A Critique of Modern Cosmology

[Transparencies of the talk delivered at Valencia in June 2006 by Jayant V. Narlikar, Inter-University Centre for Astronomy and Astrophysics, Pune, India]

The Pythagoreans believed that the Earth goes round a central fire. Why don't we see the fire? To answer this criticism they had to invent a 'counter-earth' going round the fire and just blocking our view of it. To the query why we do not see the counter-earth, they replied that Greece was facing the other way.
“Cosmologists are often wrong but never in doubt”: Lev Landau

Max Born: “…modern cosmology has strayed from the sound empirical road into a wilderness where statements can be made without fear of observational check…”

Longair (1986, Beijing IAU Symposium on Observational Cosmology): There is no evidence that $\Lambda \neq 0$ and I find the classical Friedmann models to have the great appeals of simplicity and elegance.

Longair (2006, Valencia) …
Why at any given epoch are we so confident that we have the final solution of the cosmological problem at that epoch?

The confidence would be justified if the current paradigm were founded on a well established physical theory and on direct observations besides following the basic criterion of repeatability of experiments.
Repeatability of experiments

A contrast with astrophysics:

The law of gravitation was tested many times in the solar system, vide planetary motions, motions of comets, discovery of Neptune…

In stellar evolution stars of different masses provide test of theory of stellar structure; each star is an experiment.

Saha’s ionization equation provides a clue to the stellar temperatures through spectroscopy of different stars.

There are numerous observations of stellar spectra that can be interpreted to tell us about the composition of interstellar dust.
In standard cosmology we have a scenario covering the history from the big bang to the present, in which no stage was repeated.

- Big bang (?)
- Quantum fluctuations
- Inflation
- Initiation of structure formation
- Baryogenesis
- Nucleosynthesis
- CMBR: Last scattering surface
- Formation of large scale structure
Soundness of basic physics:

The physics behind the formation of last scattering surface is well established. It uses the well understood results in electrodynamics.

The physics behind the primordial nucleosynthesis is also well established. So, although the event occurred only once, between 1-200 second, the calculations can be trusted.

[Contrast : Stellar nucleosynthesis provides several ‘experiments’ for testing its various processes.]
But what of the physics at $10^{16}$ GeV?

1. We still do not know what is the basic (grand unified, supersymmetric, string based...) interaction that operated when inflation took place.

2. The matter density at that epoch was in the neighbourhood of at least $10^{50}$ g cm$^{-3}$. What is the equation of state of matter at this high density? [Recall how much research went into the equation of state of neutron star matter at density of $10^{15}$ g cm$^{-3}$.]

3. Flat spacetime statistical mechanics cannot be applied to the ensemble of particles at this stage.
Inflation, a full-fledged theory or an act of faith?

1. Is the inflation with a beginning, after the singular epoch and quantum gravity era? If so which brand of inflation is accepted by cosmologists today? What decides the $V(\phi)$? If there was no singular epoch and we had only eternal inflation, then why with the parameters that are taken to define it?

2. Has anybody solved the equations of general relativity that describe a finite bubble growing within a de Sitter universe? It is a time dependent problem requiring matching of boundary conditions across the bubble.
3. If the expansion during inflation is approximated by $e^{at}$, then it is assumed for the growth of primordial inhomogeneities that the causal length scale is $c/a$. What is the justification of this since the horizon size of $c/a$ applies only to the full de Sitter spacetime and not to a truncated and approximate de Sitter spacetime that is used for inflation?
**Dark Matter or Emperor’s New Clothes?**

If we keep our trust in laws of Newton and Einstein then there is

(i) definite evidence for dark matter in flat rotation curves of galaxies, and,
(ii) less definitive evidence from clusters of galaxies (...are all clusters really virialized?)

What is the dark matter made of?

If we follow straightforward extension of astronomy the conclusion should be that dark matter is baryonic.
However, this conclusion lands the standard model into trouble on two counts:

1. There will be no primordial deuterium
2. There would be unacceptably large inhomogeneities in CMBR

To save the paradigm therefore the assumption is made that the bulk of dark matter is non-baryonic (NBDM).

To date there is no laboratory candidate for NBDM. Particle physicists in their extrapolation do not have a definitive candidate for NBDM. Yet it is asserted with confidence that the NBDM is cold and has abundance 23% as opposed to 4% for baryonic matter.
[A correct statement would be that unless these amounts are there, the model fails.]

Contrast with primordial nucleosynthesis is seen in the care gone into verifying that the deuterium abundance is indeed as per prediction of the model vs: the uncritical acceptance of CDM as actually being there in such a large amount.

Note: Simply finding a super-symmetric particle in an accelerator is not enough. It is necessary to show that the 23% NBDM abundance is in the form of that particle.
What is really the observable universe?

If the origin of CMBR is as per standard model, then astronomers are not able to observe the universe prior to $z = 1000$.

Even what WMAP sees is radiation at the present epoch. That it came from the last scattering surface is inferred from the cosmological model.

All aspects of the very early universe in fact are unobservable... [Audience trying to infer what is going on behind the stage curtain from the way it shakes.]

Direct observations take us to redshifts of the order of 6-8 where specific objects of those redshifts are seen...assuming that the Hubble law of redshift-distance still holds.
Dark energy:

The post-1999 swing in favour of a cosmological constant has become bogged down in theoretical mire:

1. A constant $\Lambda$ does not work unless one accepts a fine tuning of $10^{-10^{8}}$.

2. A variable $\Lambda$ does not follow from any elegant theory but is forced in by demanding a good fit with the supernova data.

3. Are the supernova data really reliable? Note the ifs and buts: standard candle, gravitational lensing, intergalactic dust. Given the earlier fate of the $m$-$z$ relation of 1960-80, should we not be more cautious in putting all cosmic eggs in the $\Lambda$-basket?
Summary:

The bulk of research in cosmology today is based on laws of physics that have been extrapolated to unverified limits, relates to epochs of the universe that cannot be directly observed, involves a state of matter that is untested in the local laboratory and is not dealing with events that are repetitive.

The concordant and precise picture claimed today has been achieved at a cost of many epicycles and ignores the history of the subject.
Fred Hoyle (1970): “…I think it is very unlikely that a creature evolving on this planet, the human being, is likely to possess a brain that is fully capable of understanding physics in its totality. I think this is inherently improbable in the first place, but, even if it should be so, it is surely wildly improbable that this situation should just have been reached in the year 1970.”

[1970 was prior to inflation, GUT, NBDM, Λ, CMBR anisotropies…]

A plea to the cosmologists present here: Please treat the subject as open with some room for alternative ideas…
Cosmologists today are like a flock of geese...
Post-script: Grote Reber, the pioneer radio astronomer also did not like the concept of big bang and drew my attention to the following comic strip...

![Comic Strip](image1)

![Comic Strip](image2)