Lecture 22: Common Big Bang Misconceptions

Note Title 4/18/2011

This follow's Peacock's Cosmological Physics, pages 86 – 89

① The initial singularity

(a) "All matter is gathered in a single pt"

This is not true... all places in the universe exist at all times, no "points" are created.

This is important b/c the CMB photons from areas of the sky do not have a common past. If all the universe was in a pt, then they would.

(b) The big bang as an "explosion"

Just bad... implies things at rest that start moving.

(c) Into what does universe expand...

↳ Not well posed in usual sense of big bang.

(Although it may work in some inflation / multiverse theories.)

(2) The origin of the redshift as "moving away"

SR Doppler shifts ... $1+z = \sqrt{\frac{1+v/c}{1-v/c}}$

You can not use this to say some distant quasar is receding at .95c ... or you shouldn't.

In local coordinates, nothing is moving.

(3) The Nature of expansion

(a) Space is swelling up.
(b) Space is being created.
(c) Space is expanding into...

All these are bad – look to our relational view of GR – what changes is the relation of distance b/w objects

(d) Dot on a balloon that is being inflated...
↑ a Galaxy

In this case the dots grow, which they don't. Gravity, chemistry hold things together and set the local size.

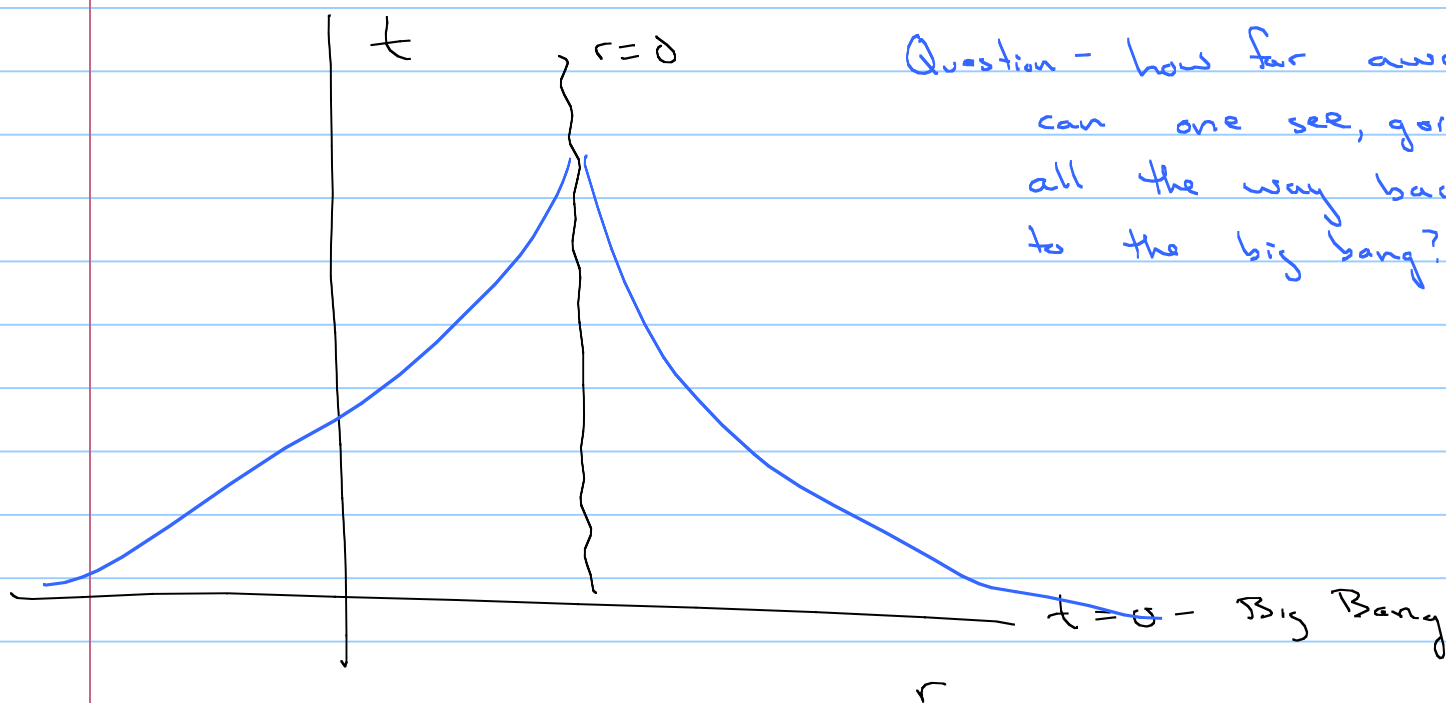
You could glue a penny on the balloon to be a galaxy.

(4) What came before the big bang?

↳ Ill-posed Question... classical physics can not answer this.

- But maybe a Quantum Gravity theory will eliminate the Big Bang... or maybe not

(5) The meaning of past horizons.



Question - how far away can one see, going all the way back to the big bang?

$ds^2 = 0$ for light $\Rightarrow$ $dt^2 = a^2(t)\,dr^2$

Past light cone $\Rightarrow$ $$\int_0^r dr = -\int_{t_0}^{t} \frac{dt}{a(t)}$$

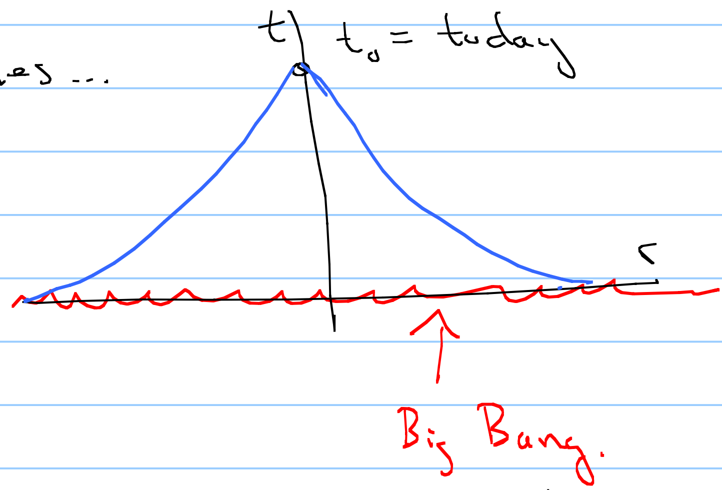
Flat, matter dominated universe, $a(t) \sim \left(\frac{t}{t_0}\right)^{2/3}$

where t_0 = age of universe today

$$r = -t_0^{2/3} \int_{t_0}^{t} t^{-2/3}\, dt = -3 t_0^{2/3}\, t^{1/3} \Big|_{t_0}^{t}$$

$$\boxed{r = -3 t_0^{2/3}\, t^{1/3} + 3 t_0}$$

So light cones...

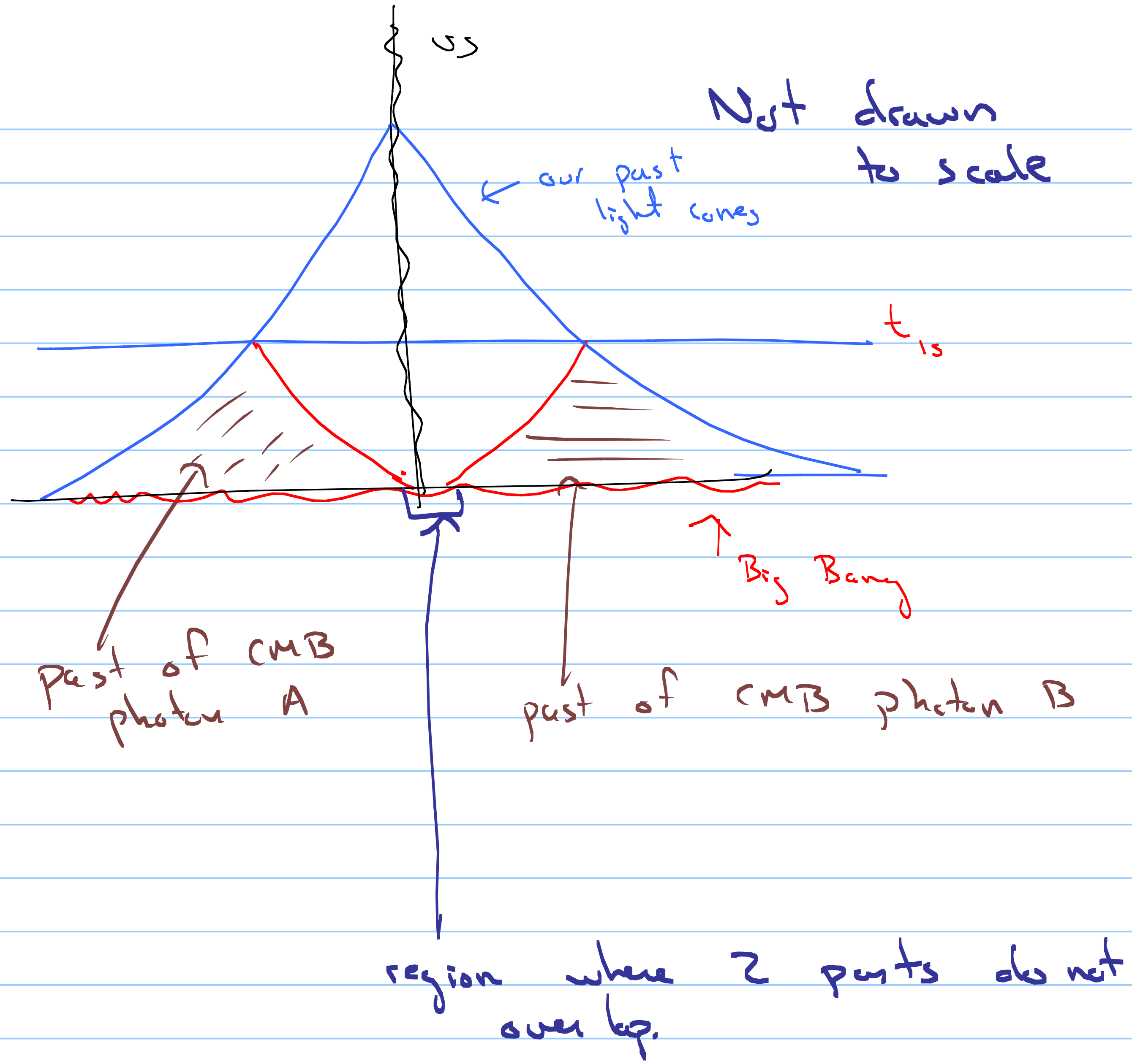


If $t_0 = 13.5$ byr, $r_{Horizon} = 3t_0 \simeq 40$ byr

is the furthest away value of r we could see at the big bang.

But what is biggest value of r? Well infinity of course. So we can only see a fraction of the universe.

For CMB photons produced at time of last scattering $t_{ls} \sim 400{,}000$ yr — the distance to the horizon is far less



So mystery: How can CMB be so uniform if no causal event in their past exists?