Chaos in Gauge-Gravity Correspondence

String Phenomenology 2014
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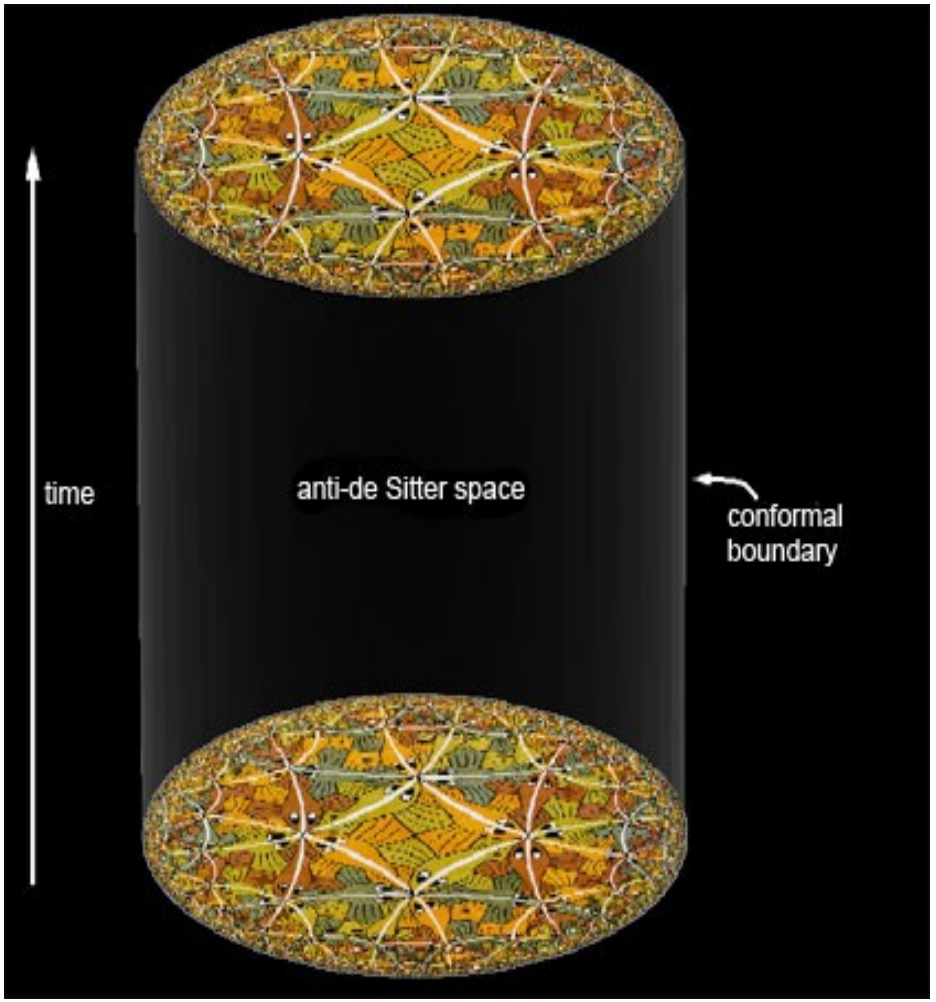
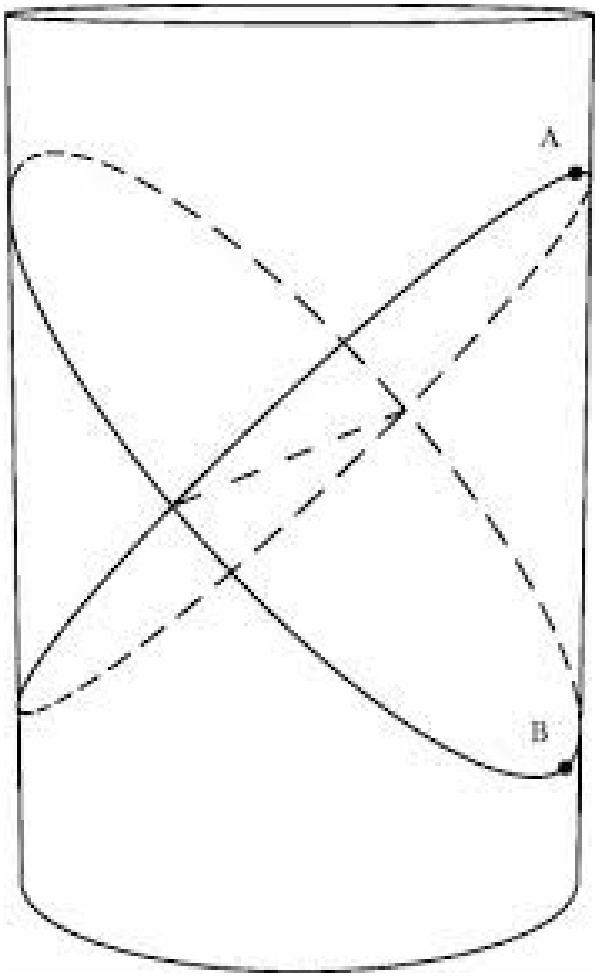
Anti de Sitter spacetime

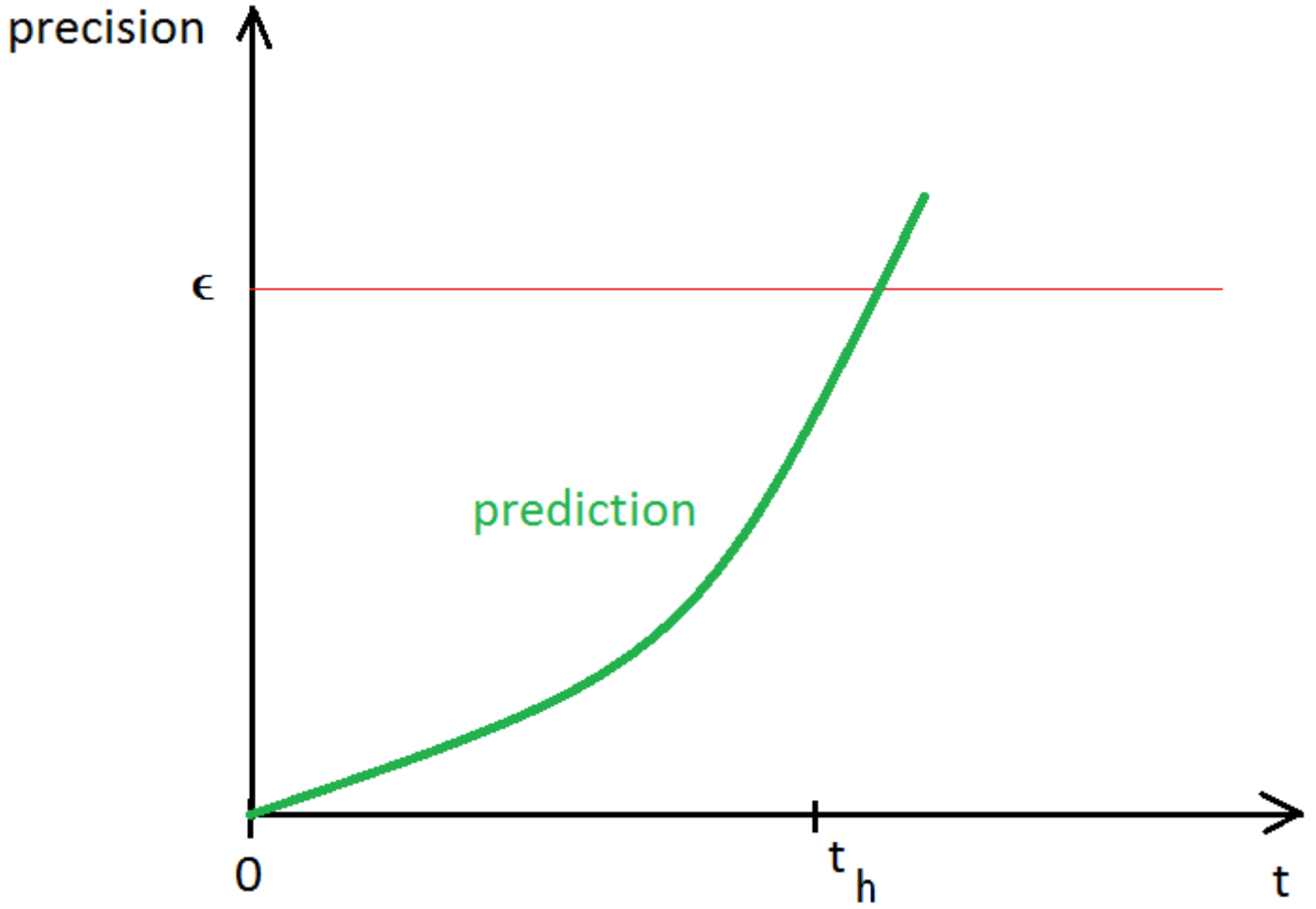




$$R = - \frac{n(n-1)}{L^2}$$

Chaos

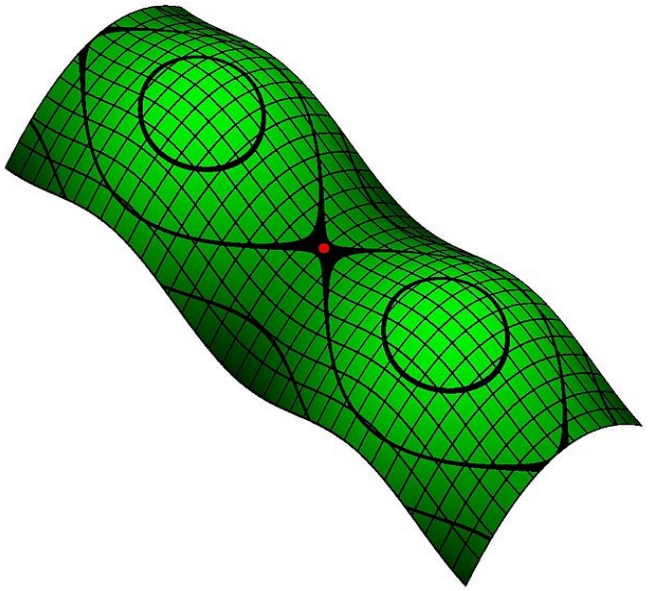
- Horizon of predictability:



Chaos

- Anosov property:

$$T_q Q = E_q^+ \oplus E_q^0 \oplus E_q^-$$



- Ergodicity and information lost:

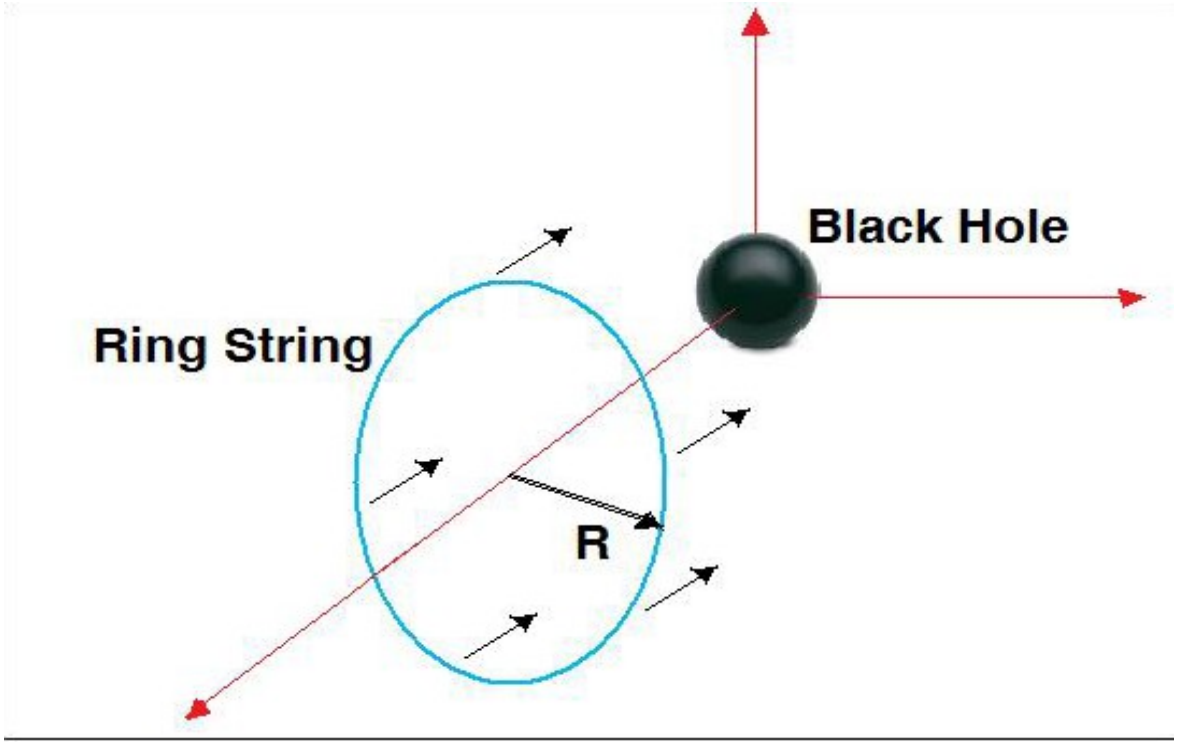
Ergodicity of a continuous dynamical system means that its trajectories "spread around" the phase space.

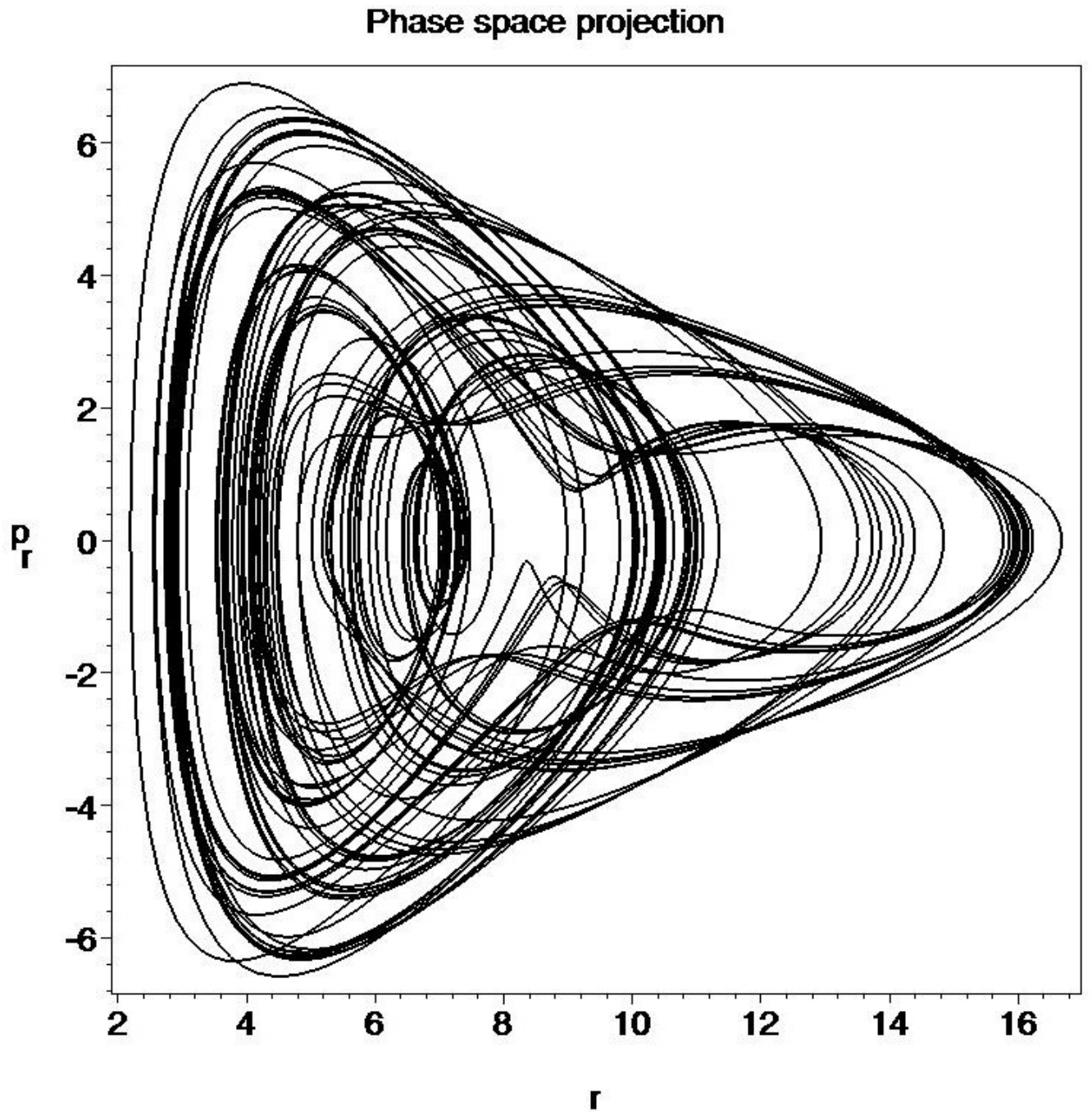
A property of continuous dynamical systems that is the opposite of ergodicity is complete integrability.

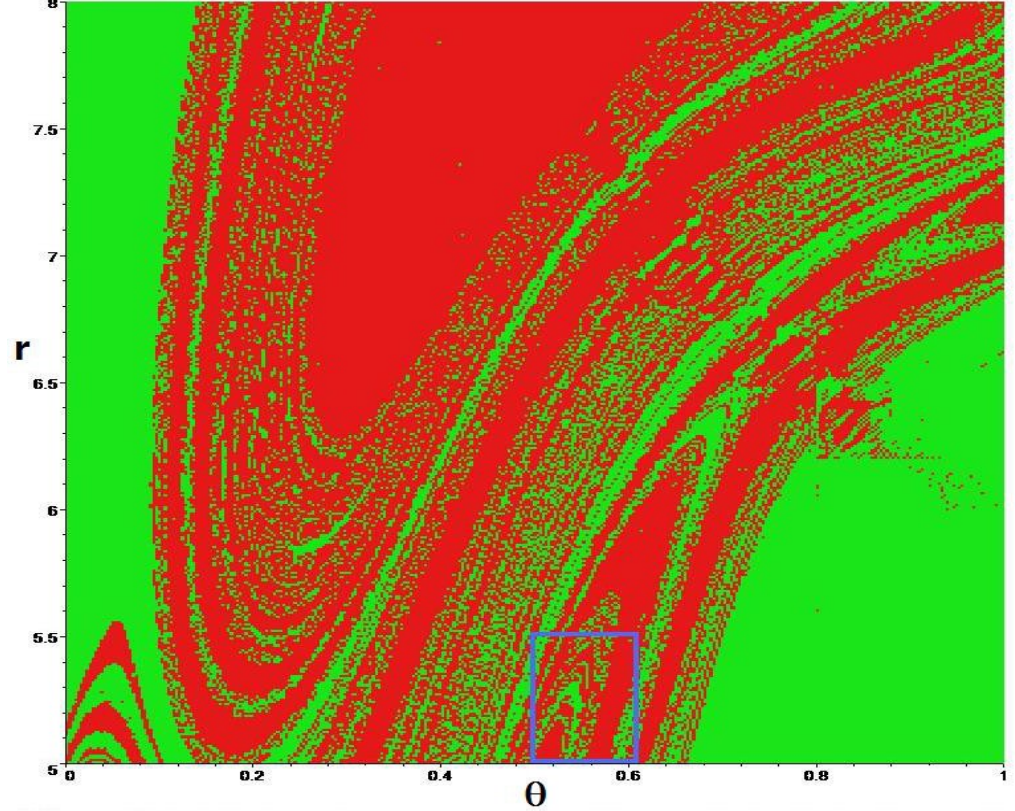
Chaos around a horizon

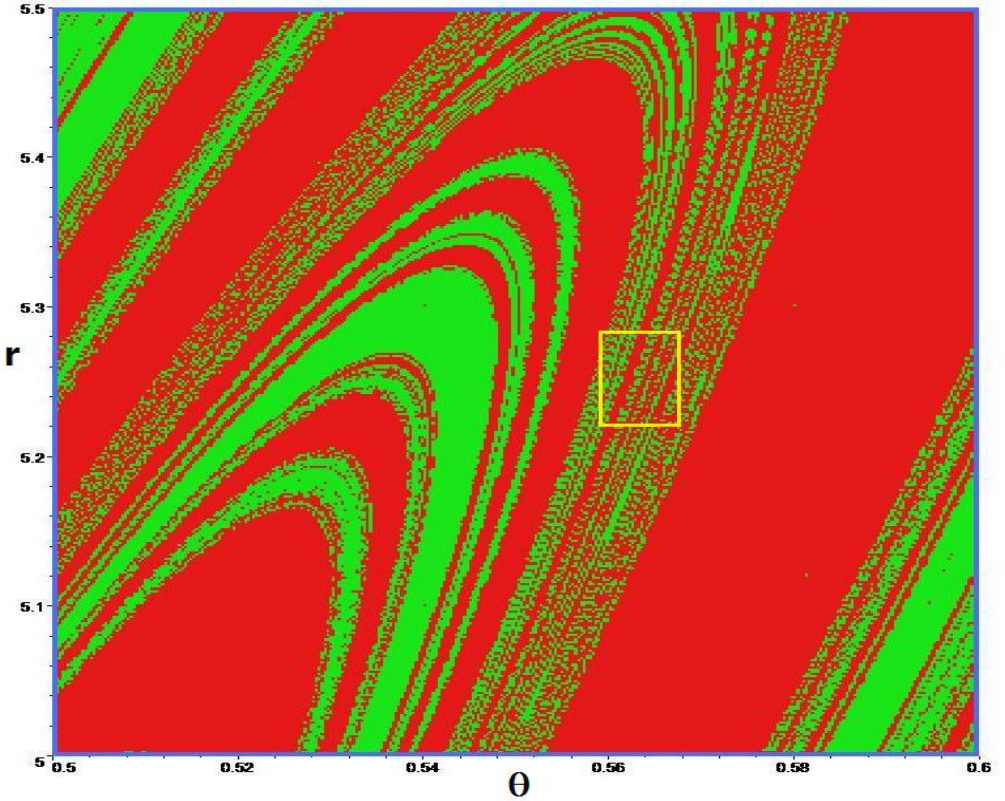
."Chaotic scattering and capture of strings by black hole", A. V. Frolov and Arne L. Larsen, Class.Quant.Grav. 16 (1999) 3717-3724

"Chaos in the Gauge / Gravity Correspondence", L. A. Pando Zayas, C A. T-E JHEP 1009 (2010) 094




Phase space projection
6
4
2
0
-2
-4
-6
p
r
2
4
6
8
10
12
14
16
r


r
θ


r
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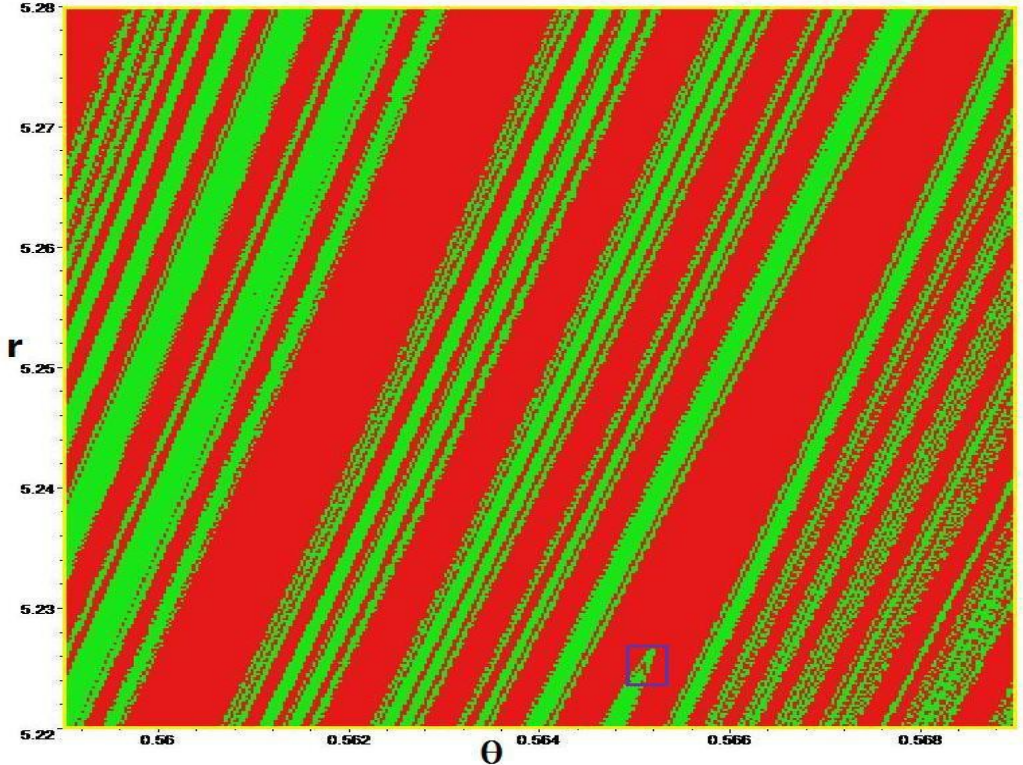
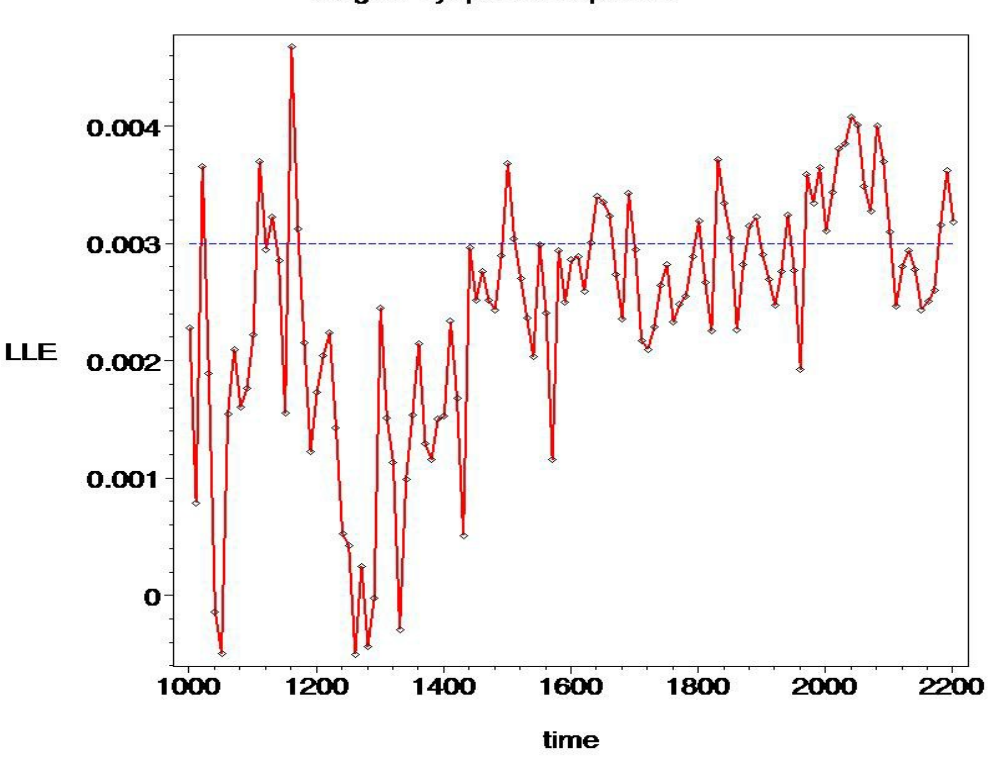

r
θ


Largest Lyapunov Exponent
LLE
time

α' corrections

1.- Out of equilibrium holographic systems.

2.- IR-UV flows in Gauge-Gravity.

3.- Bulk reconstruction associated with a given boundary.

4.- String Cosmology (higher order corrections)

5.- Definition of Chaos

6.- Chaos vs Integrability

Factors determining the onset of chaos:

1.- Bulk dimension

2.- Asymptotics (boundness)

3.- Attractor (horizon)

4.- Dimension of the probe.

Results

A whole set of tools for describing the geodesics behavior of particle and rings is being used. It includes the analysis of the focusing property, the computation of the largest Lyapunov exponent and of the whole Lyapunov spectrum, the computation of the power spectrum and the analysis of the falling time.

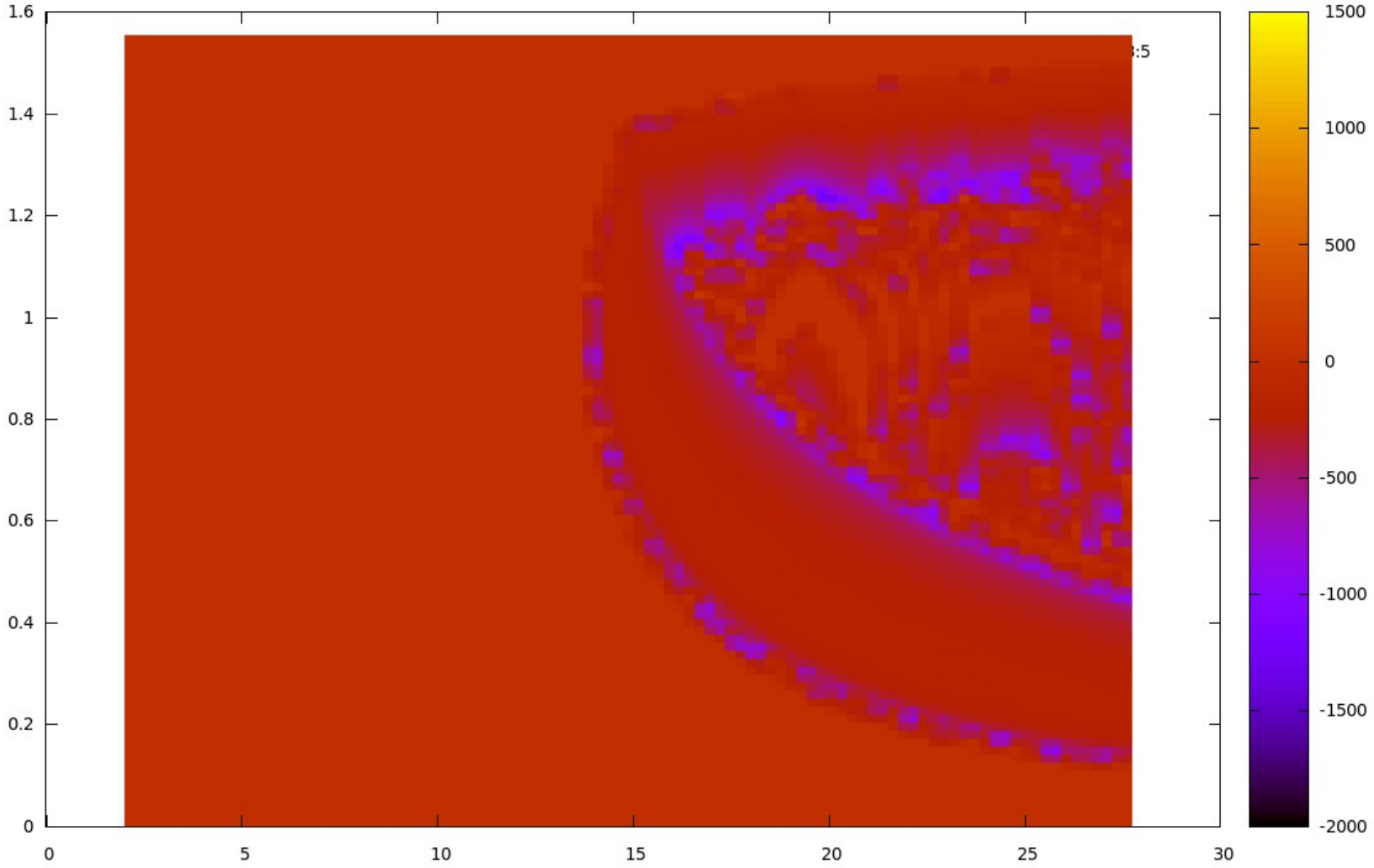
The known exact solutions for particle and rings in 2+1 were used to tune the numerical codes.

Premiliminary results for AdS-Schwarszchild in 3+1 suggest that all the geodesics finally fall behind the horizon, but it is not possible to predict how long it takes for any given geodesic.

This would indicate a new kind of chaos where (by tunning the radius of the horizon) it is possible to predict the asymptotic state of the system (trapped in the black hole), but is is not possible to predict when that state is going to be reached.

Results


WORK IN PROGRESS


1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
5
10
15
20
25
30
1500
1000
500
0
-500
-1000
-1500
-2000