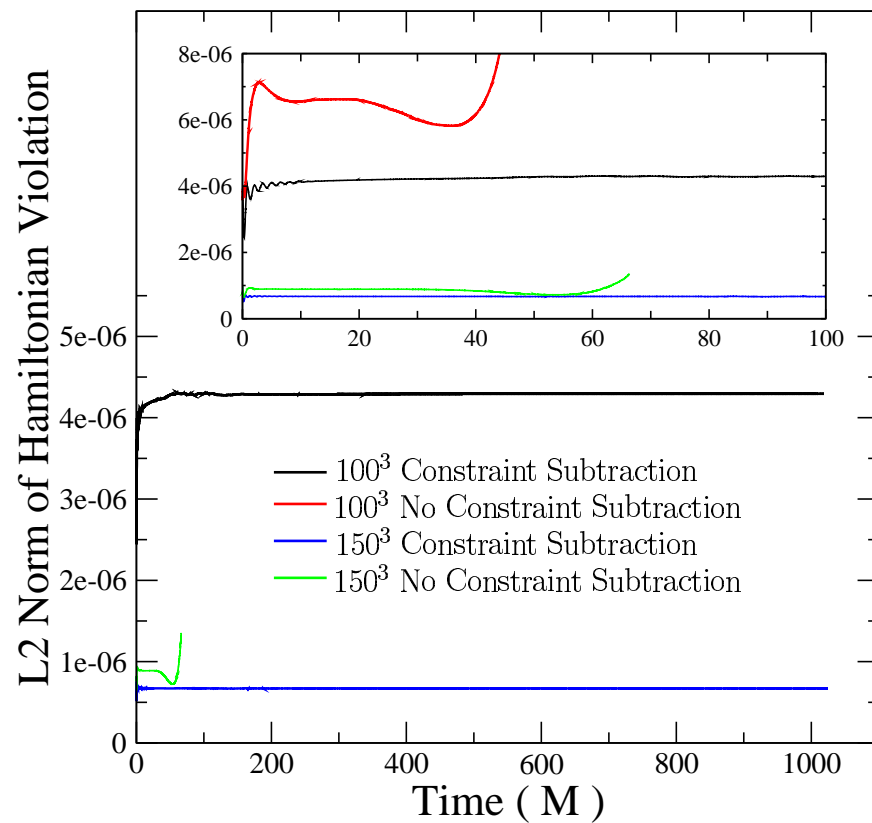


# Constrained Evolution Successes and Problems

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Center for Relativity  
University of Texas at Austin

# Constraint Subtraction



Isolated Schwarzschild Hole

Domain:  $-10M \dots 10M$

Constraint Subtraction:

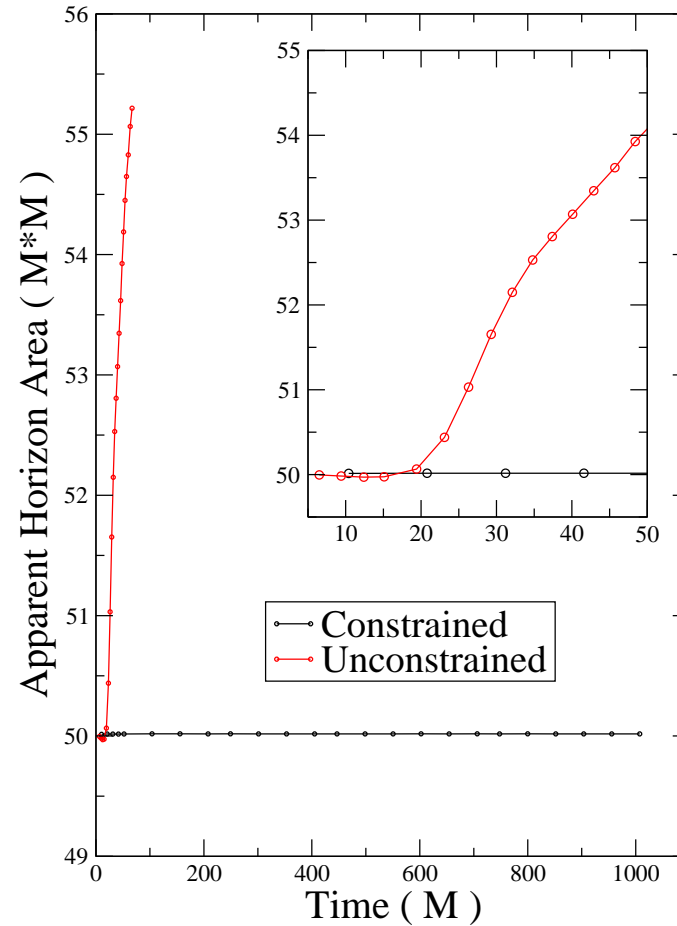
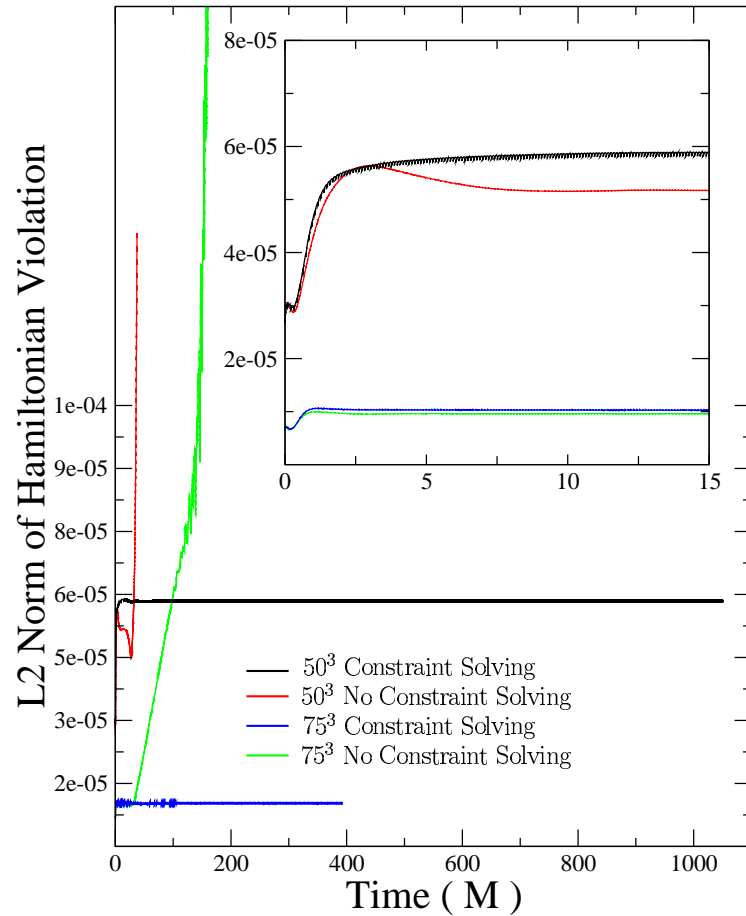
$$-0.232 \alpha g_{ij} H - 0.18 \alpha K_{ij} H$$

# Constraint Solving Only

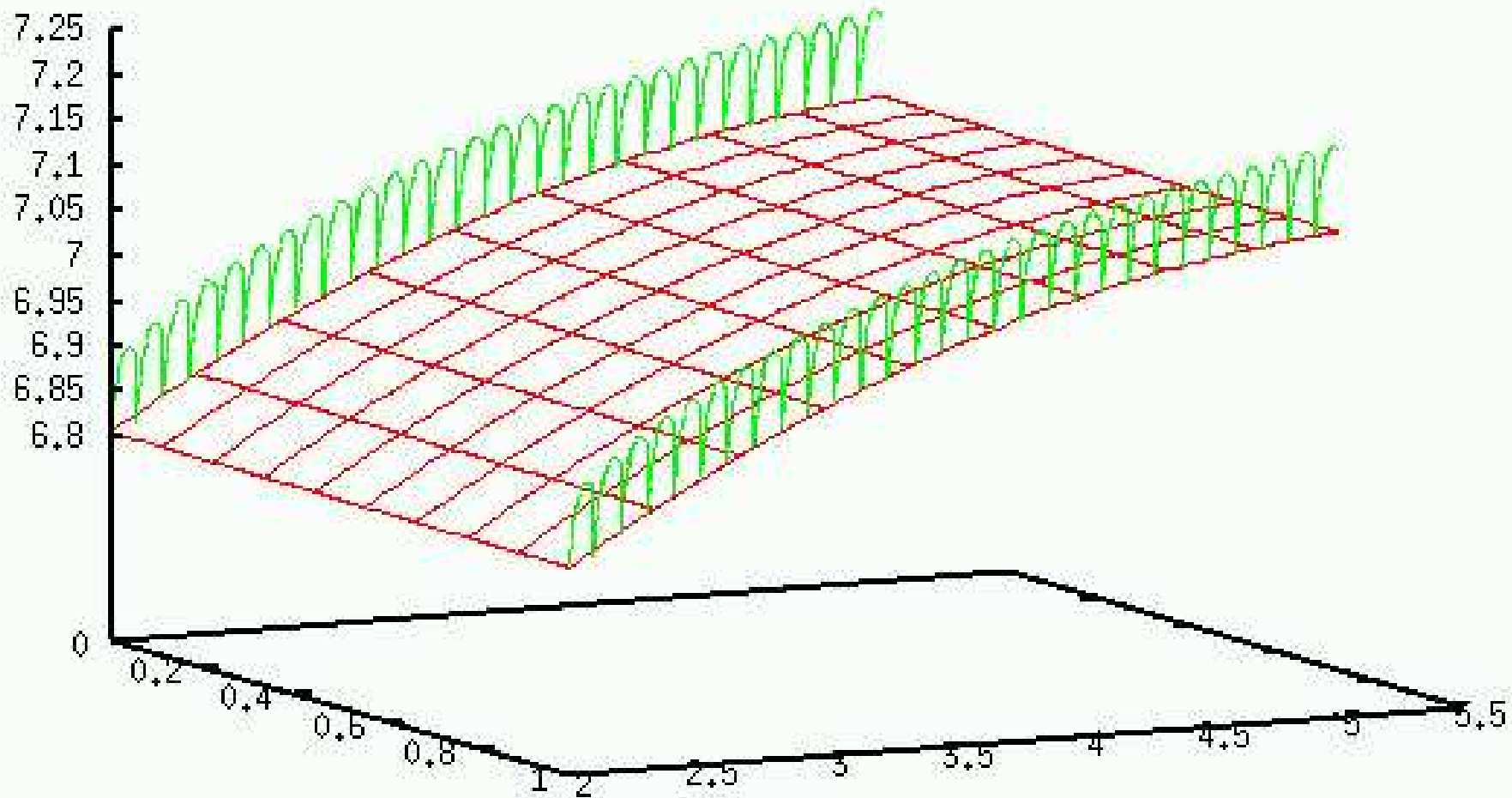
No Constraint Subtraction

Isolated Schwarzschild Hole

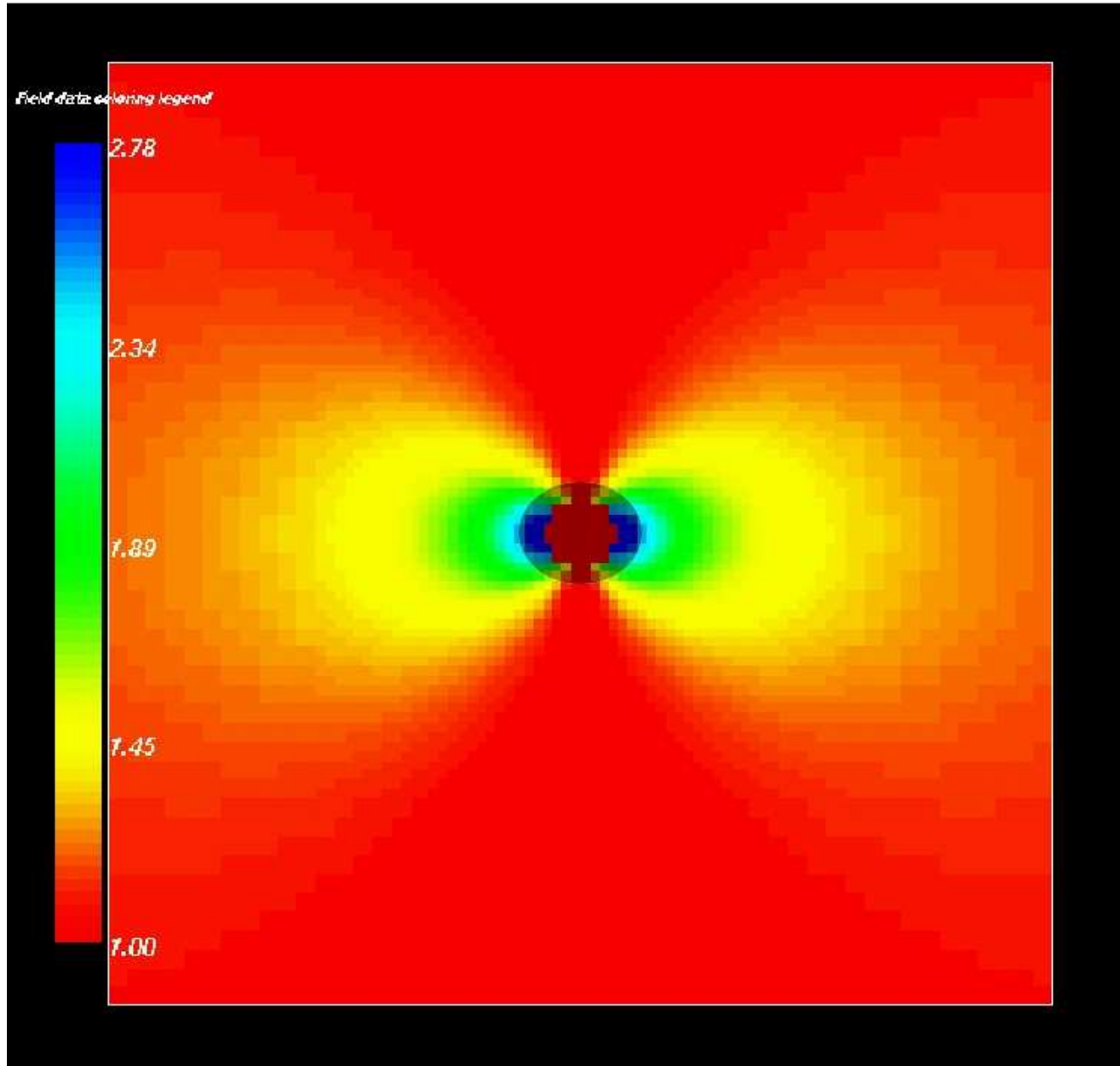
Domain:  $-5M \dots 5M$



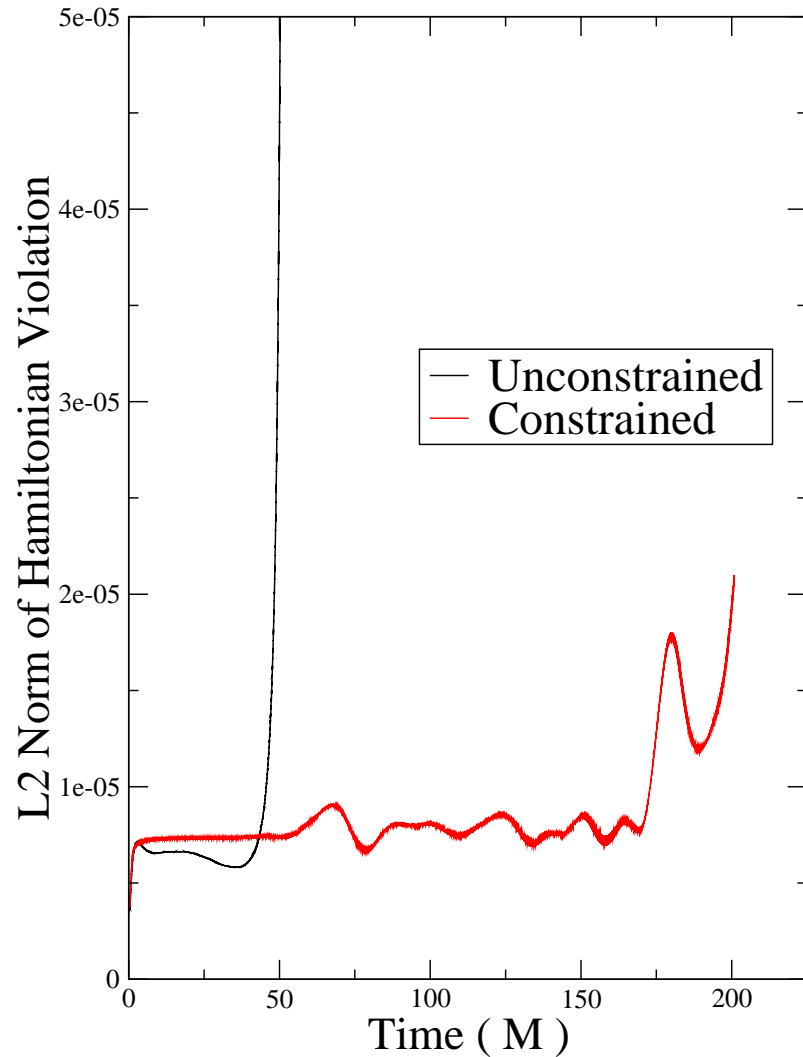
# Constraint Surface



# Region Not Constrained



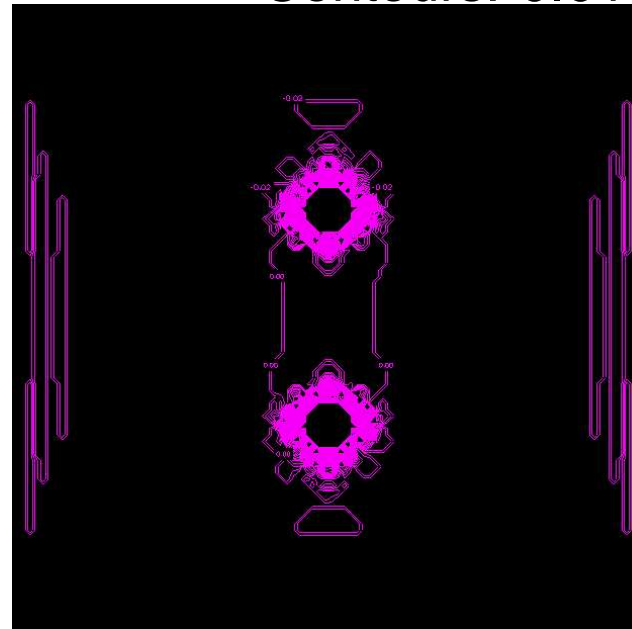
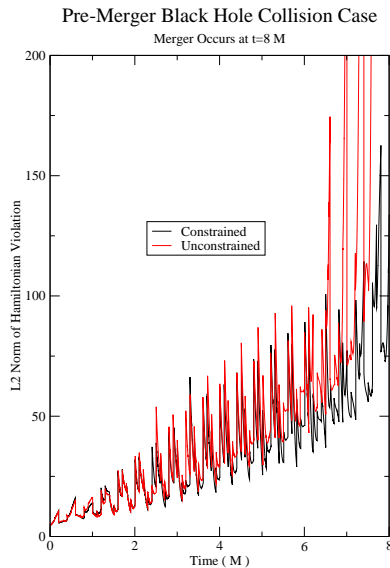
# Constraint Solving Only



Isolated Schwarzschild Hole  
Domain:  $-10M \dots 10M$   
Grid:  $100^3$   
No Constraint Subtraction

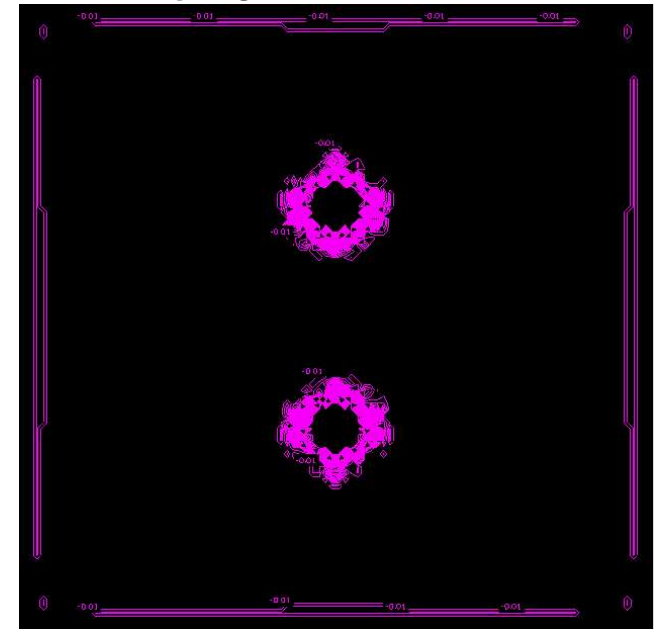
# Pre-Merger Binary Black Hole

Hamiltonian Violation  
Contours: 0.01      Time: 5M



Unconstrained

Max: 2.0    Min: -5.9



Constrained

Max: 1.5    Min: -4.6

Two Schwarzschild holes initially at  $x = \pm 6M$  boosted  $vx = \mp 0.5$

Domain:  $-10M \dots 10M 100^3$

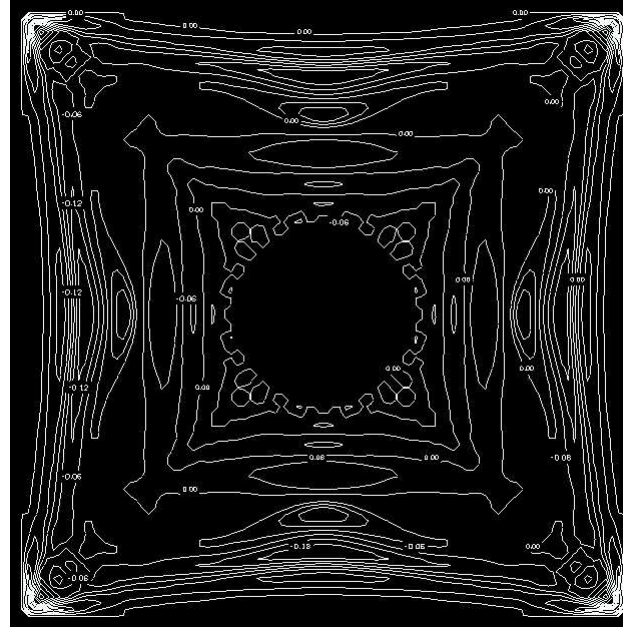
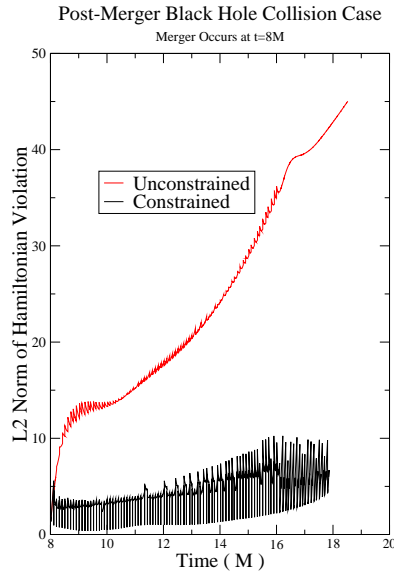
Constraint Subtraction:  $-0.232 \alpha g_{ij}H - 0.18 \alpha K_{ij}H$

Merger occurs at  $t = 8M$ ; Constraint solver solves  $r = 1.65M$  and out

# Post-Merger Binary Black Hole

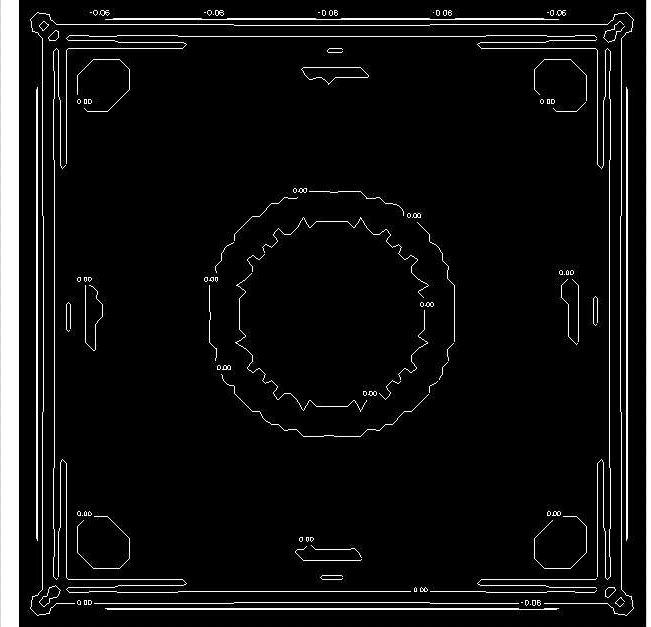
Hamiltonian Violation

Contours: 0.06 Time: 17.5M



Unconstrained

Max: 0.44 Min: -0.47



Constrained

Max: 0.30 Min: -0.27

Two Schwarzschild holes initially at  $x = \pm 6M$  boosted  $vx = \mp 0.5$

Domain:  $-10M \dots 10M$   $100^3$

Constraint Subtraction:  $-0.232 \alpha g_{ij}H - 0.18 \alpha K_{ij}H$

Merger occurs at  $t = 8M$ ; Constraint solver solves  $r = 1.65M$  and out