AAS-222, Indianapolis, Indiana Poster June 2013

Universe Has Been Coasting Since Z=50

David Bartlett & John Cumalat

University of Colorado

Abstract

For some time we have been finding evidence in the local universe that both Newtonian gravity and Maxwellian electromagnetism need modification: specifically a massive photon ($mc^2=10^{-25}$ eV) and a graviton of the same, but imaginary mass.
The non-relativistic equations for gravity and electricity share a common factor, $k_o=2\pi m /h\ c=400$ pc:

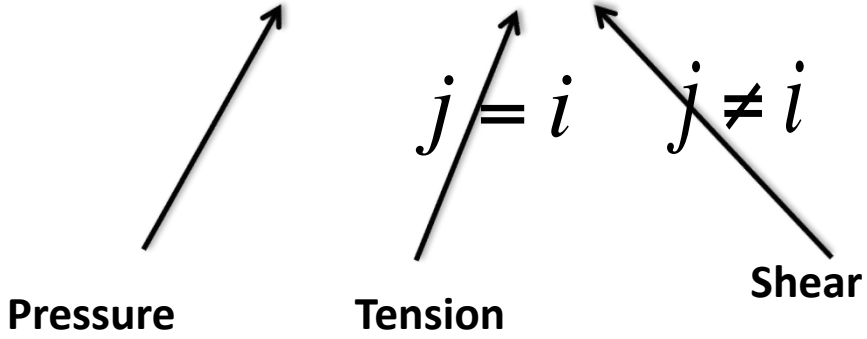
$$\nabla^2 \phi + k_o^2 \phi = 4 \pi G \rho;\ \phi=-GMCos[k_oR]/R$$

$$\nabla^2 \phi - k_o^2 \phi = -4 \pi \rho;\ \phi=-QExp-[k_oR]/R$$

We have proposed a relation between 400 pc and the structure in clusters of galaxies at about 128 h^{-1} Mpc as observed by Broadhurst(1990) and in red galaxies by Ryabinkov, Kaurov, and Kamaniker(2012). What was 400 pc at a lookback z of $10^{5.63}$ is 170 Mpc now. Further at a z= $10^{5.63}$, the energy stored in baryons is the same as that stored in gravity: $\rho_m= \rho_g=(1/2)\ \phi\rho_m=k_o^2/2\pi G$.(Here we use natural units c=h-bar=1). Additionally this energy density is 8 R_∞^4, where R_∞= 13.6 eV. We now propose that this triple numerical coincidence indicates a cosmological reality. Structure really begins to form at this early time.
We suggest a universe that has been retarded by a massive photon ($a(t) \alpha t^{1/2}$) from the time of nucleosynthesis till z=50 when the first stars form. Since then, it has been coasting ($a \alpha t$). We will show how this cosmology helps explain the association that Verschuur has found between WMAP peaks and HI maxima and minima. References to our previous work may be found at http://www-hep.colorado.edu/Cosinusoidal/ and in the article, "Analogies between electricity and gravity", Metrologia 41 (2004) S115-S124.

Chibisov's Stress Tensor (July 1976) with our assumption of a photon mass, $m_\gamma = 10^{-25}$eV ($k_0 = \hbar/m_\gamma c = 2\pi/400$pc)

$$M_{ij} = (1/4\pi)(-\delta_{ij}B^2/2 + B_iB_j + \delta_{ij}k_0^2A^2 - k_0^2A_iA_j)$$



Let k be the wave number of the Fourier decomposition of the field. If $k > k_0$, the B fields dominate. If $k < k_0$, then the vector potential A dominates.

Uses of the Massive Photon

Can bind individual galaxies into clusters

Can bind the entire universe

Is the Universe bound magnetically?

Coasting

$$\vec{A}(m_\gamma \neq 0)$$

$$a = const\ t \qquad a = const\ t^{1/2} \Rightarrow t^2 = a^4 / const^4$$

$$\dot{a} = const \qquad \dot{a} = \frac{1}{2} const\ t^{-1/2}$$

$$H \equiv \frac{\dot{a}}{a} = \frac{1}{t} \qquad H = \frac{1}{2t}$$

$$\ddot{a} = 0 \qquad \ddot{a} = -\frac{1}{4} const\ t^{-3/2}$$

$$q = \frac{\ddot{a}}{a} = 0 \qquad q = -\frac{1}{4t^2}$$

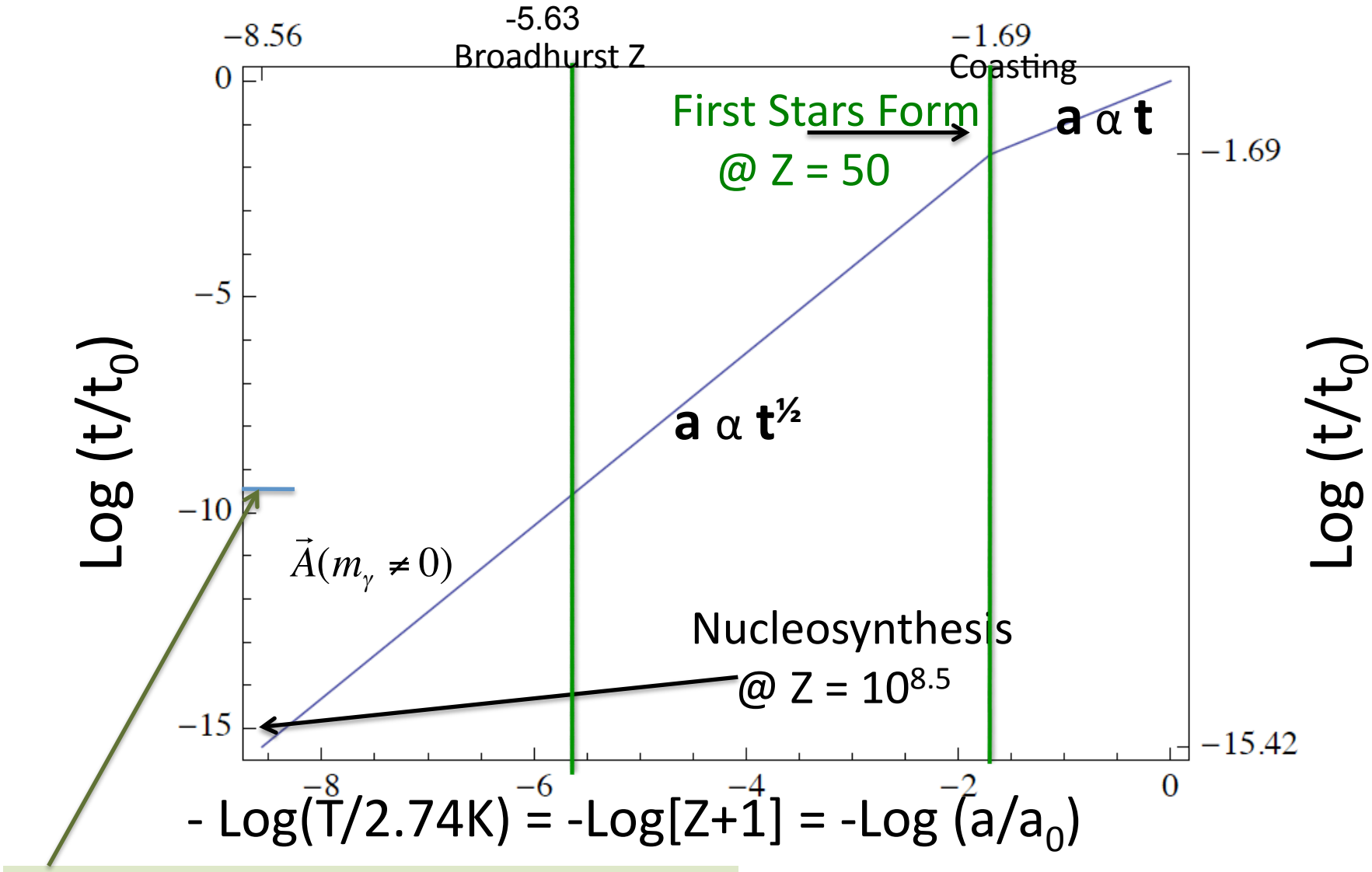
$$\ddot{a}a^3 = 0 \qquad \ddot{a}a^3 = -\frac{const^4}{4}$$

$$a^3 \propto \frac{1}{A^2(t)}$$

$$\therefore \ddot{a}(t) \propto -A^2(t)$$

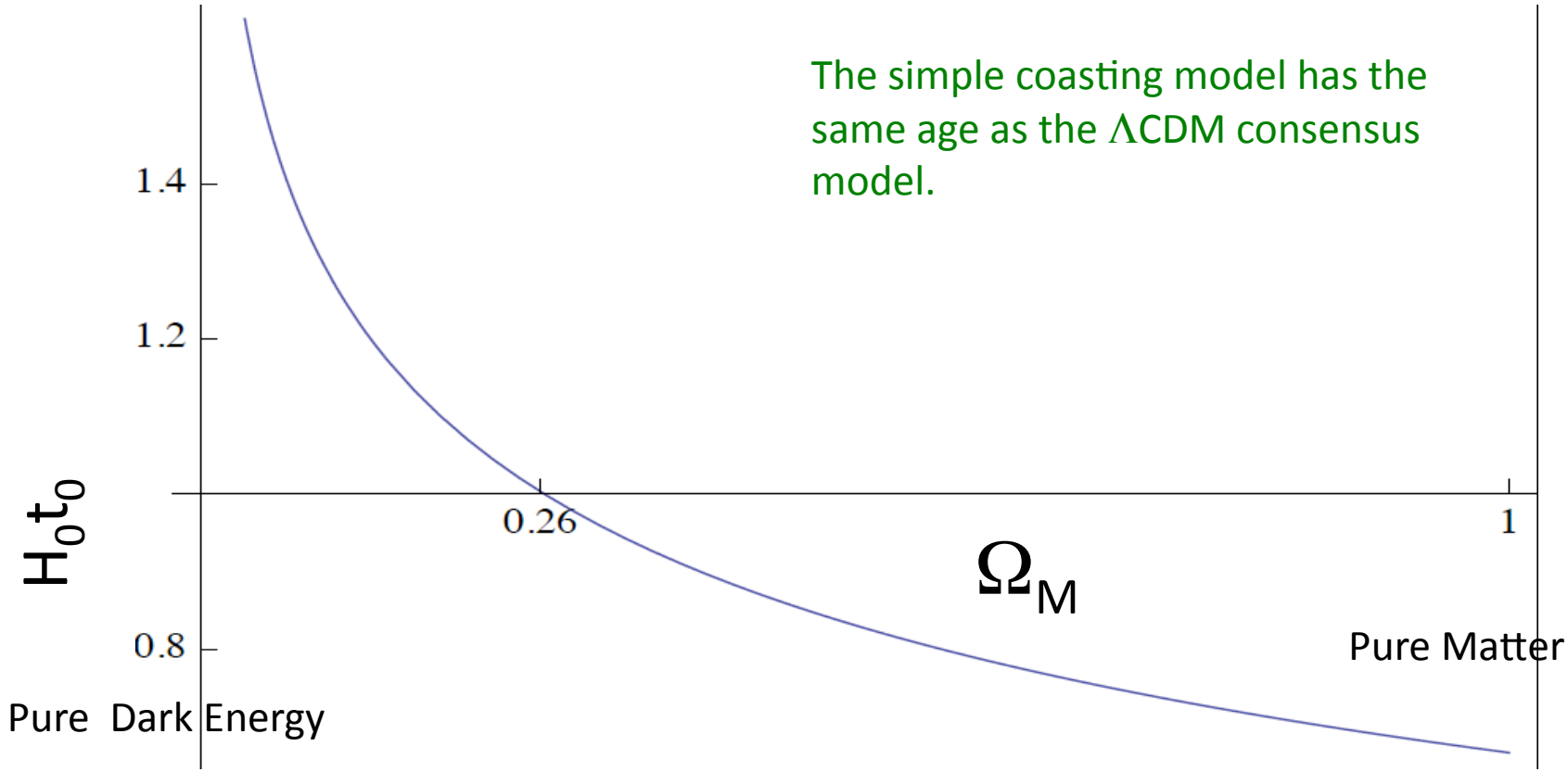
For both cases the Potential Energy in an expanding sphere is conserved.

Evolution of cosmological time versus scale a



Broadhurst time = 2.5 years after Big Bang

H_0t_0: Coasting = 26% Matter and 74% Dark Energy

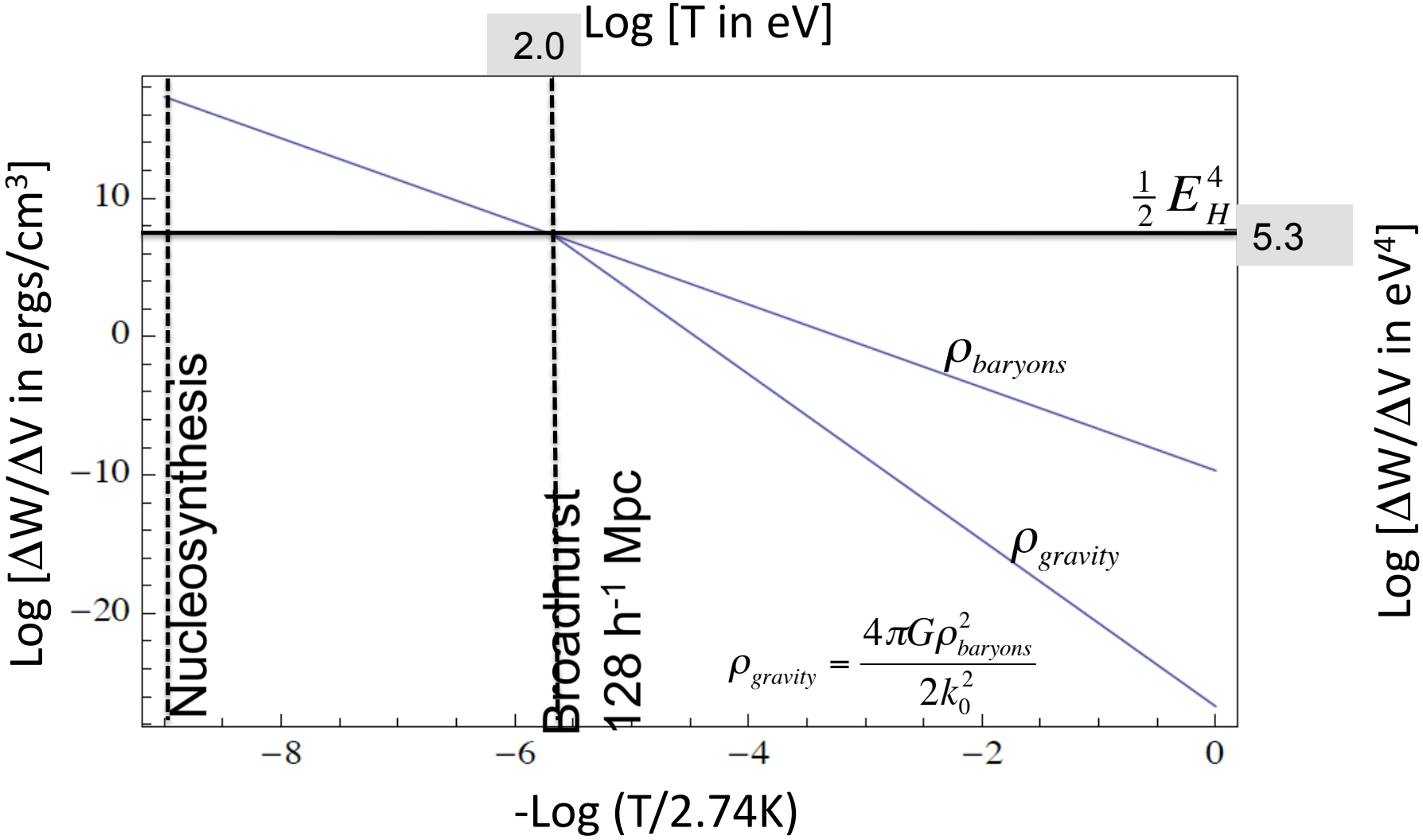


$$H_0 t_0 = \int_1^\infty \frac{dy}{y\sqrt{\Omega_M y^3 + \Omega_R y^2 + \Omega_\Lambda}}$$

$$\Omega_R = 0$$

$$\Omega_\Lambda = 1 - \Omega_M$$

Energy Density (Matter & Gravitational)



Quasi-Periodical Features in the Distribution of Luminous Red Galaxies

Ryabinkov, Kaurov, and Kamaniker(2012)

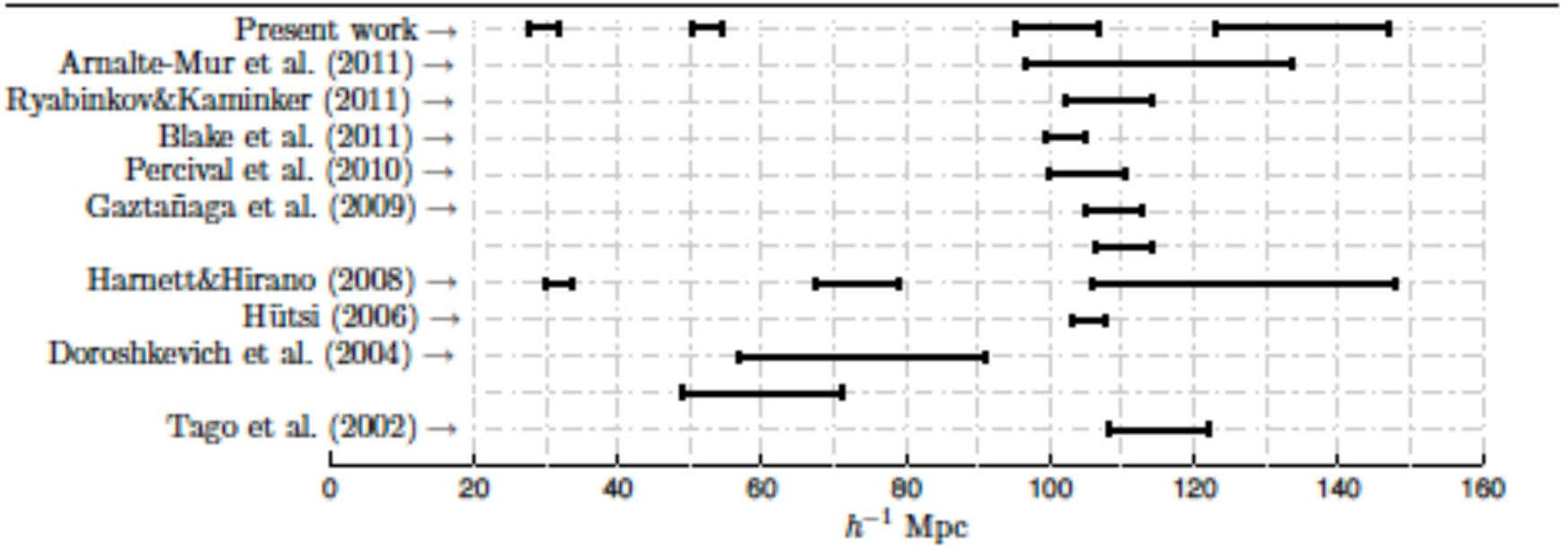


Fig. 7 Cosmological characteristic scales obtained in the last decade by a few groups of authors, the references are indicated in the left column. Horizontal segments depict uncertainties indicated by the authors except the error bar attributed to the results of Percival et al. (2010) (at $\Omega_m = 0.28,\ z = 0.2$), which we estimated on the basis of data given in the cited paper. The error bar related to the results of Arnalte-Mur et al. (2011) is also introduced rather arbitrary on basis of their Figure 2.

128 h^{-1} Mpc Structure

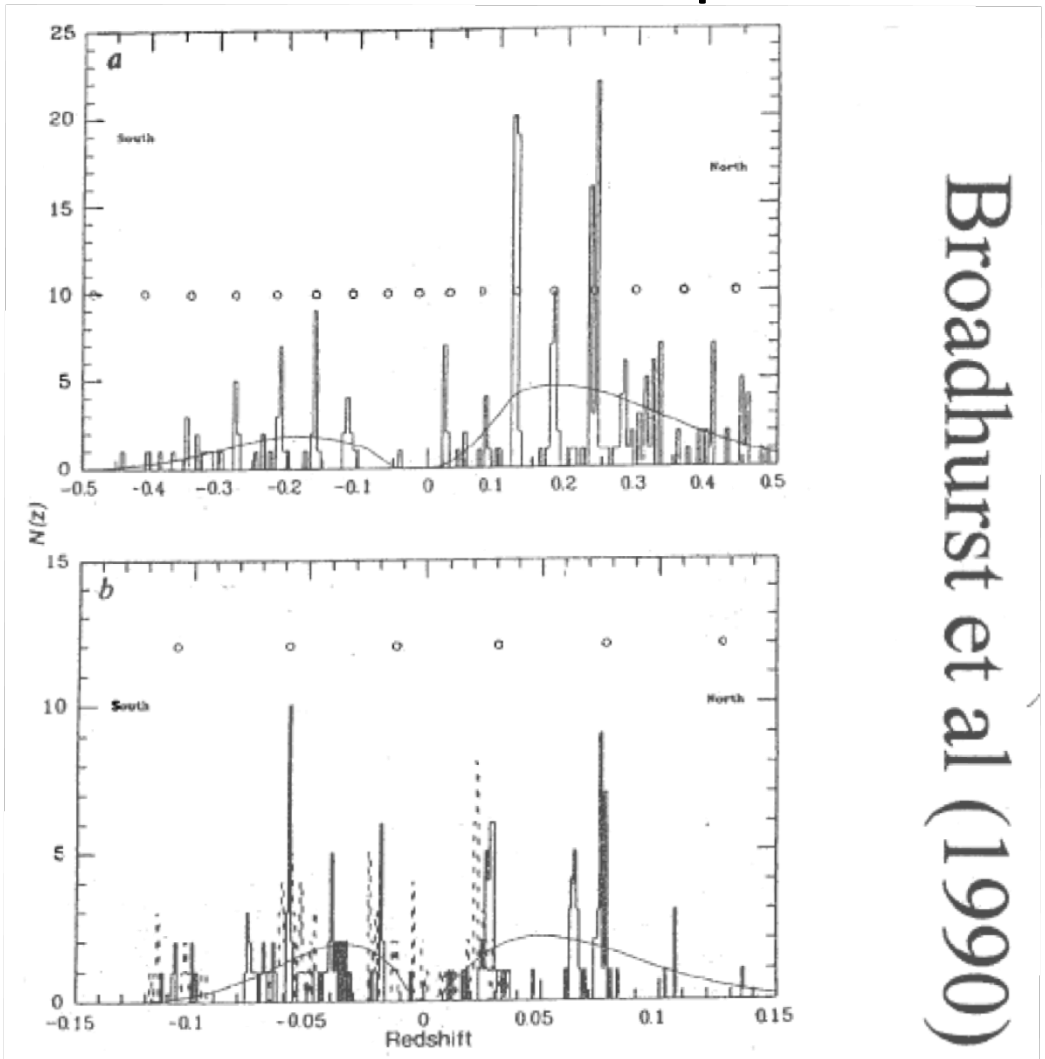
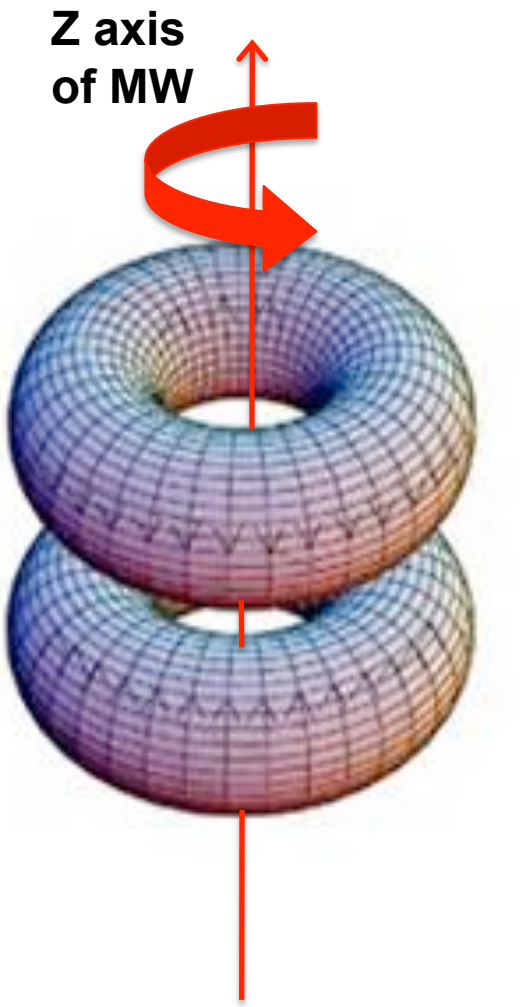


FIG. 1 Redshift distribution for four surveys at the Galactic poles with selection functions indicated as solid curves and normalized to each data set. Solid histograms refer to fields close to each other in position; dashed histograms refer to more widely distributed fields (SP3 and SP4 in the south, NP4 in the north[3,4]). *a* refers to faint samples[5,6] and *b* to bright surveys[2-4]. Circles indicate a best-fit constant comoving separation of 128 h^{-1} Mpc for $q_0 = 0.5$.

Broadhurst et al (1990)

Patterns at 400pc at $z = 10^{5.63}$ become expanded to 128 h-1 Mpc today.

Suppose Underlying Magnetic Field at Broadhurst

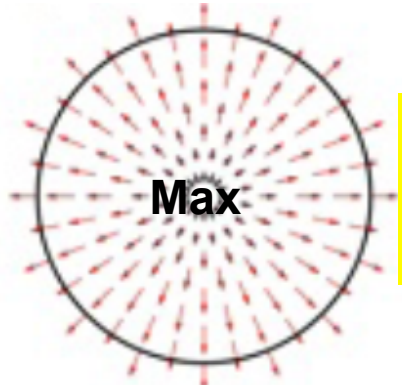


Arrows on Torus indicate any of **A, B or J** as they are parallel to each other.

Axis is the z-axis of MW which has survived "as the axis of evil" with dilution since Broadhurst time 2.5 years after Big Bang.

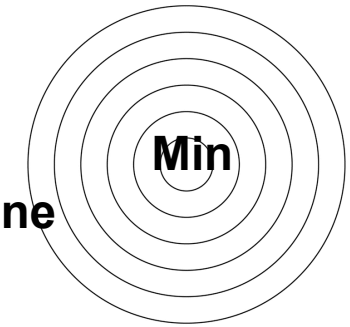
Comparison of E polarization in Recent WMAP Data (Hinshaw et al 2013)

View along Z-axis



Strong Radial E Mode

View along x-y plane



Weak Tangential E Mode

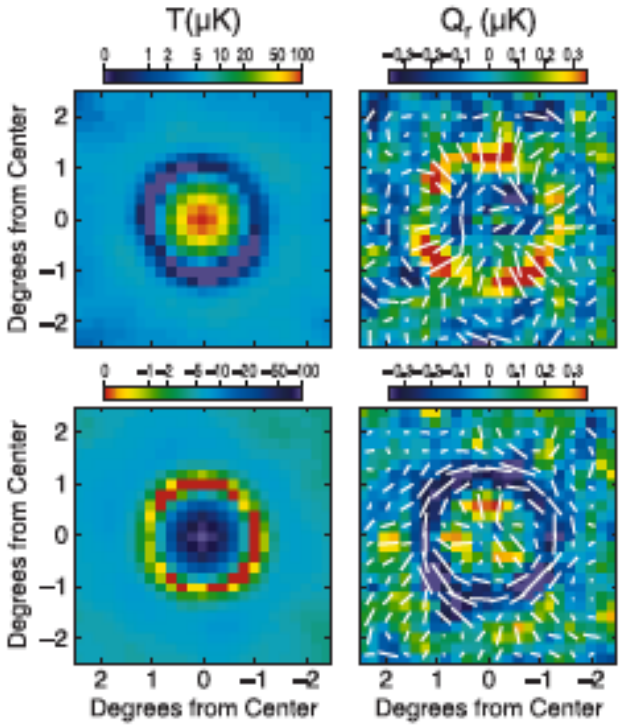
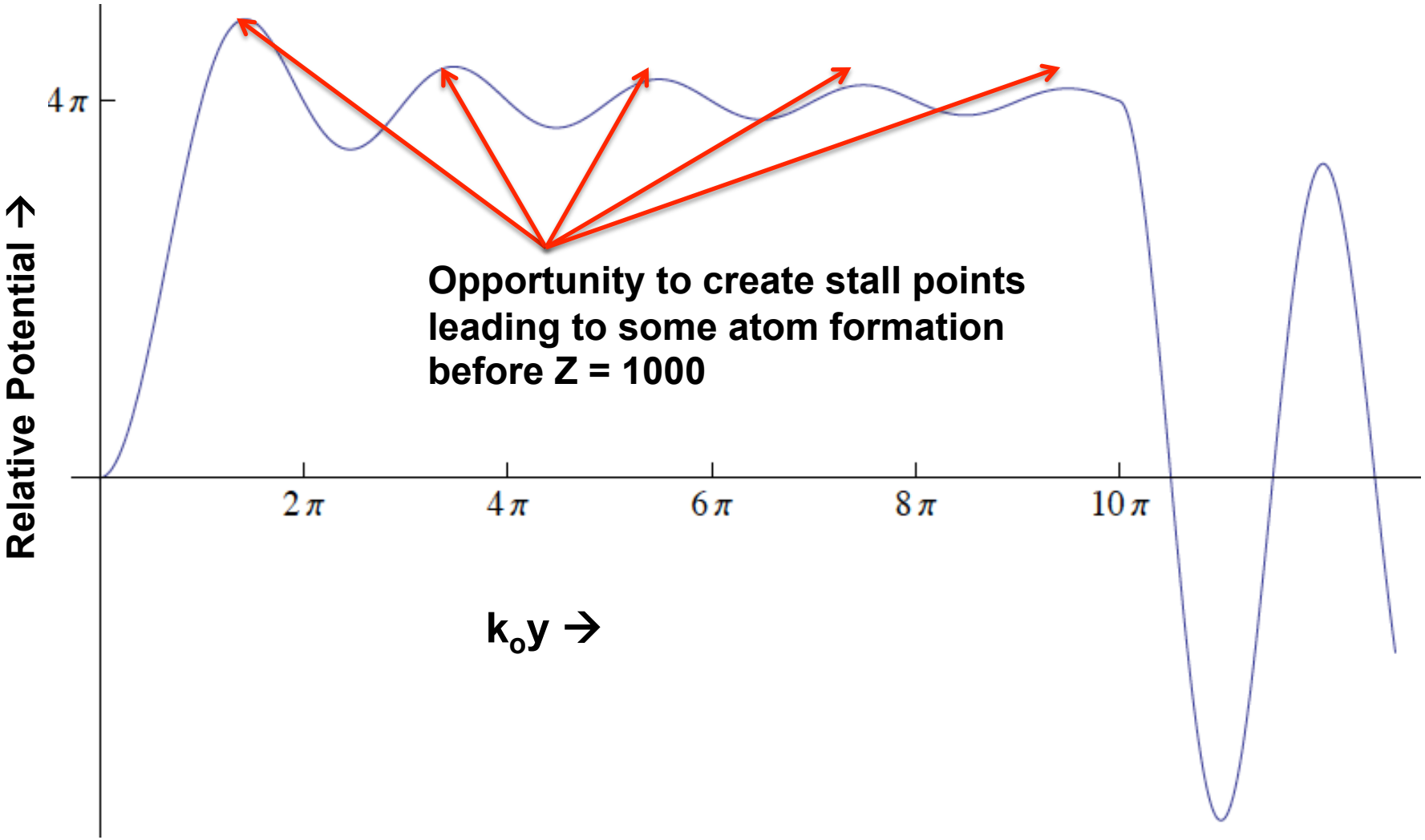


FIG. 12.— Co-added maps of temperature, T, and polarization, Q_r, smoothed to a common resolution of 0°.5, and stacked by the location of temperature extrema. (The polarization maps were not smoothed for the analysis, however.) *Top-left*: the average temperature hot spot. *Top-right*: the rotated polarization map, Q_r, stacked around temperature hot spots. *Bottom-left*: the average temperature cold spot. *Bottom-right*: the rotated polarization map, Q_r, stacked around temperature cold spots. The polarization images are color-coded so that the red ($Q_r > 0$) shows the radial polarization pattern, while blue ($Q_r < 0$) shows the tangential polarization pattern. The lines indicate polarization direction. These images are a striking illustration of BAO in the early plasma, and phase coherence in their initial conditions.

Calculation of the Gravitational Potential versus 1 dimension for Solid Slab of Matter and half thickness, y_o; $k_o\, y_o = 10\pi$



The Lithium Problem (PDG 2012)

Helium and Deuterium results agree well with the Standard Model of cosmology --- But ….

^{7}Li/H primordial calculations lie outside of the recent measurements.

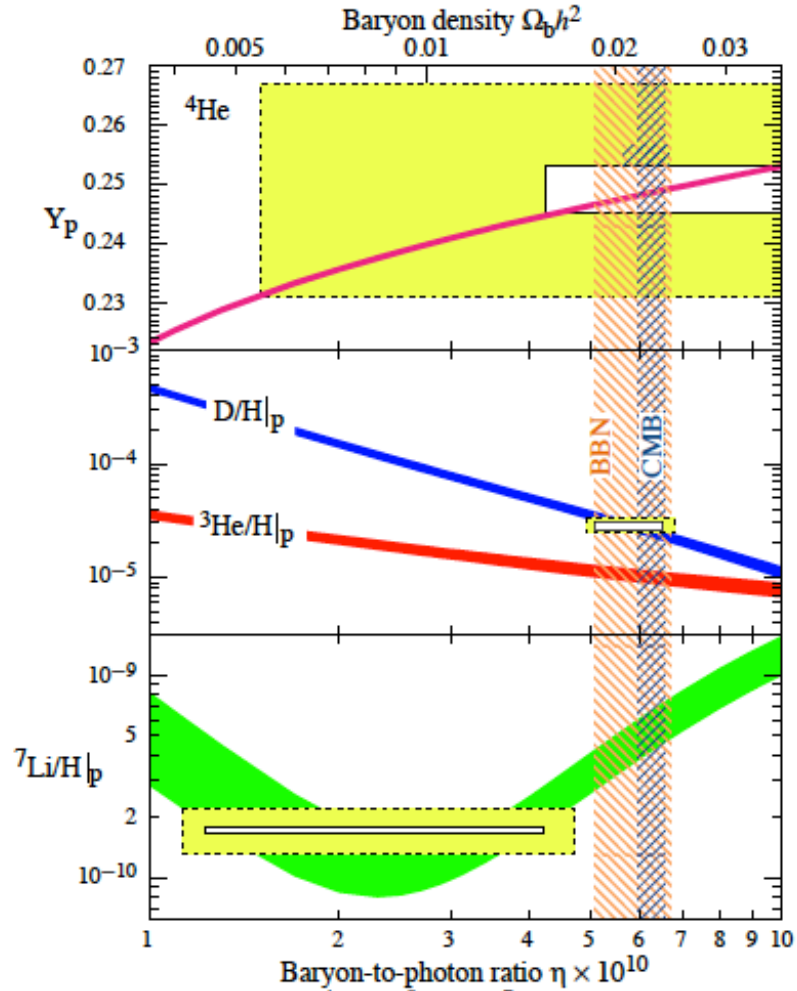


Figure 22.1: The abundances of ^{4}He, D, ^{3}He, and ^{7}Li as predicted by the standard model of Big-Bang nucleosynthesis [14] — the bands show the 95% CL range. Boxes indicate the observed light element abundances (smaller boxes: $\pm 2\sigma$ statistical errors; larger boxes: $\pm 2\sigma$ statistical *and* systematic errors). The narrow vertical band indicates the CMB measure of the cosmic baryon density, while the wider band indicates the BBN concordance range (both at 95% CL).

Three Alphas → ^{12}C (only in stars)

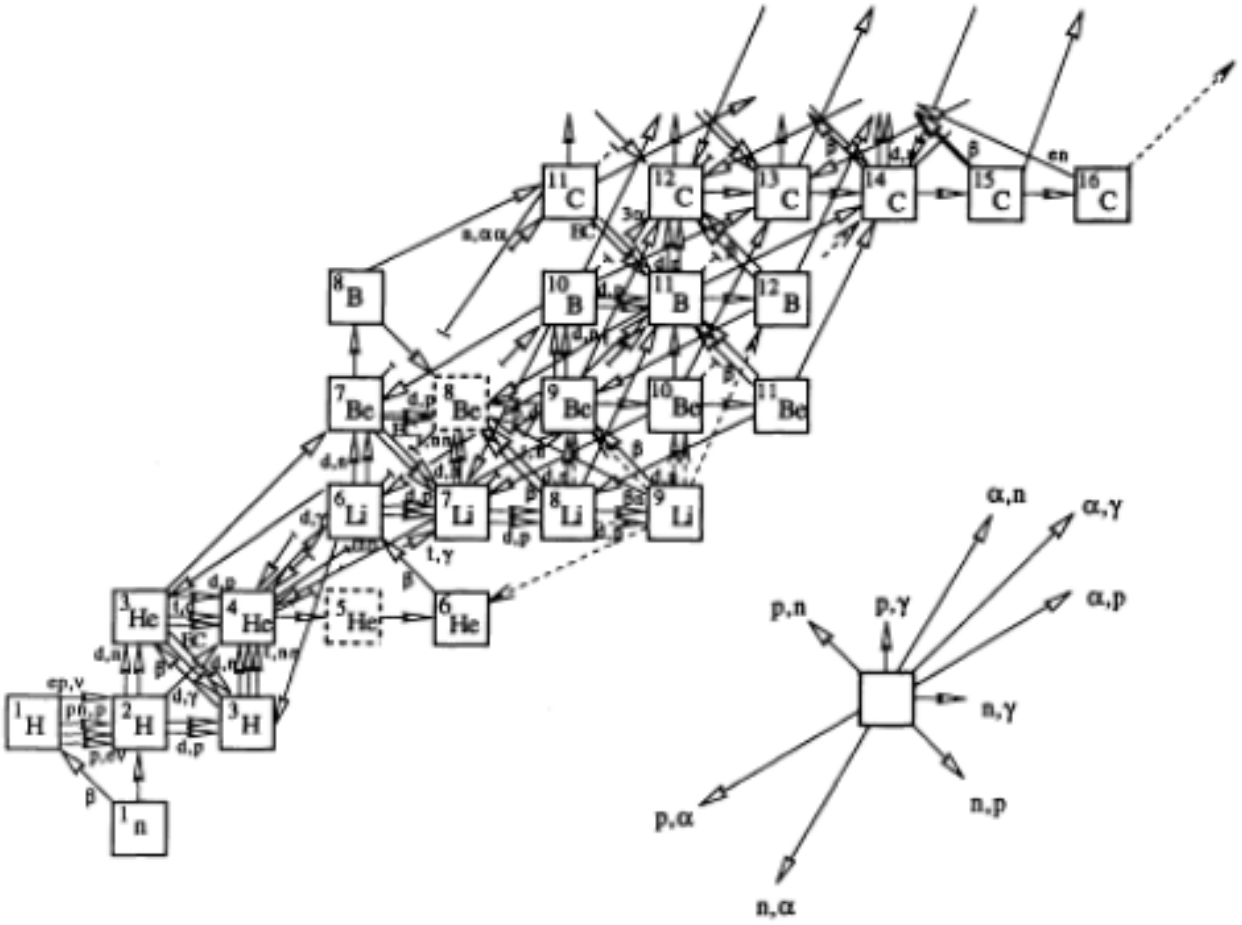


FIG. 1.—Reaction network used in the code. Estimated reactions are shown with dashed lines.

Is there any other way to get to Carbon 12 before recombination? Neutral Atoms?

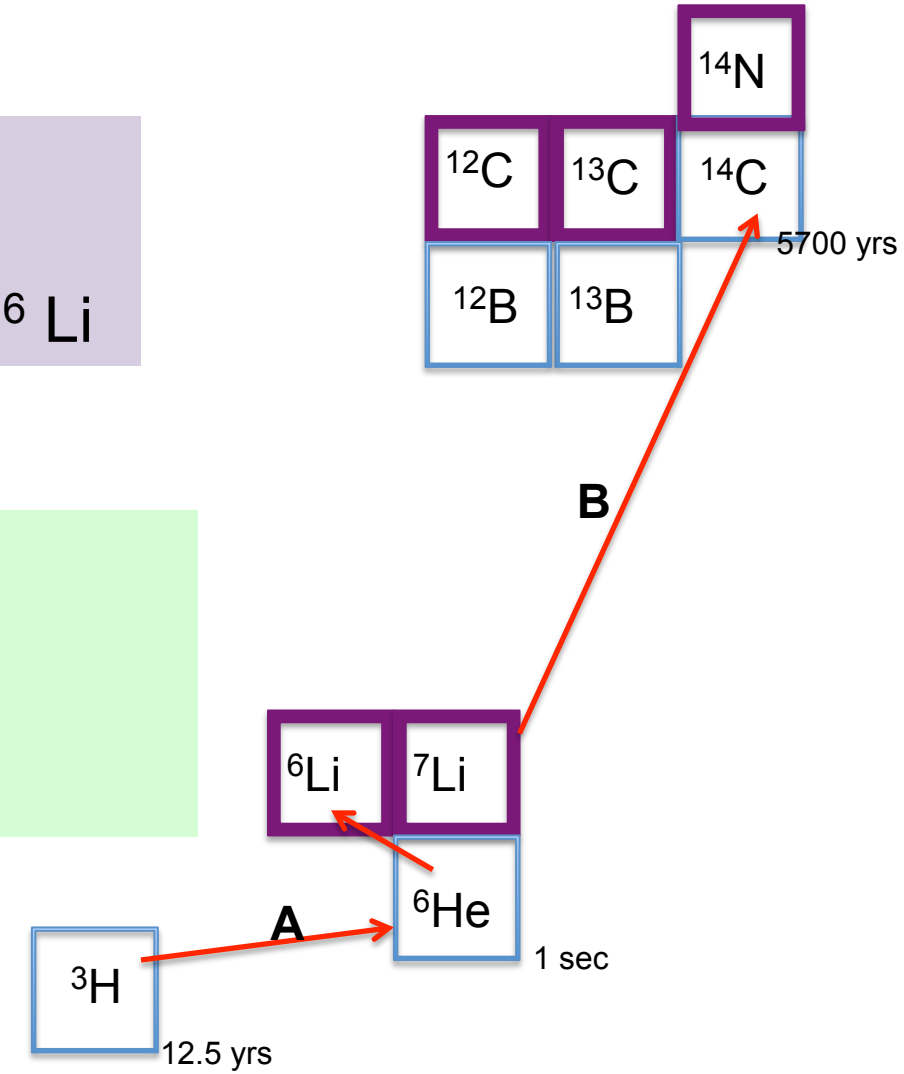
Early Fusion of Atoms?

A. To Generate ^{6}Li,

$^{3}H + {}^{3}H \rightarrow \gamma + {}^{6}He$; $^{6}He \rightarrow \beta^{-} + {}^{6}Li$

B. To Deplete ^{7}Li,

$^{7}Li + {}^{7}Li \rightarrow \gamma + {}^{14}C$



Summary

We wish to thank John Bohn for a helpful conversation concerning boson correlations.

In other presentations we have discussed the role of a massive photon in binding the Coma Cluster and in star formation in 30 Doradus.