

Cyclocosmos

*A Poetic Essay, Both Integral and Derivative,
Concerning the Cyclic Universe of
Steinhardt and Turok*

By Bill Robinson

In Science, as Nature, what affects our hearts
Is not the exactness of peculiar parts;
'Tis not a number, or function, we beauty call,
But the joint force and full result of all.

So I'll tell the quaint tale in several quatrains
Of a vast Cosmology in Dueling Membranes.
Behold *Figure One* telling the whole Cycle's Tale
While I chant this long Poem at the pace of a Snail.

The common wisdom of Bang and Inflation
Must now deal with a serious Aberration
Of accelerated Expansion and an Inconstant Hubble.
Reviving Lambda papers over the trouble—
For *Einstein*, Triumph; but for Philosophers subtle,
The scenarios offered cause many to grumble.
Plucked out of nowhere, this new Scalar Potential
Powers the growth, but what is essential
Is a sense of Why? When? Whither? Wherefore?
Why does it happen? What happened before
The Big Bang? And the Numbers fine-tuned,
So many, so Vital; we're left to assume
Our little Bubble had it precisely all right.
The rest of the Cosmos, now lost in the Night
Beyond our Horizon (says Inflation) is boundless.
Right here is Special, though before it was groundless
To see ourselves Central in the Universal Order.
A privileged Place has a familiar Odor.
Something is rotten in the State of Denmark,
And not only *Hamlet* can make that remark.

Now what can we do when faced with this Mystery?
Perhaps we do well with lessons from History.
A touch of *Copernicus*, one of *Occam's* close shaves,
Abandoning convention—to no Idea be Slaves.
For *Steinhardt* and *Turok*, well-versed in M Theory

(Which to most is Obtuse and makes our heads weary)
 Four-D is no limit; the Five of *Kaluza-Klein*
 Gives space for two Branes and a Solution sublime.
 We live on one Brane with another nearby
 Across that Fifth Dee o'r which nothing can fly.
 While they're separate by Fermis, the Scalar Potential
 Governs expansion and contraction in ways Providential.
 It powers the Bang and gives rise to new Matter
 And makes it all happen with Curvature flatter
 Than could have been possible with earlier Theories.
 It means that our own Universe is just one of a Series,
 Born again and again in infinite Sequence
 With increasing Entropy so dilute in appearance
 That no one can see it and Nothing runs down.
 The Specter of *Einstein* comes neigh with a frown;
 "What gives with GR? You've made a Disaster
 With *Beta* and *Phi-dot* and a custom Scale Factor.
 My dear Proper Clock is now Conformal Time—
 Sounds like a theory contrived for the Rhyme!"
 Oh dear! After all, to be charged with a crime
 Of Cosmic proportions by Doctor Einstein
 Is serious business. Can the Variation stand test?
 There's no direct way, but LISA is best
 For choosing 'tween 'flation and Branes that are bouncing.
 Left-over G-waves from the Bang are announcing
 Guth's Inflation is right; while if there are none,
 Then Cycles have favor and *Steinhardt* has won.

Recurring Big Bangs with no Singularities—
 As wholesome as *Shakespeare* without the Vulgarities.
 How do they manage? It's a little complex;
 Metric dt squared is *a-hat* squared dx
 Squared minus dt squared. It's *a-hat* that matters,
 Staying finite while Everything crunches to tatters—
 Clear down to Quark Soup, but not down all the way
 Like *Robertson-Walker's* scale factor a .
 (Don't grow to Infinity and don't shrink to Zero;
 If your theory does this than you'll be a Hero.)
 Why are things this way, and not something Other?
 The cyclical Pattern is like an Attractor,
 So that once it gets going it starts to converge
 And all possible Variants in time nearly merge.
 Not quite exactly, it's not just repeating—
 Post-Bang in a second it's different, defeating
 The problem of re-runs we all know too well;
 This theory's of the Heavens and not one of Hell.

Compared to the data, the theory seems right—
 Euclidean, with Galaxies accelerating in flight,
 Infinitely large with smooth Microwave.
 Those isotropic photons from the Bang is what gave
 The reason for making Inflation in the first place.
 If you look in directions opposite in Space,
 Why are they similar? They haven't been talking!
 No A to B contact, no matter how fast they're walking.
 Inflation smoothes quickly and then disappears
 Into Nowhere. But Cycles use a billion Years
 Before the Crunch, so Regions now distant commune
 Beyond their Horizons and become in tune
 With the Spectrum of bumps that evolve to each Galaxy
 And Cluster and Void that all can now see.

Let's tour the whole Cycle from Now to Now
 Explaining each step, and then showing how
 It depends on Potential V and Scalar Field Φ ,
 Skipping Math so complex that grown Scholars cry.
 We contemplate the Gist, and communicate that Deed,
 For Fools rush in where Angels fear to read.
 With a ratio of one to a thousand, you'll agree
 We need Pictures, not Words: see *Figure Three*.
 With V as abscissa and Φ as the ordinate,
 Energy both Kinetic and Potential coordinate
 Along this strange curve from minus forever to One
 Where we are now, as we'll be when we're done.
 Our expansion grows quicker; soon we roll downhill.
 V and Φ flow below zero, Expansion slows until
 In Trillions of years it ceases—we're due for Collapse.
 Conformal Time flips negative, so Normality snaps.
 In only Ten Billion we're at Point number Four,
 A second from Crunch. Everything onwards is more
 Quickly evolving; to follow, our Minds suffer Strains.

Let me not to the meeting of two Branes
 Admit impediment. V goes past its Minimum
 And then back to Zero at the Death of the Continuum—
 Or so it would seem when Φ is minus Infinity.
 Scale factor a declines to Nothing. Only Divinity,
 Or β , can save us from a point-like End.
 But a -hat is Finite, and we pass through the Bend
 With a flood of new Matter as the Branes pull apart
 And Φ 's back to Zero, giving all a fresh Start.

In a Zeptosecond we return to Point Eight;
Phi puts on the Brakes and becomes quite Sedate.
Fourteen Billion Years more marks our inhabited State,
An Unpreferred Place and Unpreferred Date.

The Cyclic Idea of *Steinhardt* and *Turok* in
Essence is Method, not settled and locked in
As Theory with everything set in its place.
It points to existence beyond Time and Space.
The proper study of Mankind is Physics,
If it be extended beyond the limits of Cynics.
This cyclical Cosmos is all mechanistic
Which compared to Experience, is not Realistic.
The Enlightenment of *Pope*, *Voltaire* and *Swift*
Gives us a dead World and throws out the Gift
Of something transcendent to Rock, Mud, and Clay.
Is there nothing that happens when we sit down to pray?
However advanced, these Cycles don't feature
Our Awareness, which exists—sayeth the Preacher.

So ends this long Poem with hopes you aren't bored
Or bewildered, and I forgive if you've snored.
The subject is Endless, beyond limits of Mind;
Shall we venture to look? And What shall we Find?
The World of the Senses and Logic tells Lies,
But it's what we have here, so a Physicist—tries!

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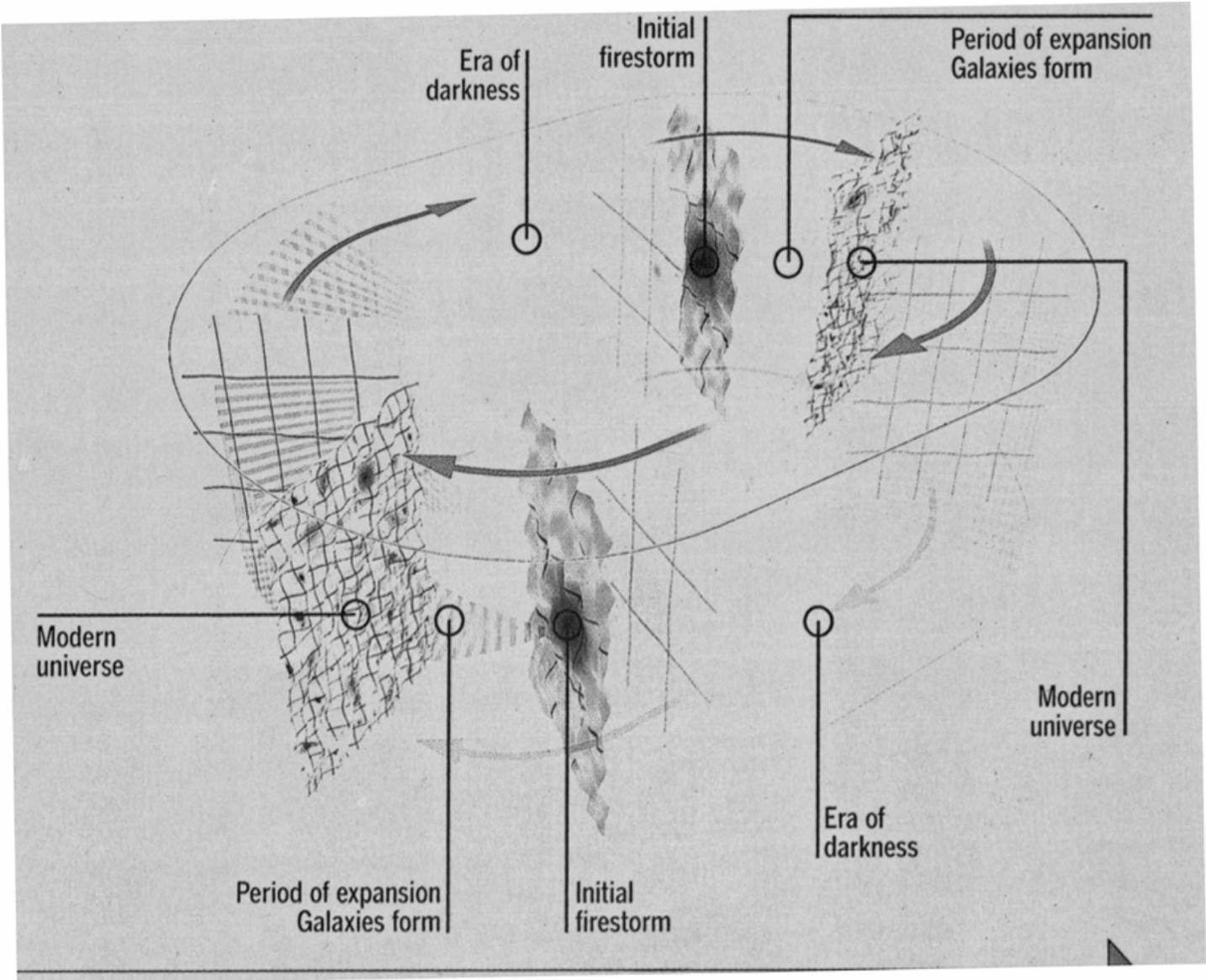


Figure 1

(Discover Magazine, February 2004)

Figure Two: Mathematical Ingredients Boiled down to a Minimum to Help Follow the Poem

The universe is flat and homogeneous

$$ds^2 = -dt^2 + a^2 dx^2$$

with a being the Robertson-Walker scale factor.

The effects of β include a fifth force that violates the equivalence principle, too weakly to observe now. One possible function for $\beta(\phi)$:

$$\beta(\phi) \sim e^{-\phi/\sqrt{6}}$$

For the transition to allow a smooth passage, a above is replaced with scale factor $\hat{a} = a \beta(\phi)$. This new, improved scale factor stays finite as $a \rightarrow 0$ at the transition. This means that *on the branes*,

$$ds^2 = -dt^2 + \hat{a}^2 dx^2.$$

One of two equations of motion is

$$\frac{\ddot{a}}{a} = -\frac{8\pi G}{3} [\dot{\phi}^2 - V + \beta^4 \rho_R + \frac{1}{2} \beta^4 \rho_M]$$

Thus V represents what is customarily thought of as *dark energy density*, which acts like negative pressure.

Proper time is rarely used in the cyclic universe literature. Instead, the two main forms of time are *coordinate* time t as used above, and *conformal* time τ ; $dt^2 = \hat{a}^2 d\tau^2$. Since it uses \hat{a} , τ flows through the bounce when $a \rightarrow 0$.

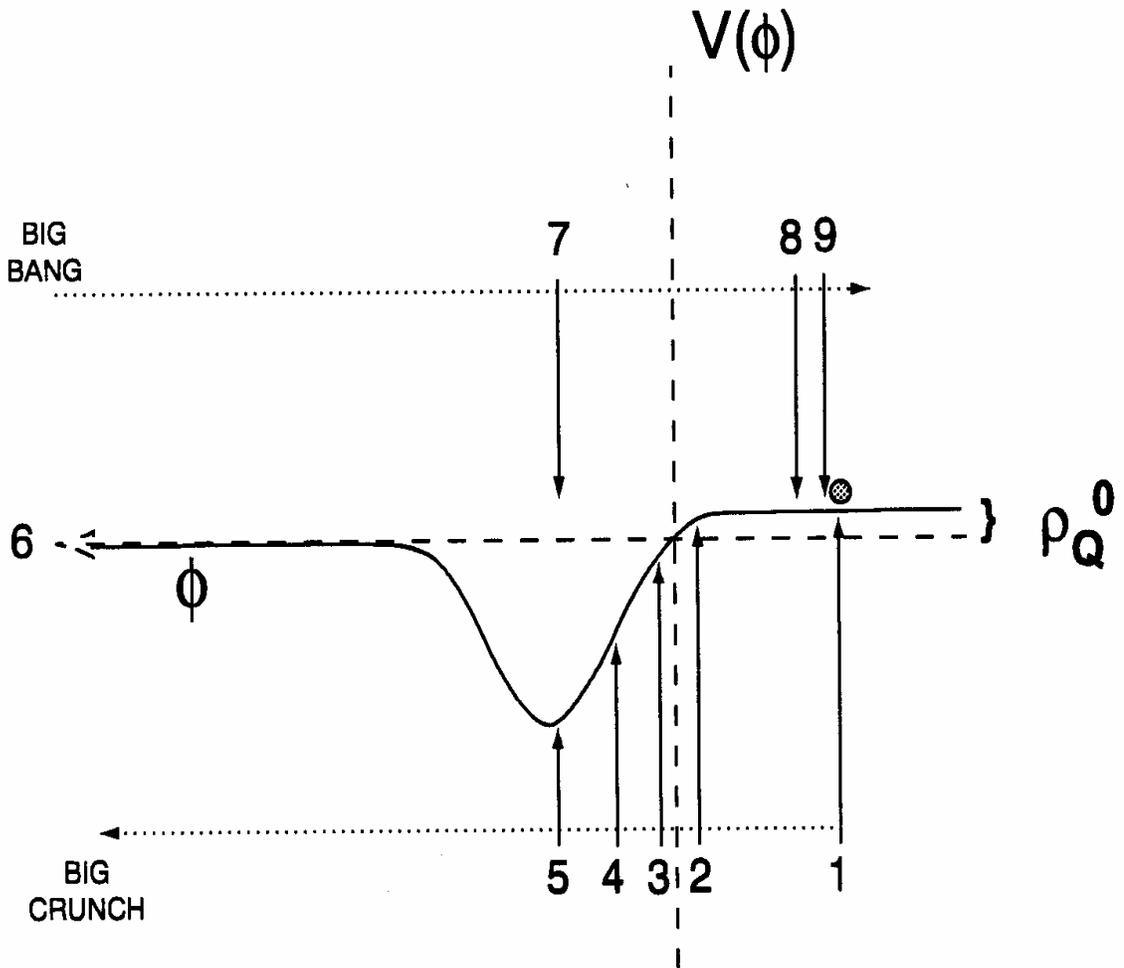


Figure 3

(from P. Steinhardt, N. Turok *Cosmic Evolution in a Cyclic Universe*)