Wormhole in Higher-dim. Space-time: Dynamics

Outline & Summary

(a) “Fate of Morris-Thorne (Ellis) wormhole” was numerically investigated in 2002. [HS & Hayward, PRD66, 044005]. The fate is either black-hole collapse or inflationary expansion, depending on the excessed energy.

(b) The higher-dimensional Ellis wormhole solutions are obtained.

Perturbation study suggests instability. [Torii & HS, PRD88 (2013), 064023]

Numerical evolutions in 4-6 dim confirm its instability. [this poster]

(c) The wormholes in 5-dim. Gauss-Bonnet gravity are numerically obtained. Evolutions suggest that positive GB term accelerates throat inflation.

Motivations

Why wormholes?
- Make great science fiction - short cuts between otherwise distant regions.
- Morris & Thorne 1988, Japan "controversy" etc.
- Increase our understanding of gravity when the usual energy conditions are not satisfied, due to quantum effects (cosmic strings, Hawking radiation) or alternative gravity theories
- They are very similar to black holes - both contain (negatively) curved surfaces and can be defined by trapping horizons (TH)

What are wormholes?
- BH and WH are inseparable? (New study?)

N-dim. Ellis Wormhole sol.

A Wormhole Solution (n-Dims, massless ghost scalar)
- Algebraic symmetry, $\delta^2 - \rho^2$ and $\mu\lambda$ which define the trapping surface (TH)
- Static, $f, l \neq 0$, and massless real $\psi = \delta$.

Perturbation Analysis

WH evolution in 4, 5, 6-dim. GR

In prep.

Results in 4-dim. GR

PRD66 (2002) 044005

Field Eqs.

Bifurcation of the horizons
- go to a Black Hole or Inflationary expansion

WH evolution in 5-dim. GB

in prep.

Field Relations in 5-dim. Gauss-Bonnet gravity

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