Was Our Universe Born in a Black Hole?

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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).

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

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

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

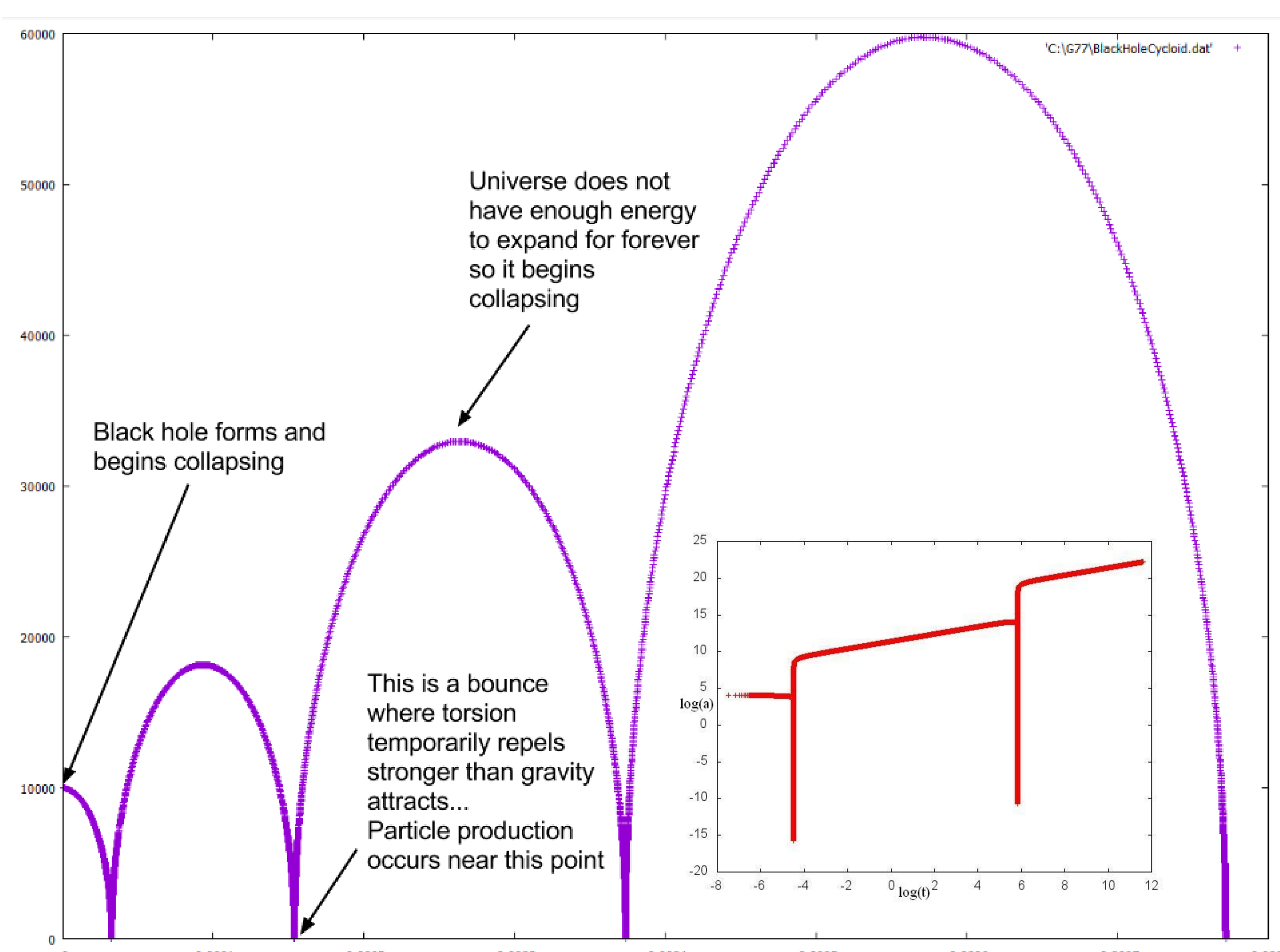

Fig. 1. Sample scale factor $a(t)$. Several bounces, at which a is minimum but always >0, may occur.

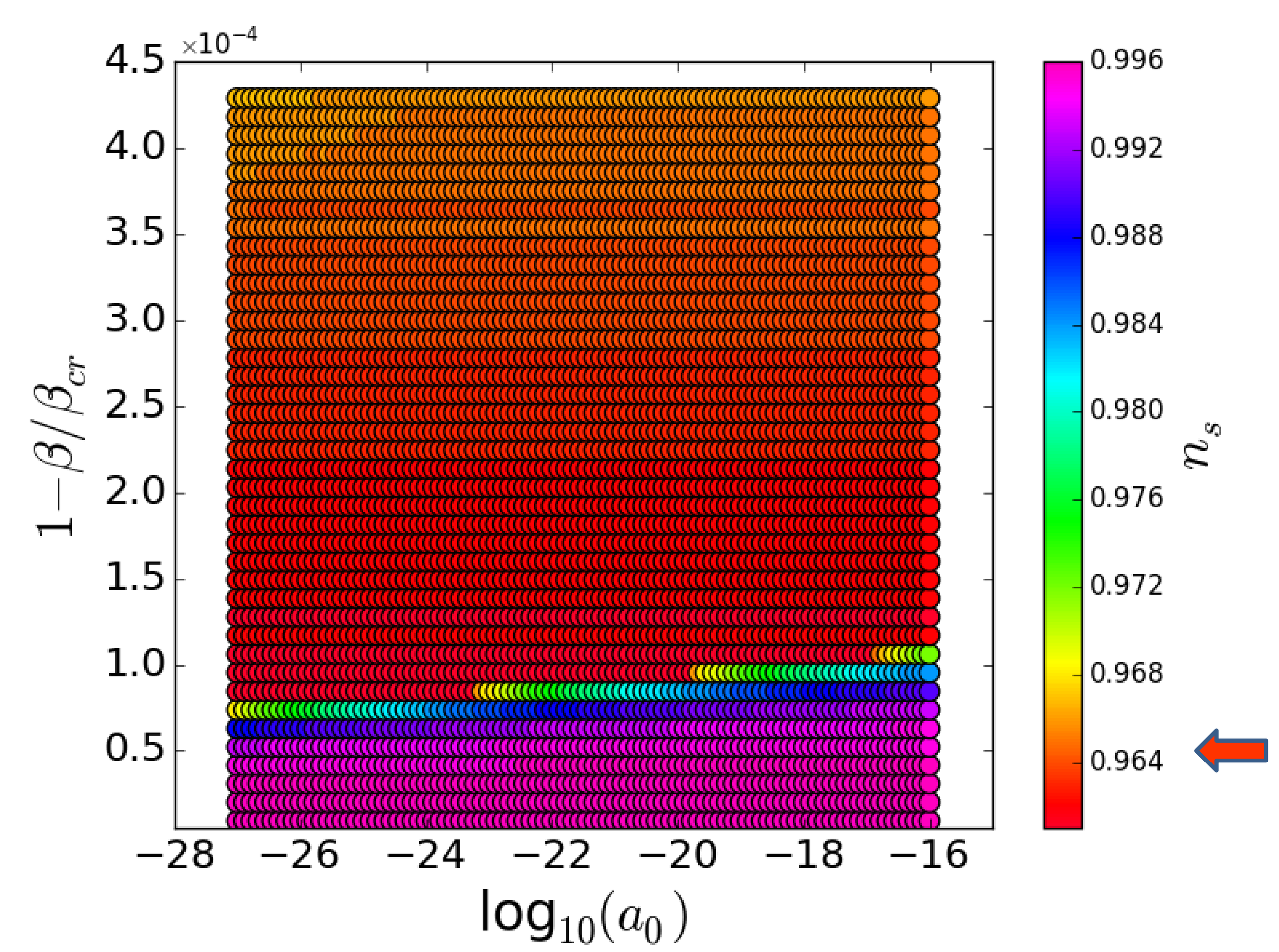

Fig. 2. The simulated values of n_s in our model are consistent with the observed CMB value n_s for a small range of β and a wide range of a_0 (m).

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.

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