcy's law, but is mathematically very similar to Arnol'd's. This dissipative metric induces a distance function on densities, which following Brenier can be interpreted as an optimal transportation problem, and is well-known in statistics. While the geometry on volume-preserving transformations has mostly negative curvature, the one on densities has non-negative sectional curvature.

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