UNIVERSE AS A HIGGS BOSON FACTORY

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CONTENT

✠ Cosmological models & SNeIa data

✠ CMB data evidences

✠ PARTICLE CREATION in CONFORMAL FLAT SPACE

$$ds^2 = a^2[d\eta^2 - d\mathbf{x}^2]$$

[A.A. Friedmann *The WORLD as Space & Time* 1924; Second Ed. 1965]

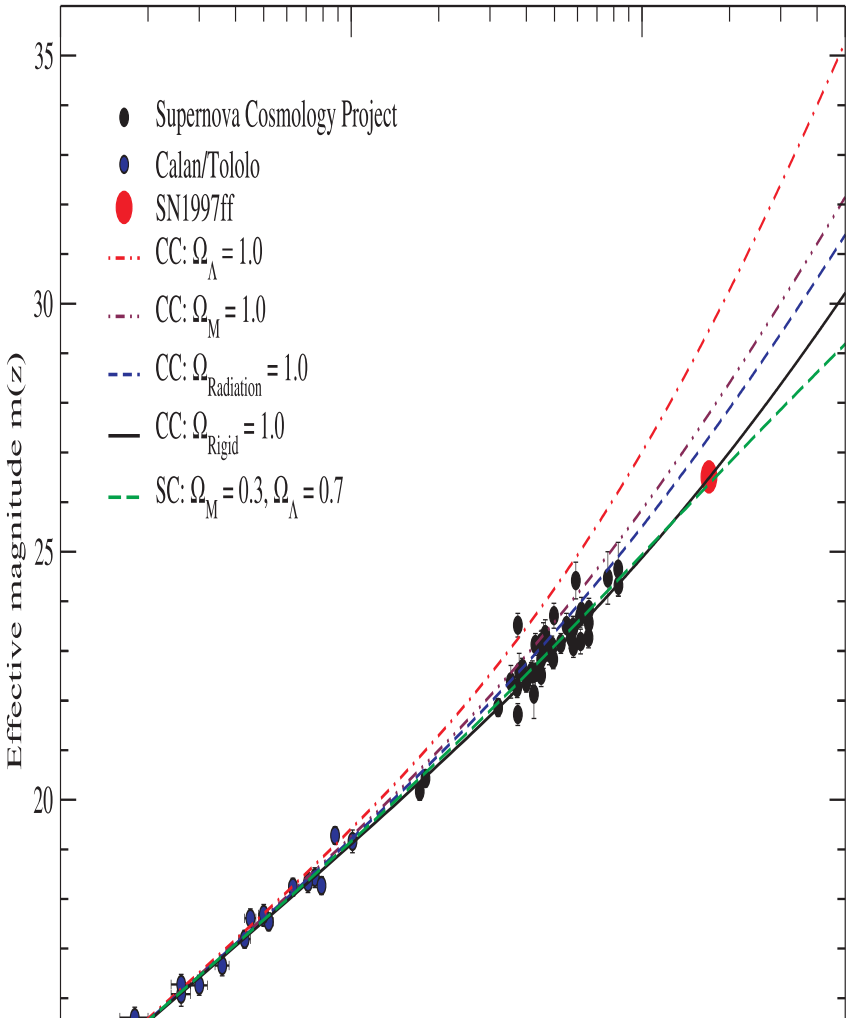
$$ds^2_{\rm Einstein} = a^2(\eta)[d\eta^2 - dr^2],\quad ds^2_{\rm conformal} = \frac{ds^2_{\rm Einstein}}{a^2} = [d\eta^2 - dr^2]$$

SHORT DISTANCES & LONG ONES

$$\boxed{R^{\rm SC}_{\rm SNeIa} = r_{\rm photon}\cdot a},\qquad a \leq 1 \qquad \boxed{R^{\rm CC}_{\rm SNeIa} = r_{\rm photon}}$$

$$\boxed{r_{\rm photon}(z) = \eta_0 - \eta = \int_{a_0=1}^{a=1/(1+z)} d\bar{a}\frac{1}{\sqrt{\rho_c(\bar{a})}}}$$

$$\rho_c(a) \equiv \rho_{\rm cr}\left[a^4\Omega_\Lambda + \Omega_{\rm R} + a\Omega_{\rm M} + \frac{\Omega_{\rm Rigid}}{a^2}\right] = \left[\frac{da}{d\eta}\right]^2$$



evolution of matter masses explains long Supernovae Distances $\boxed{\uparrow}$ $R_{\rm SNeIa}$ at z $\boxed{\rightarrow}$ via dominant kinetic energy of scalar field Q $R_{\rm SNeIa} = R_{\cdot_{\rm p=\rho=0.85\pm0.10}}(1+z)$, with

$$\boxed{r_{\rm horizon}(z) = H_0^{-1}(1+z)^{-2}}$$

[see black line]; whereas Standard Cosmology of evolution of space lenghs requires dominant scalar field potential energy $R_{\rm SNeIa} = R_{\Omega_\Lambda=0.7,\Omega_M=0.3}$ [see green line].

D. Behnke, *et al.* Phys. Lett. **B 530** (2002) 20;

A. Zakharov, V. Pervushin, Int. J. Mod. Phys. **D19** (2010) No.9

BASIS of CC is Dirac's DILATON theory:

$$W=\int d^4x\left[-\frac{\sqrt{-g}e^{-2D}}{6}R^{(4)}+e^{-D}\partial_\mu\left(\sqrt{-g}g^{\mu\nu}\partial_\nu e^{-D}\right)+\mathcal{L}_{\rm SM}\right]$$

P. Dirac, Proc. R. Soc. Lond., **A 333**, 403 (1973).

DIRAC'S DILATON GRAVITATION THEORY CAN EXPLAIN THE SNeIa DATA WITHOUT ATTRACTION OF THE INFLATION MODEL with ΛCD-MATTER.

A. Zakharov, V. Pervushin, *Conformal Cosmological Model Parameters with Distant SNe Ia Data: 'gold' and 'silver'*,
Int.Jour.Mod.Phys.(2010) **D 19** No. 9 arXiv:1006.4745 [gr-qc].

A. Arbuzov *et al.*, Phys. Lett. B **691**, 230 (2010)

PLANCK'S DISCRETE ACTION HYPOTHESIS in CC

$$|W_{\rm horizon}| = [\rho_{\rm cr}] \cdot V^{(4)}_{\rm horizon}(a_{\rm Pl}) = [M^2_{\rm Pl} H^2_0] \cdot r^4_{\rm horizon}(a_I) = \hbar$$

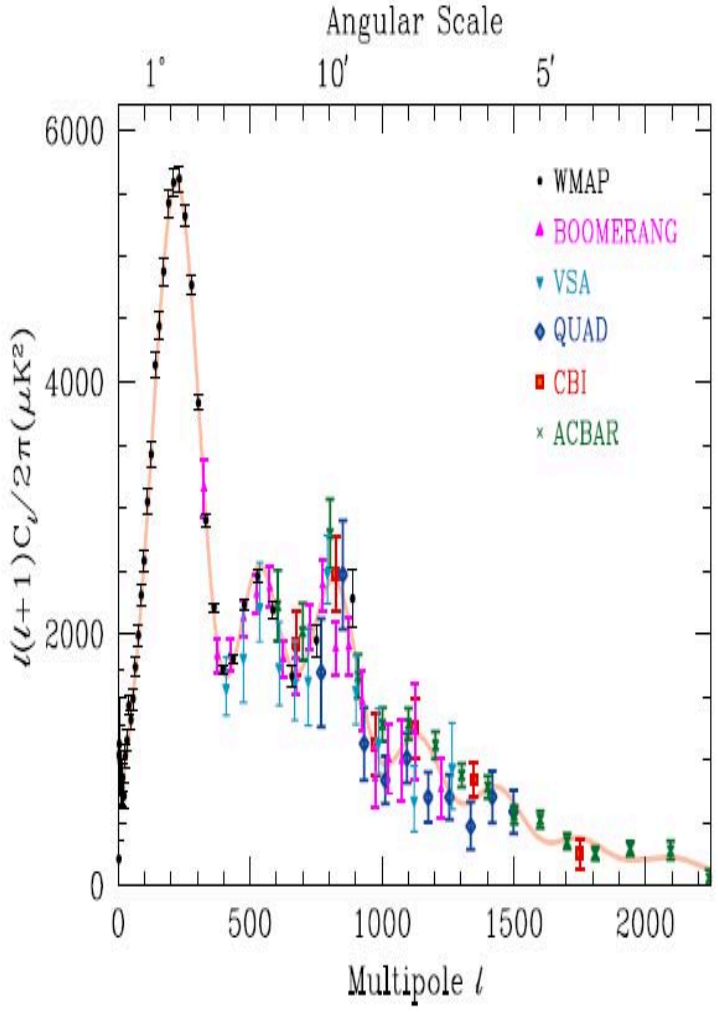
A.B. Arbuzov *et al.*, Phys. Lett. B **691**, 230 (2010)

✠ PLANCK's EPOCH $a^8_{\rm Pl} \dfrac{M^2_{\rm Pl}}{H^2_0} = 1 \qquad a_{\rm Pl} \sim 10^{-15}$

EW epoch: a single pair W^+W^- $\qquad \boxed{a_{EW} \sim \left[\dfrac{H_0}{M_{\rm W}}\right]^{1/3} \sim a_{\rm Pl}}$

CMB epoch: a single $\gamma_{\rm CMB}$ $\qquad \boxed{a_{CMB} \simeq \left[\dfrac{H_0}{T_{\rm CMB}}\right]^{1/2} \sim a_{\rm Pl}}$

Both they can explain CMB power spectrum by processes $h \to 2\gamma,\ W^+W^- \to 2\gamma,\ ZZ \to 2\gamma$.



CMB peaks $\frac{\triangle T_{\rm CMB}}{T_{\rm CMB}}$ $\boxed{\uparrow}$ at multipoles ℓ $\boxed{\rightarrow}$ REFLECT numbers of 2γ processes

$\boxed{h \to 2\gamma,\ \ell \simeq 220}$

$\boxed{W^+W^- \to 2\gamma,\ \ell \simeq 546}$

$\boxed{Z\ Z \to 2\gamma,\ \ell \simeq 800}$

at $r_{\rm horizon}$ and PREDICT the SM boson spectrum:

$$\boxed{\frac{M_Z}{M_W}=1.134\big|_{\rm hep} \approx \left(\frac{800}{546}\right)^{1/3}=1.136}$$

$$\boxed{M_h=2M_W\left[\frac{220.1}{546}\right]^{1/3}\approx 120\,{\rm GeV}}$$

WMAP DATA TEST Komatsu E. et al., Astrophys. J. Suppl. Vol. 180, 330 (2009)

In CC SNeIa is compatible with all epochs including Higgs PARTICLE CREATION at $a \to 0$, BUT NOT γ, f

in conformal flat space $\frac{ds^2}{a^2(\eta)} = [(d\eta)^2 - (d\mathbf{x})^2],\ M = aM_0$

$$W_\phi = \int d\eta \mathbf{L}_\phi = \int d\eta \int d^3x a^2(\eta) \frac{\phi'^2 - (\partial_j \phi)^2}{2};$$

$$\widetilde{\phi} = a(\eta)\phi = \sum_{\mathbf{k}} e^{i\mathbf{k}\cdot\mathbf{x}} \left[\frac{1}{2\omega_{\mathbf{k}}}\right]^{1/2} [\widetilde{\phi}^+_{\mathbf{k}} + \widetilde{\phi}^-_{-\mathbf{k}}];$$

$$\begin{cases} \widetilde{\phi}'^{\pm}_{\mathbf{k}} = \pm i\omega_{\mathbf{k}} \widetilde{\phi}^{\pm}_{\mathbf{k}} + H\widetilde{\phi}^{\mp}_{\mathbf{k}}, & \omega_{\mathbf{k}} = \sqrt{\mathbf{k}^2} \\ \widetilde{\phi}^+_{\mathbf{k}} = \alpha_{\mathbf{k}} b^+_{\mathbf{k}} + \beta^*_{\mathbf{k}} b^-_{\mathbf{k}}, & H = \frac{a'}{a} \end{cases}$$

PROBLEM $\boxed{< | : \mathbf{H}_\phi : | >= \sum_{\mathbf{k}} \omega_{\mathbf{k}} |\beta_{\mathbf{k}}|^2 = \infty ?}$

Opinions: the DIVERGENCE can be removed by means of

1. A non-STANDARD RENORMALIZATION OF THE IMAGINARY PART, [*A. A. Grib, S. G. Mamaev, and V. M.Mostepanenko, Quantum Effects in Strong External Fields (Energoatomizdat, Moscow, 1988)*]; [*A. A. Starobinsky, JETP Lett.* **73** *(2001)371*]

2. A SPECIFIC STATISTICAL DISTRIBUTION, [*V. Pervushin, D. Proskurin, and A. Gusev, Grav. Cosmol.* **8** *(2002) 181; D. Blaschke, et al. Phys. Atom. Nucl.* **67** *(2004) 1050*]

3. THE CHOICE OF LAGRANGIAN *D. Blaschke, et al. Phys. Atom. Nucl.* **68** *(2005) 1090*

OUR REPLY is $\boxed{<: |\mathbf{H}_\phi : | >= \sum_{\mathbf{k}} \omega_{\mathbf{k}} |\beta_{\mathbf{k}}|^2 = \omega_c |\beta_c|^2}$

$\boxed{\omega_c = \sum_{\mathbf{k}} \omega_{\mathbf{k}} = \widetilde{\omega}_c H_c = \widetilde{\omega}_c a'/a}$; is Casimir energy,

$\widetilde{\omega}_c = 0.035(box); 0.04617(sph.shell)$ [A.Actor,F.Phys.**43**(1995)141]

$|\beta_c|^2$ is B-occupation number of S.O. $\boxed{\Phi'^{\pm} = \pm i\omega_c \Phi^{\pm} - H\Phi^{\mp}}$

PROOF: Straightforward calculations leads to equations of Lagrangian $\mathbf{L}_\phi$, Hamiltonian $\mathbf{H}_\phi$, & Pfaffian $\mathbf{P}_\phi = \sqrt{\mathbf{H}_\phi^2 - \mathbf{L}_\phi^2}$ with respect to dilaton $\langle D \rangle = -\ln(a) = \ln(1+z)$

$$\begin{cases} \partial_{\langle D \rangle} \mathbf{H}_\phi = 2\mathbf{L}_\phi, \\ \partial_{\langle D \rangle} \mathbf{P}_\phi = 2e^{-2\langle D \rangle} \mathbf{L}_\phi, \\ \partial_{\langle D \rangle} \mathbf{L}_\phi = 2\mathbf{H}_\phi - 2e^{-2\langle D \rangle} \mathbf{P}_\phi, \end{cases}$$

$$[\mathbf{H}_\phi, \mathbf{L}_\phi, \mathbf{P}_\phi] \Longleftrightarrow [< | : \mathbf{H}_\phi : | >, < \mathbf{L}_\phi >, < \mathbf{P}_\phi >]$$

$$< | : \mathbf{H}_\phi : | > = < 0_b | \mathbf{H}_\phi | 0_b > - \underbrace{< 0_\phi | \mathbf{H}_\phi | 0_\phi >}_{\text{constant}}$$

These Eqs. coincide with the Bogoliubov ones of COLLECTIVE oscillator squeezed by DILATON

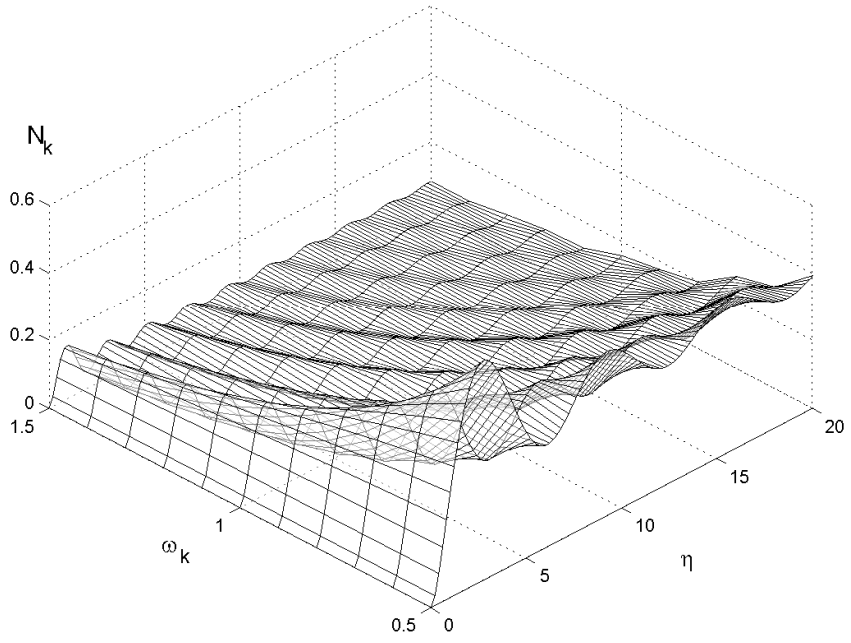
$$< | : \mathbf{H}_\phi : | > = \omega_{\rm so} < \widetilde{\phi}^+ \widetilde{\phi}^- >= \omega_{\rm so} \left[\frac{\cosh 2r_b}{2} - \frac{1}{2} \right],$$

$$< \mathbf{P}_\phi > = \frac{i\omega_{\rm so}}{4} < \widetilde{\phi}^- \widetilde{\phi}^- - \widetilde{\phi}^+ \widetilde{\phi}^+ >= \omega_{\rm so} \frac{\sinh 2r_b \sin 2\theta_b}{2}$$

$$< \mathbf{L}_\phi > = \frac{\omega_{\rm so}}{4} < \widetilde{\phi}^+ \widetilde{\phi}^+ + \widetilde{\phi}^- \widetilde{\phi}^- >= \omega_{\rm so} \frac{\sinh 2r_b \cos 2\theta_b}{2}$$

where $\omega_{\rm so} = \widetilde{\omega}_c H$ is the Casimir vacuum energy in the units of $H = \frac{a'}{a}$ and r_b, θ_b satisfy Bogoliubov eqs. of parameters of squeezing and rotation

$$\begin{aligned} r_b' &= H \cos 2\theta_b, \\ \omega_{\rm so} - \theta_b' &= H \coth 2r_b \sin 2\theta_b. \end{aligned}$$



This Figure, where
$\boxed{\nearrow}$ is time-axis of creation,
$\boxed{\uparrow}$ is number of bosons $N_{W,Z,h}$,
$\boxed{\searrow}$ is their momentum, shows us that the Universe was a factory of SM bosons W, Z, h at the Planck epoch $1 + z_{\rm Pl} \sim 10^{15}$.
This primordial boson density is very close to the Cosmic Microwave Background one.

SUMMARY

In the CONFORMAL SCENARIO, the QUANTUM UNIVERSE is a SET OF OSCILLATORS SQUEEZED by cosmological scale factor

THE VACUUM POSTULATE GIVES A SOURCE IN EQS.

& CREATION OF h, W, Z, g IN EARLY UNIVERSE

RESULTS:

✠ CC-coincidence: $a_{\rm Pl} \sim a_{EW} \sim a_{CMB}$

✠ INTENSIVE CREATION OF EW BOSONS & GRAVITONS at this instance with $E_{\rm Casimir}$ $<: |\mathbf{H}_\phi : | >= \sum_{\mathbf{k}} \omega_{\mathbf{k}} |\beta_{\mathbf{k}}|^2 = \omega_{\rm c} |\beta_{\rm c}|^2$

✠ WMAP DATA TEST for LHC

$$\frac{M_Z}{M_W} = 1.134\big|_{\rm hep} \approx \left(\frac{800}{546}\right)^{1/3} = 1.136$$

$M_h \approx 120\,{\rm GeV}$