

# Static Vacuum Geometry Determines Gravitational Collapse and Cosmology

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Beyond general relativity, regular black-hole geometries and modified cosmologies are often constructed independently, raising the question of whether black holes, gravitational collapse, and cosmology can still arise as different regimes of a common gravitational dynamics. We answer this question by showing that, within the covariant spherically symmetric effective Hamiltonian framework, the dynamics of gravity coupled to irrotational dust can be determined directly from a prescribed static vacuum family, although the Hamiltonian reconstruction of that family is not unique. Requiring the resulting dust dynamics to admit an FLRW sector further yields a necessary and sufficient restriction on the static vacuum family and determines the corresponding modified Friedmann equation. Thus, static vacuum geometry determines the collapse dynamics, while cosmological homogeneity feeds back to select the admissible static geometries. This generality may be rooted in the combined roles of general covariance and Birkhoff's theorem in the underlying theory.

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