Was Our Universe Born in a Black Hole?

Charles Peterson, Mechanical Engineering

Mentors: Dr. Nikodem Poplawski & Dr. Chris Haynes

University of New Haven, Connecticut

BACKGROUND

Black holes (regions of space from where nothing can escape) form from massive stars that collapse because of their gravity.

The Universe is expanding, like the 3-dimensional analogue of the 2-dimensional surface of a growing balloon.

Problem. According to general theory of relativity, the matter in a black hole collapses to a point of infinite density (singularity). The Universe also started from a point (Big Bang). But infinities are unphysical.

Solution: Einstein-Cartan theory. Adding quantum-mechanical angular momentum (spin) of elementary particles generates a repulsive force (torsion) at extremely high densities which opposes gravitational attraction and prevents singularities.

HYPOTHESIS

We argue that the matter in a black hole collapses to an extremely high but finite density, bounces, and expands into a new space (it cannot go back). Every black hole, because of torsion, becomes a wormhole (Einstein-Rosen bridge) to a new universe on the other side of its boundary (event horizon).

If this scenario is correct then we would expect that:

- Such a universe never contracts to a point.
- This universe may undergo multiple bounces between which it expands and contracts.

Our Universe may thus have been formed in a black hole existing in another universe. The last bounce would be the Big Bang (Big Bounce). We would then expect that:

- The scalar spectral index (n_s) obtained from mathematical analysis of our hypothesis is consistent with the observed value n_s = 0.965 ± 0.006 obtained the Cosmic Microwave Background (CMB) data.

METHOD

To evaluate our expectations:

1. We wrote a code in Fortran programming language to solve the equations which describe the dynamics of the closed universe in a black hole (NP, arXiv:1410.3881) and then graph the solutions. These equations give the size (scale factor) a and temperature T of the universe as functions of time t (see Fig. 1).

$$\frac{\dot{a}^2}{c^2}+1=\frac{1}{3}\kappa\epsilon a^2, \quad \epsilon=h_\star T^4-\alpha h_{\rm nf}^2 T^6$$

$$\frac{\dot{a}}{a}+\frac{\dot{T}}{T}=\frac{cK}{3h_{\rm n1}T^3}, \quad K=\beta(\kappa\epsilon)^2$$

2. From the obtained graphs we found the values of the scalar spectral index n_s and compared them with the observed CMB value (see Fig. 2).

RESULTS

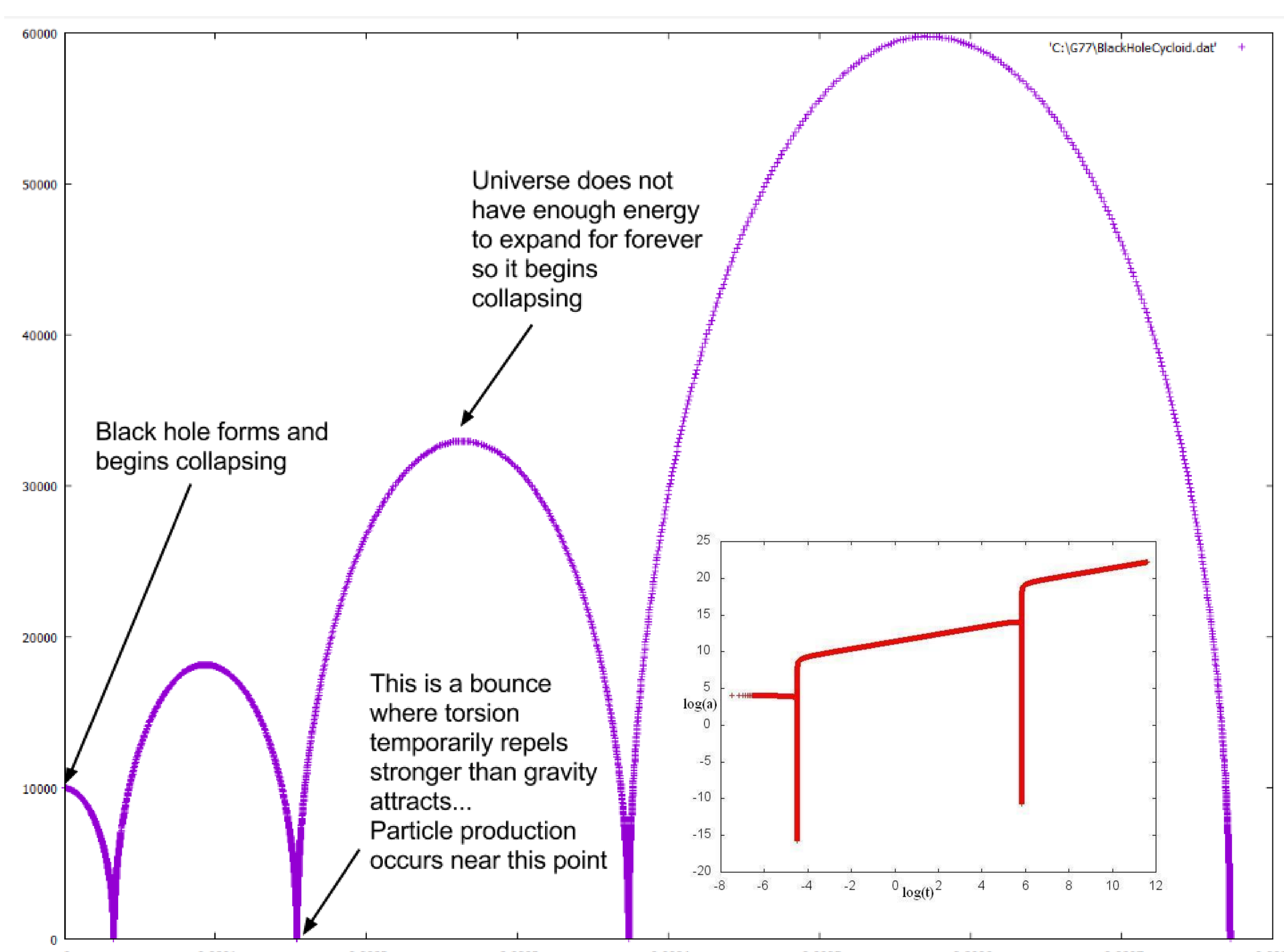

Fig. 1. Sample scale factor $a(t)$. Several bounces, at which a is minimum but always >0, may occur.

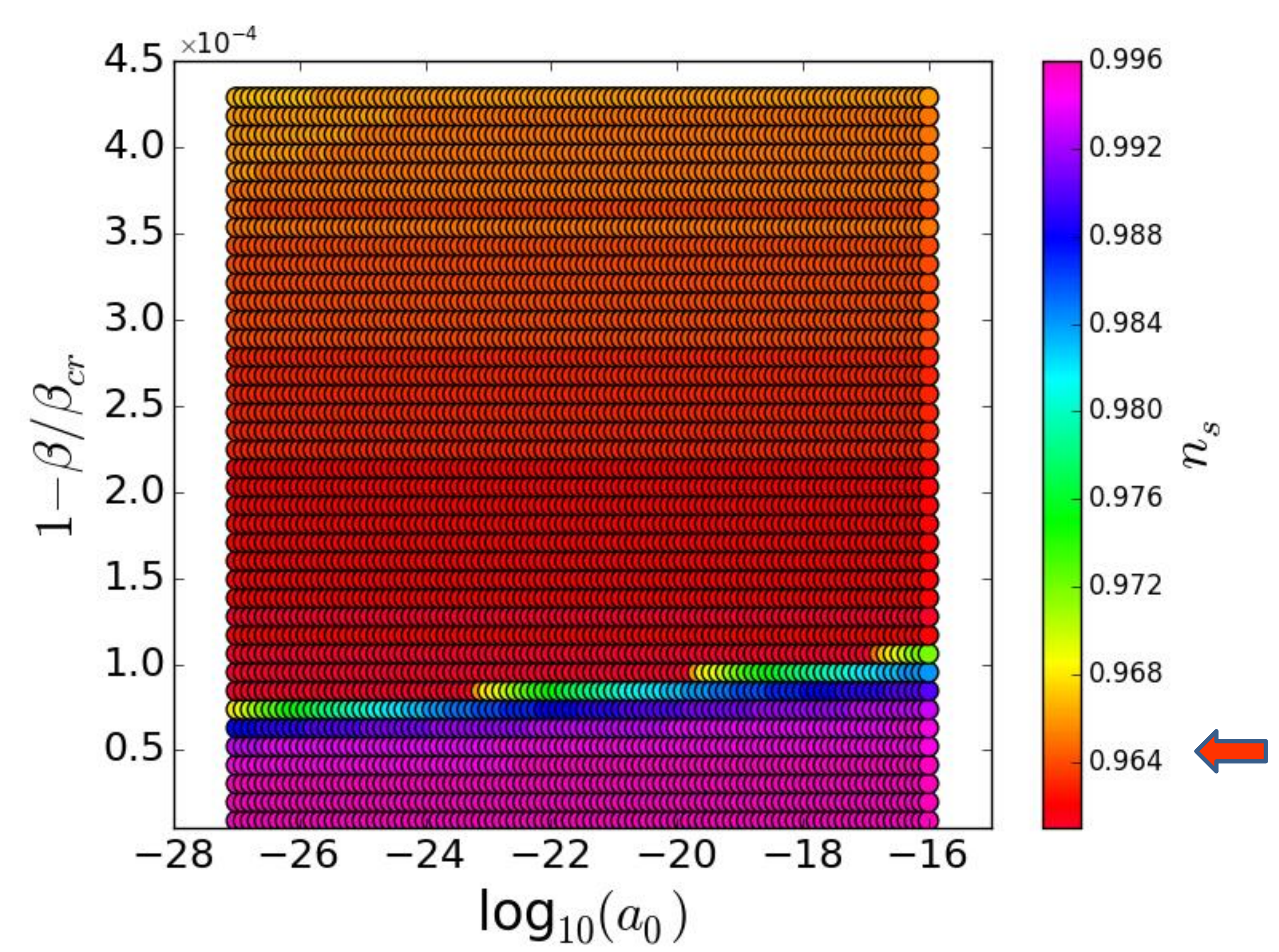

Fig. 2. The simulated values of n_s in our model are consistent with the observed CMB value n_s for a small range of β and a wide range of a_0 (m).

CONCLUSIONS

- The dynamics of the early universe formed in a black hole depends on the quantum-gravitational particle production rate β, but is not too sensitive to the initial scale factor a_0.
- Inflation (exponential expansion) can be caused by particle production with torsion if β is near some critical value β_{cr}.
- Our results for n_s are consistent with the 2015 CMB data, supporting our assertion that our Universe may have been formed in a black hole.

ACKNOWLEDGMENTS

I would like to thank my awesome teachers and mentors, Dr. Nikodem Poplawski and Dr. Chris Haynes, Dr. Shantanu Desai for his help, Carol Withers who organized the Summer Undergraduate Research Fellowship, and the donors who gave me the opportunity to pursue my research.