

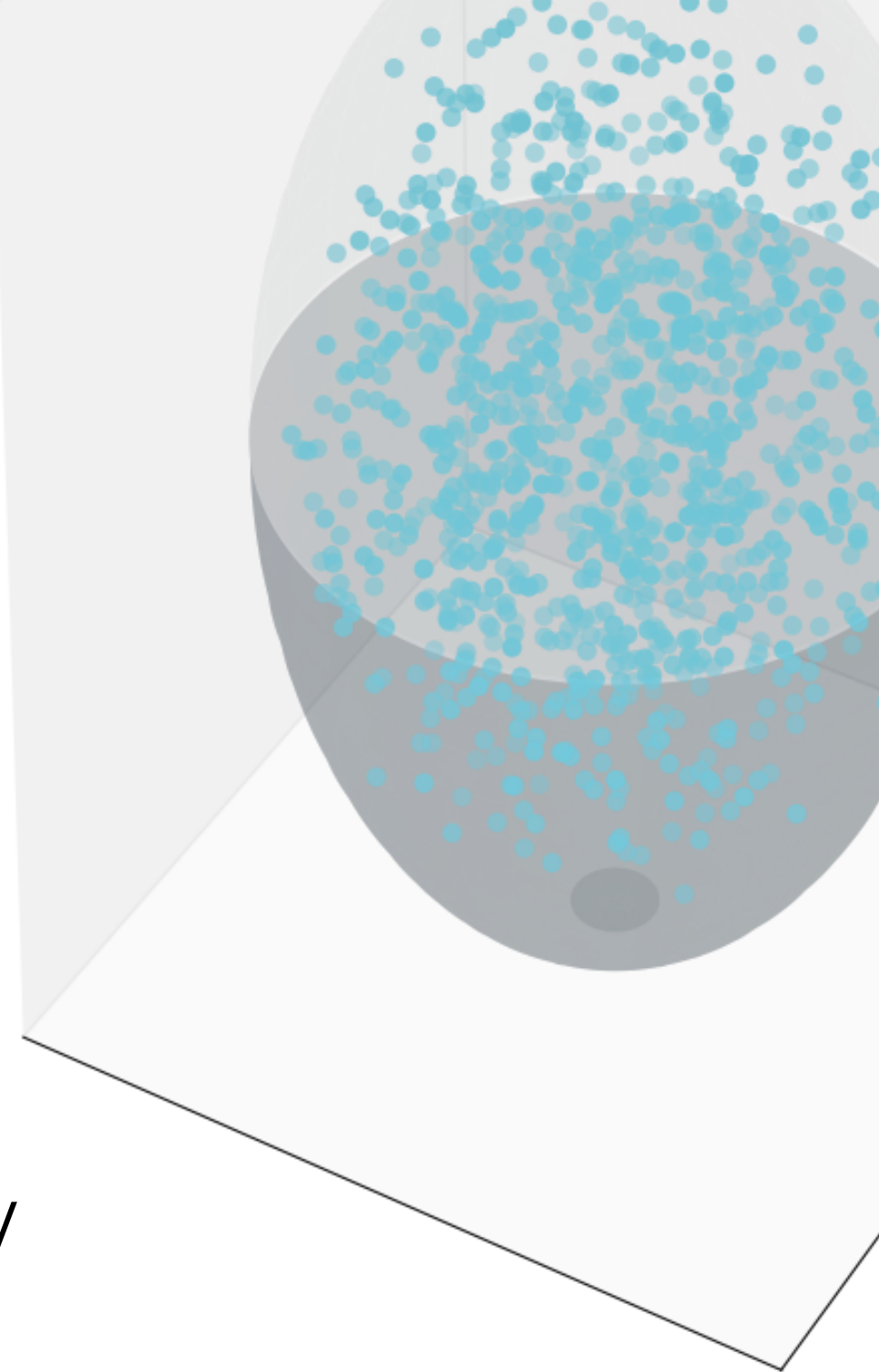
Numerical Tests of Cosmic Censorship

[with Collisionless Matter]

GR 21, New York City

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Mark A. Scheel, Daniel A. Hemberger
Caltech TAPIR | SXS Collaboration



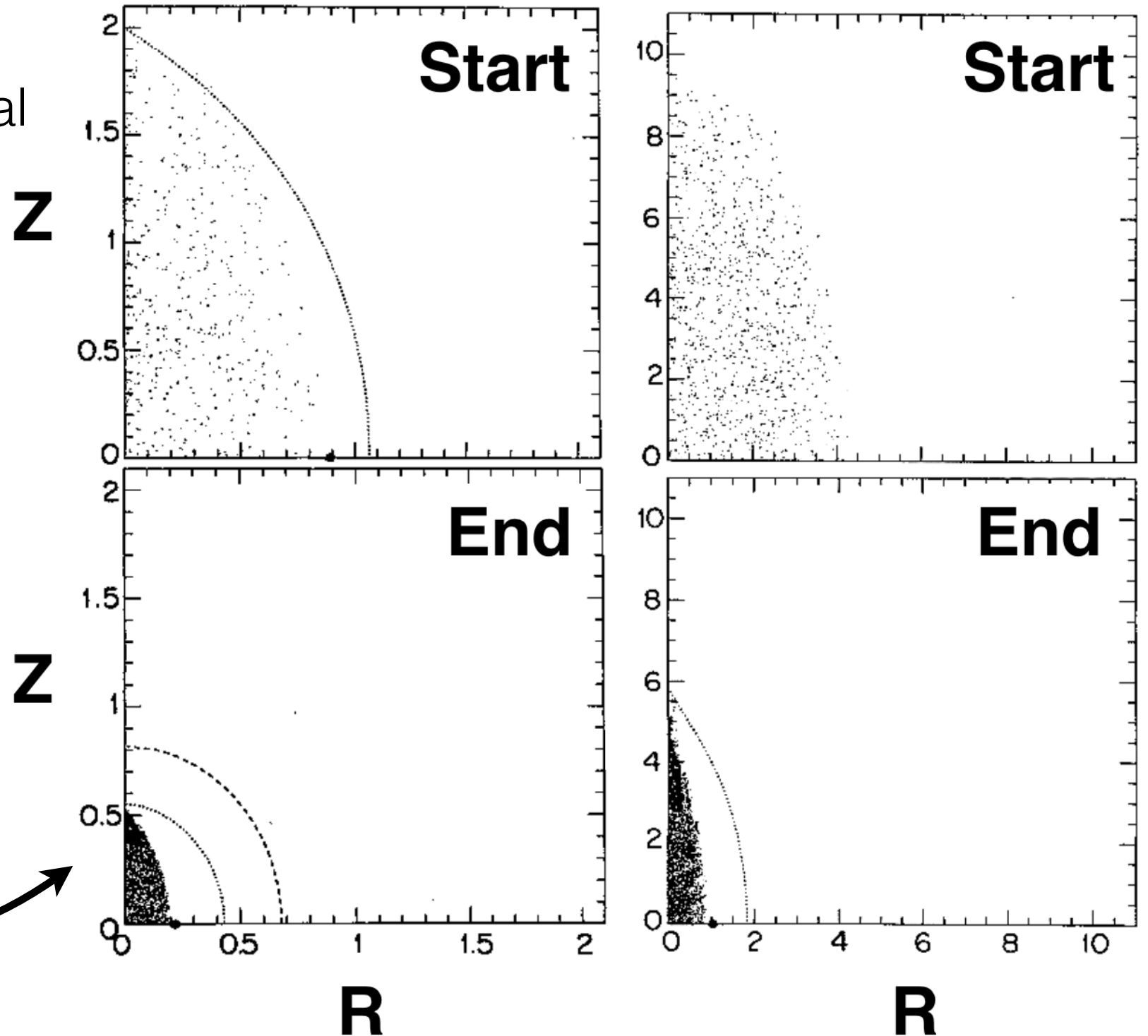
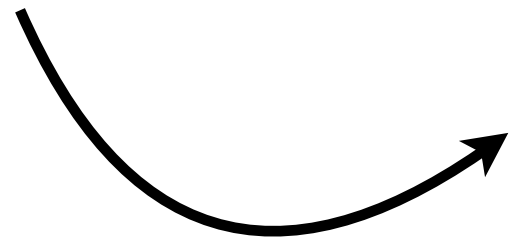
Cosmic Censorship + Previous Studies

Weak Cosmic Censorship:
singularities from gravitational
collapse are contained in
black holes

Shapiro + Teukolsky 91

$$T_{\mu\nu} = \rho u_\mu u_\nu$$

$R_{\alpha\beta\gamma\delta} R^{\alpha\beta\gamma\delta}$ blows up



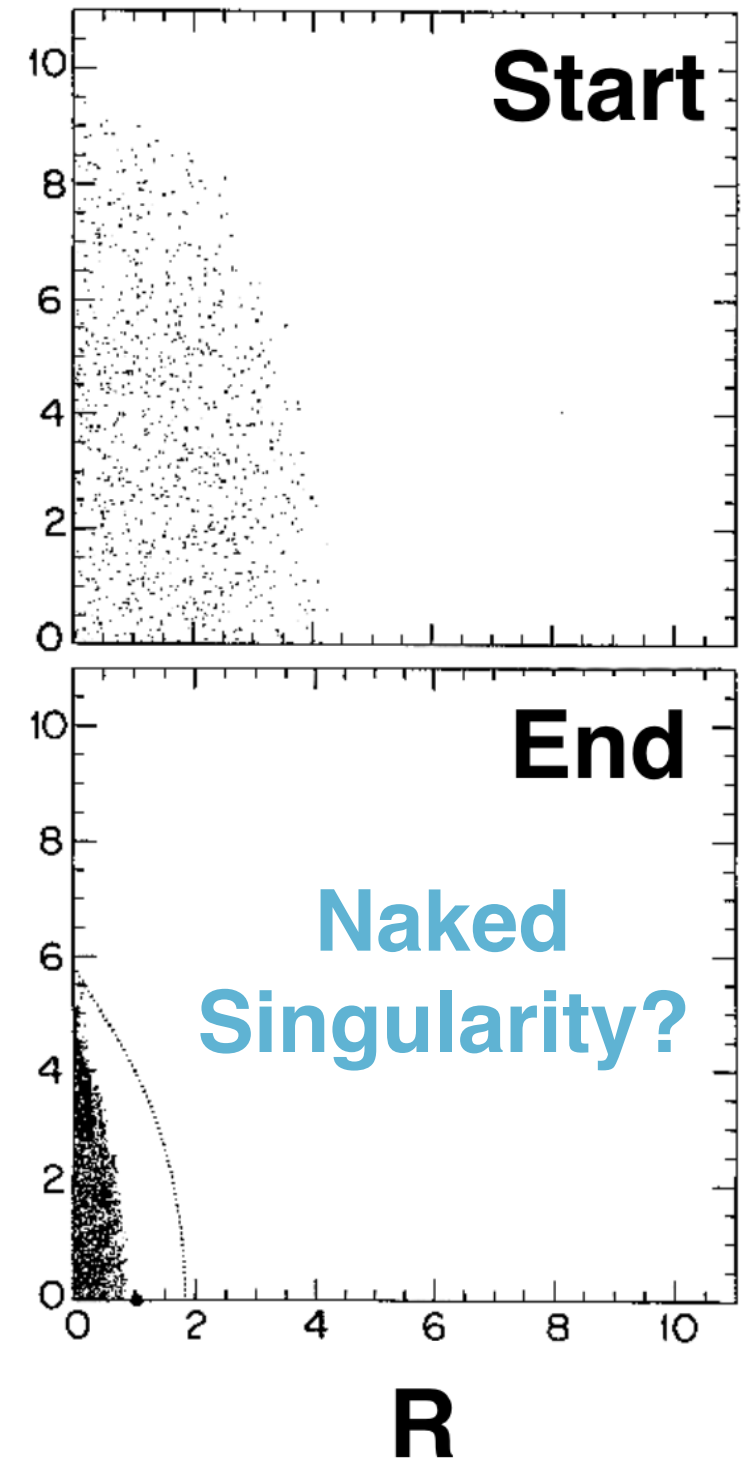
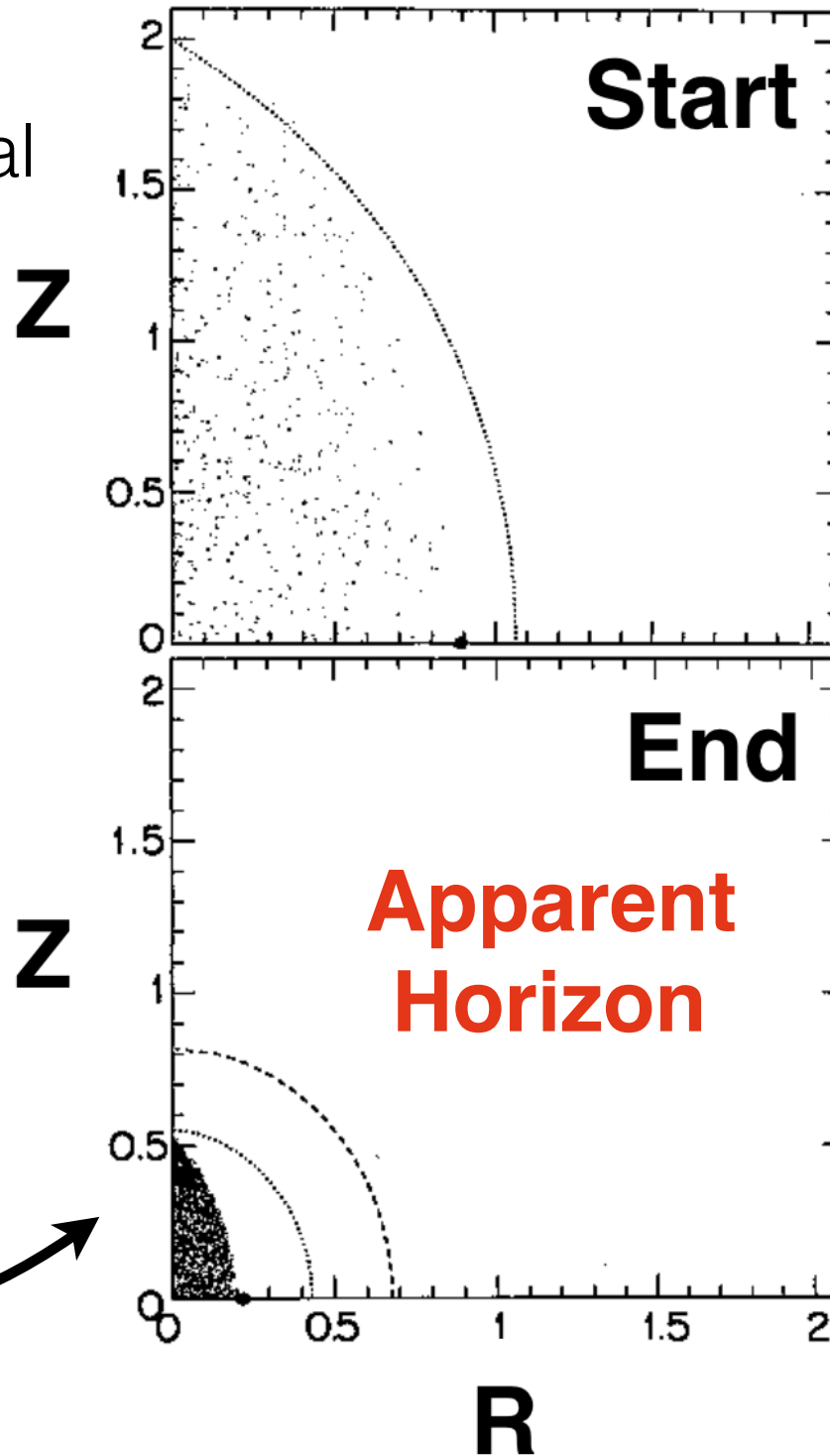
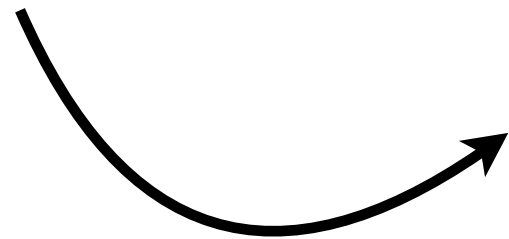
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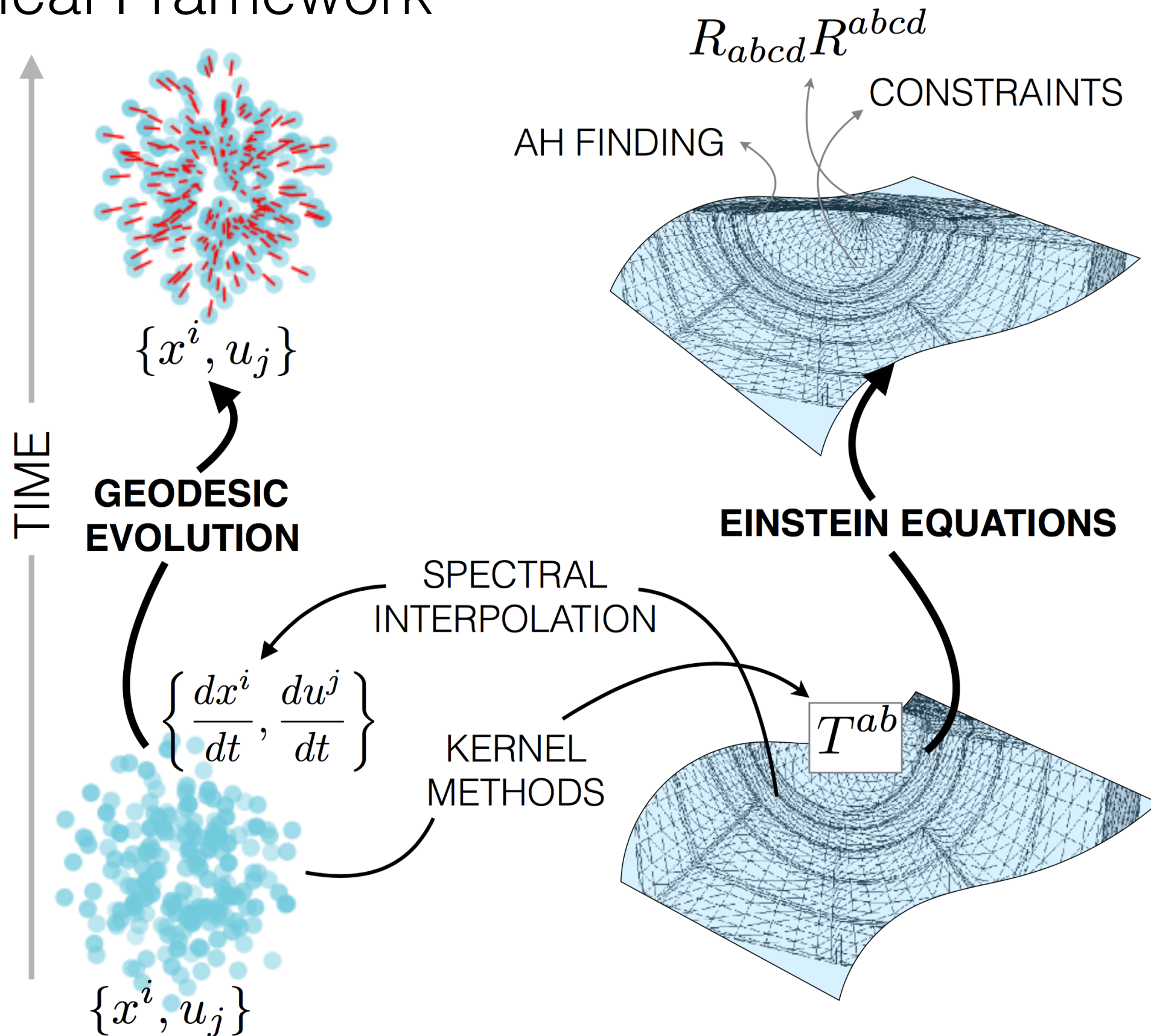
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Numerical Framework



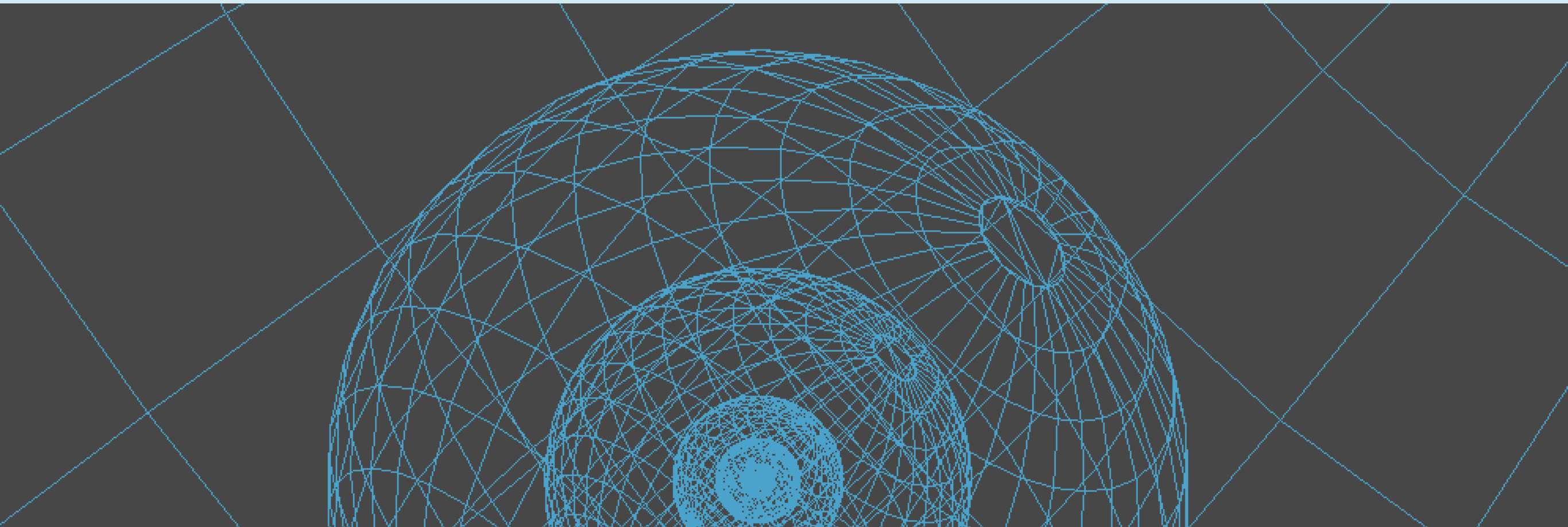
Spacetime Evolution: **S**pectral **E**instein **C**ode

Spectral Methods (Full 3D)

First-Order Symmetric Hyperbolic

Generalized Harmonic Evolution

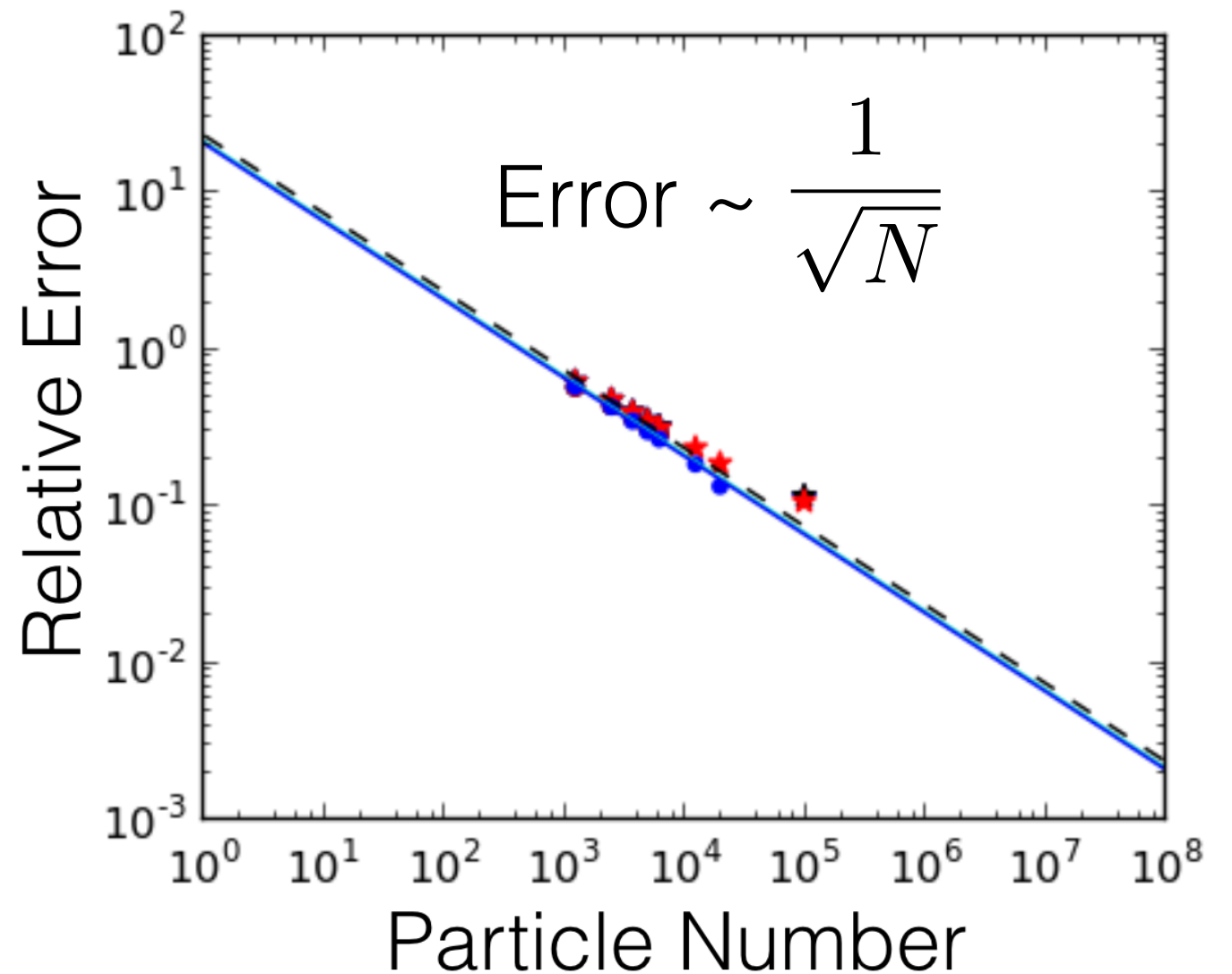
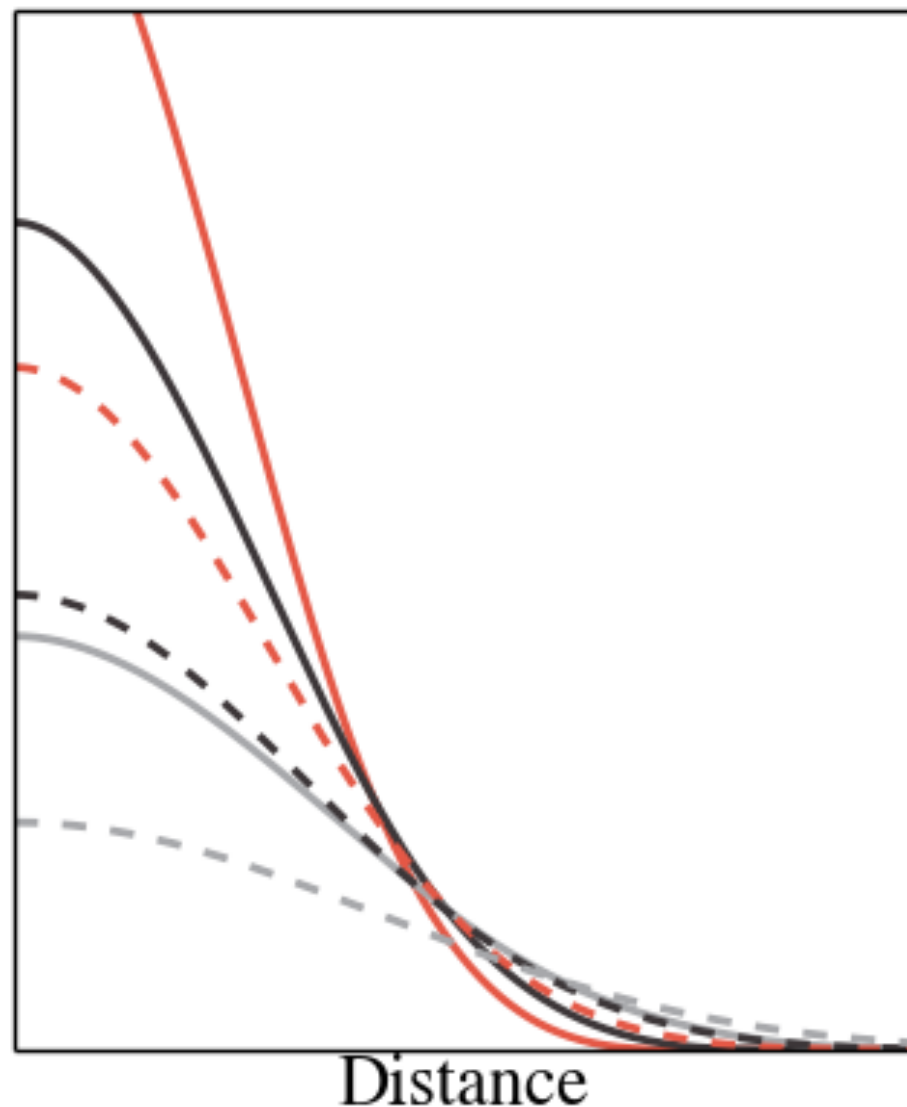
Fast-Flow Apparent Horizon Finding



Collisionless Matter Evolution

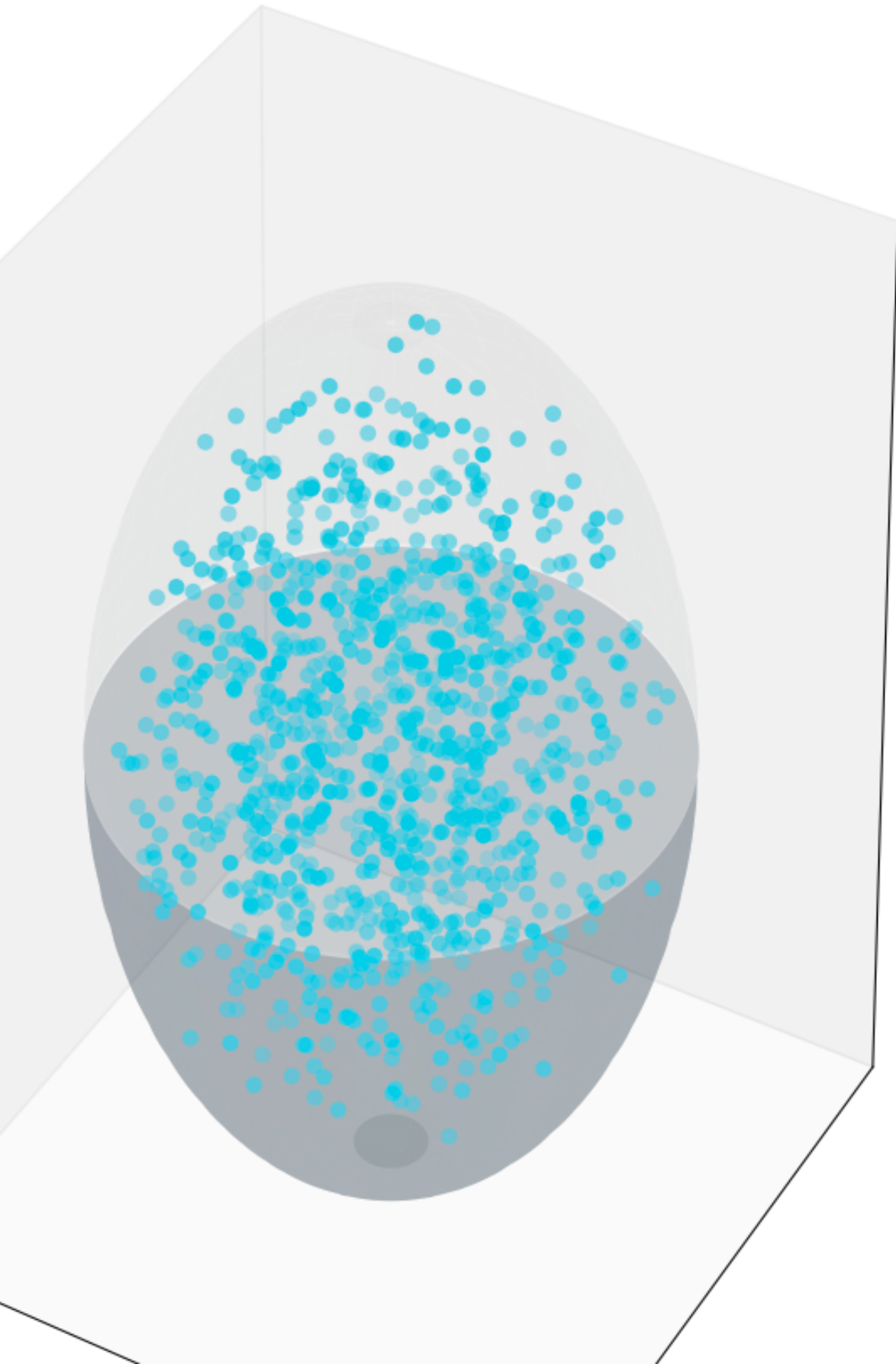
$$T_{\mu\nu} = \rho u_\mu u_\nu$$

Kernel Functions



Geodesic Equations

This Study: Initial Data



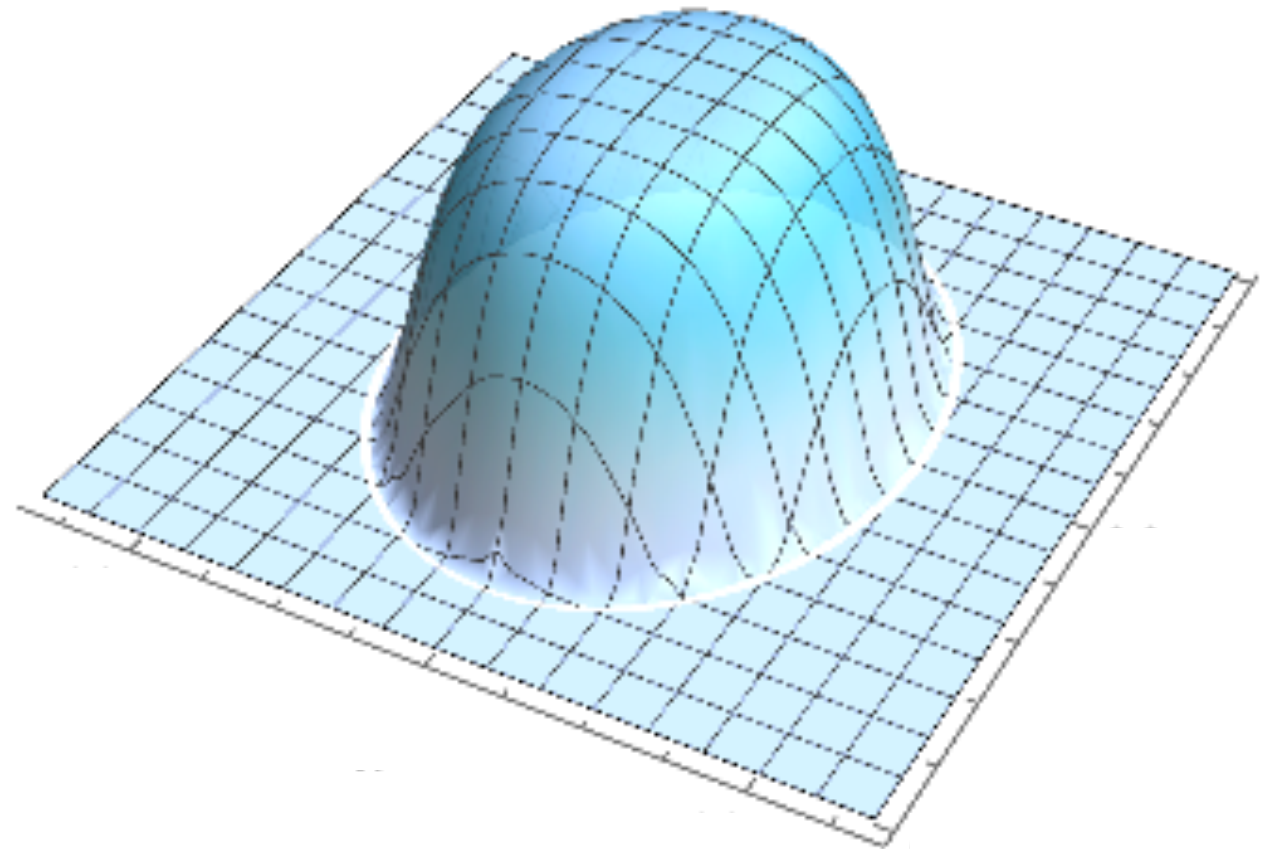
Choose density distribution

- ♦ eccentricity e
- ♦ semimajor axis c

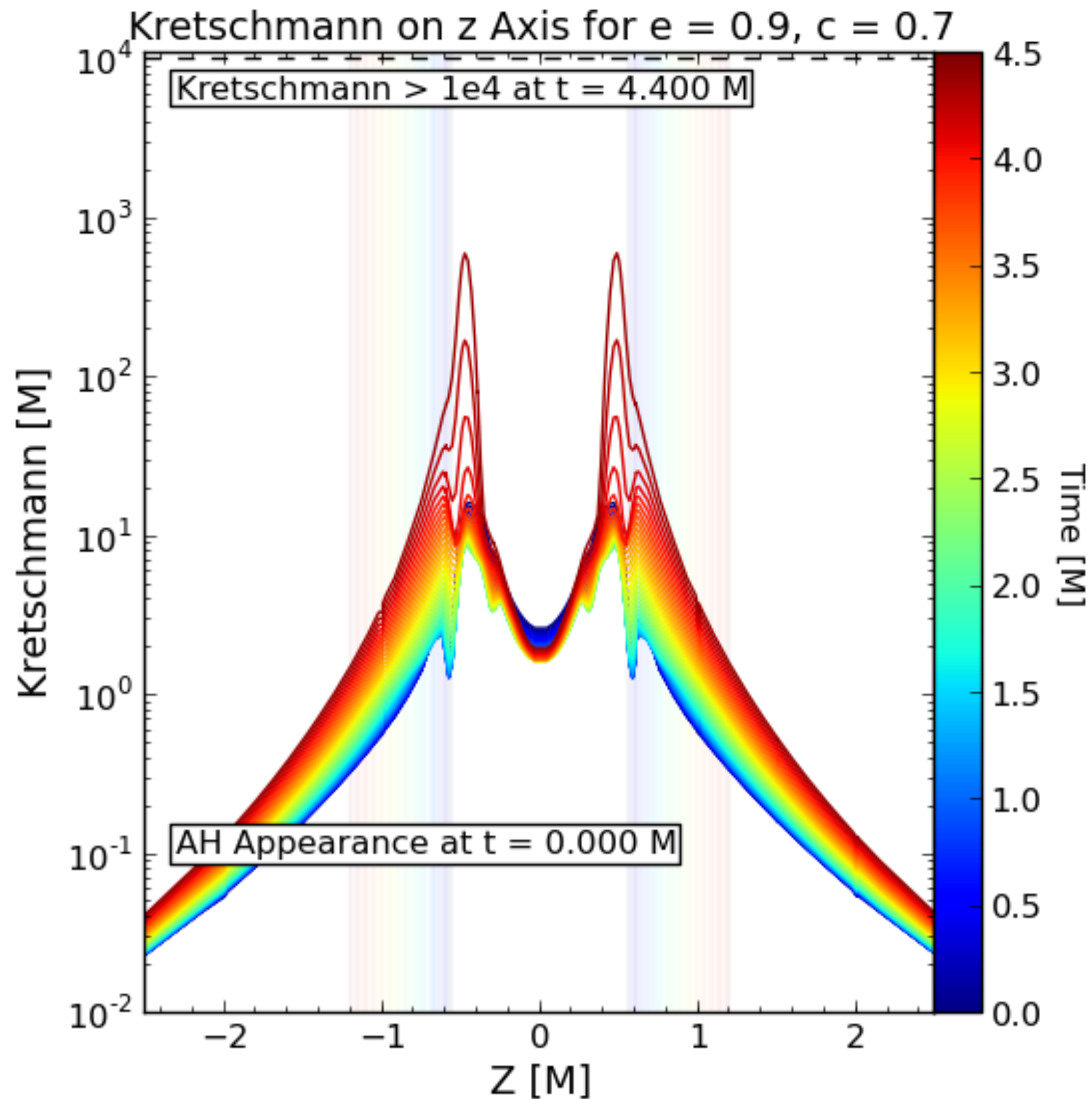
$$K_{ij} = 0$$

$$\nabla^2 \psi = -2\pi \psi^5 \rho_0$$

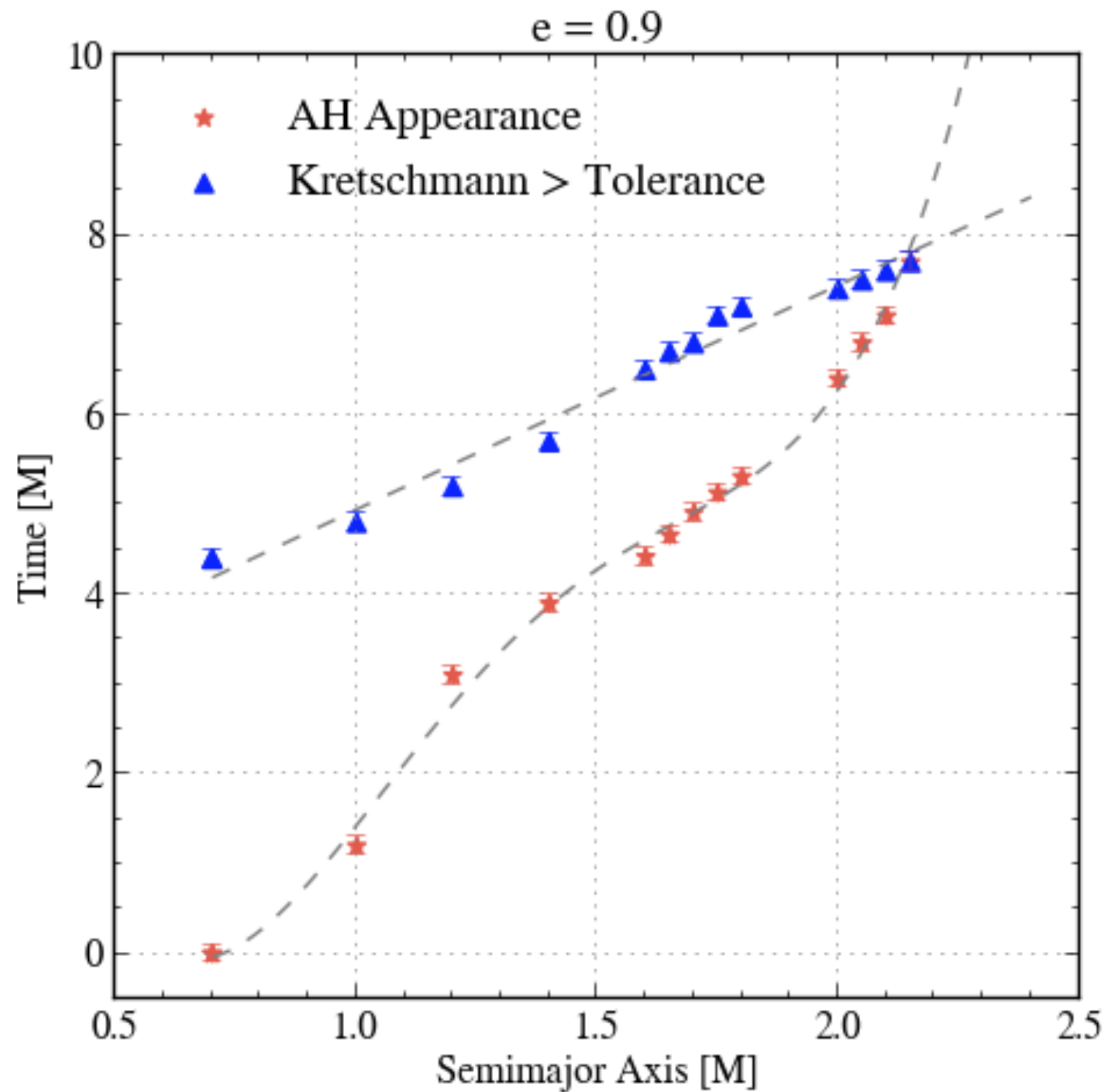
Maximal Slicing



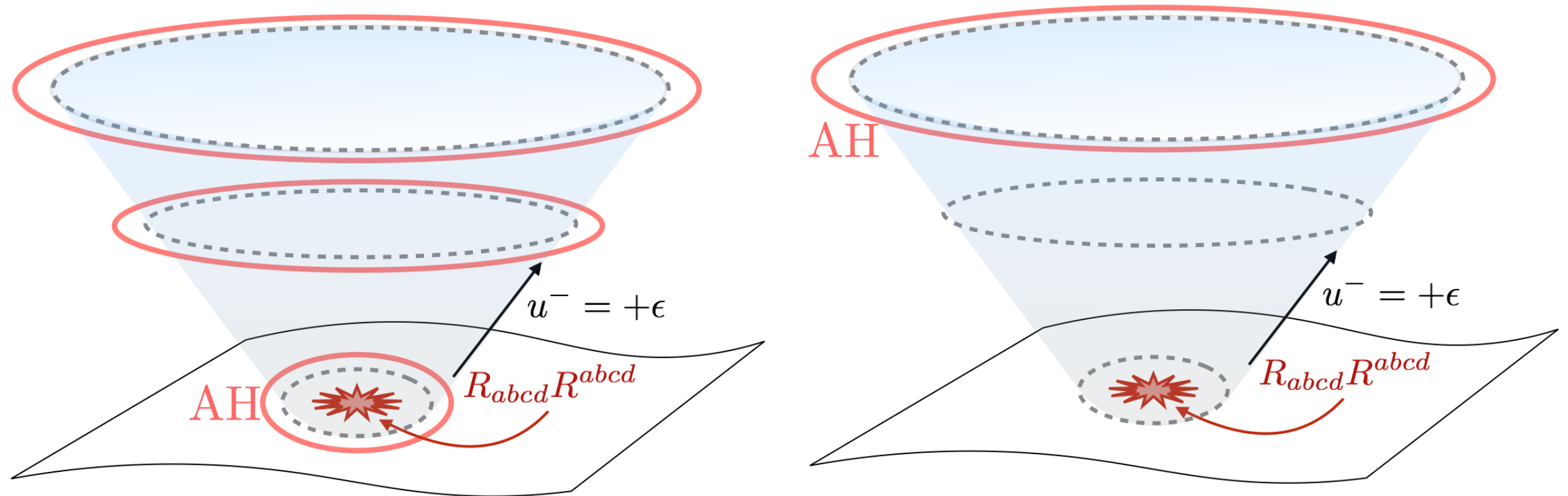
This Study: Results



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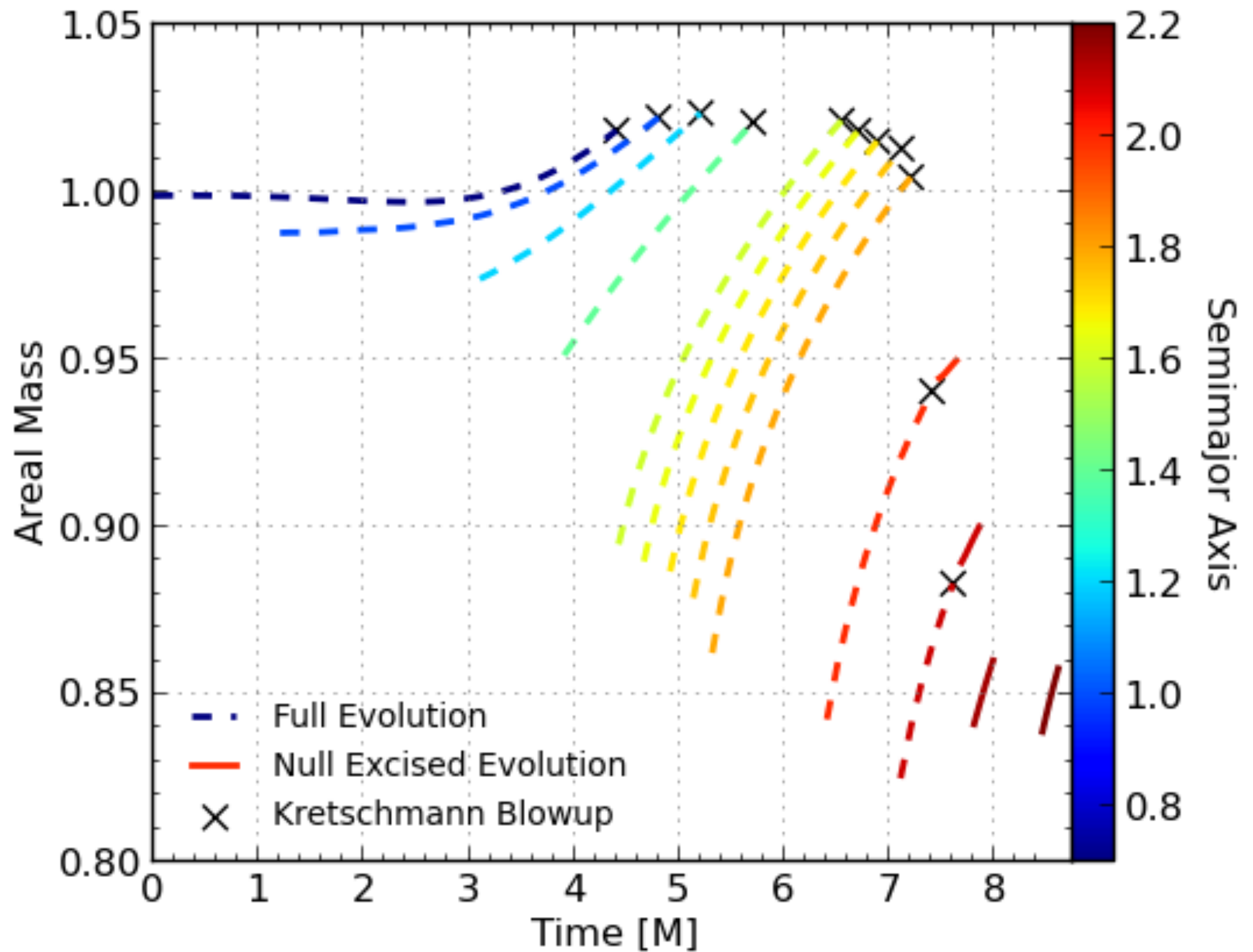


Null Excision: Life After Singularities

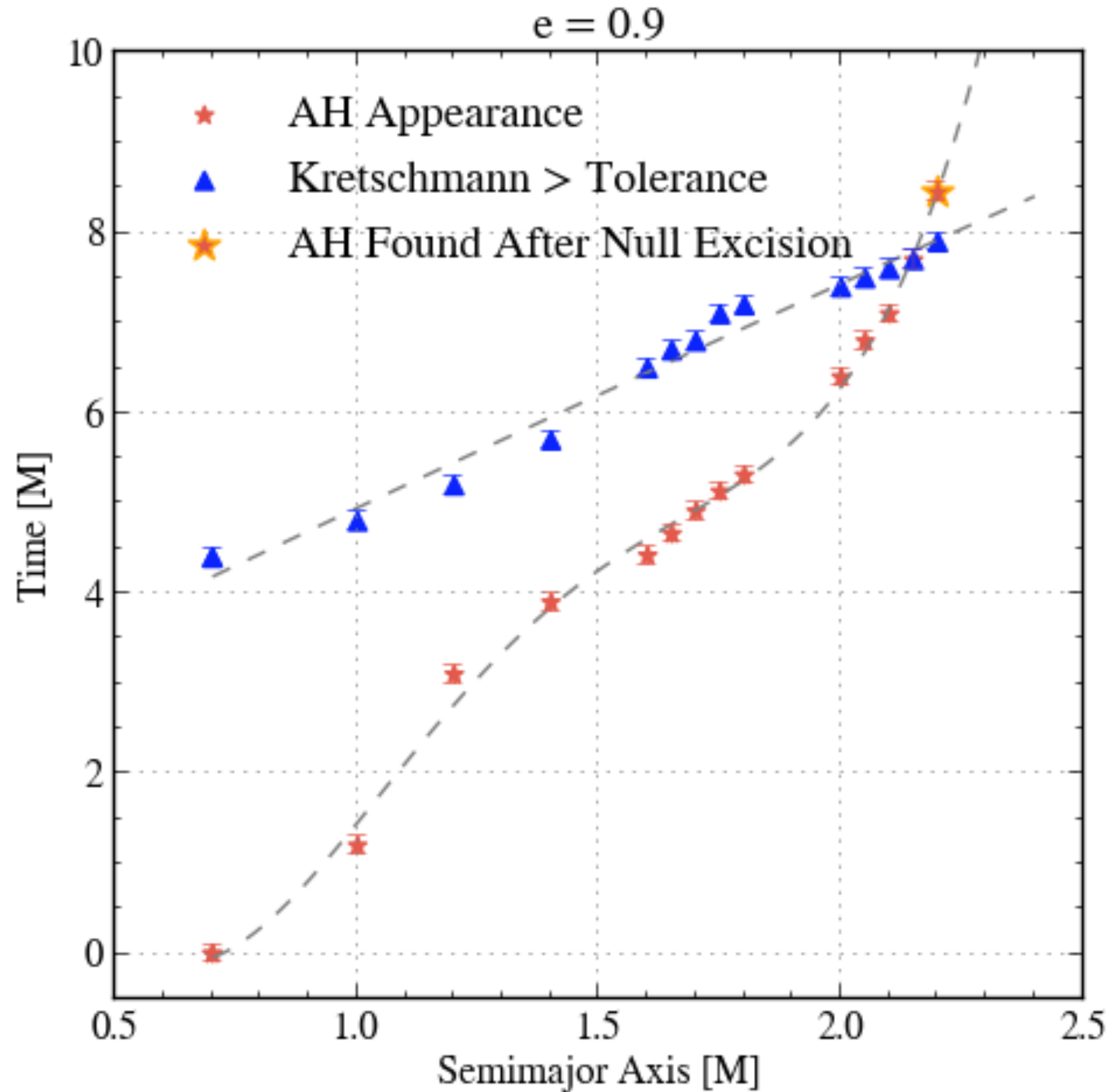


Using Control Systems

Null Excision Results



Null Excision Results



Future Work

Higher resolutions to ensure accurate + convergent results

See what these simulations tell us about cosmic censorship

Thank you!