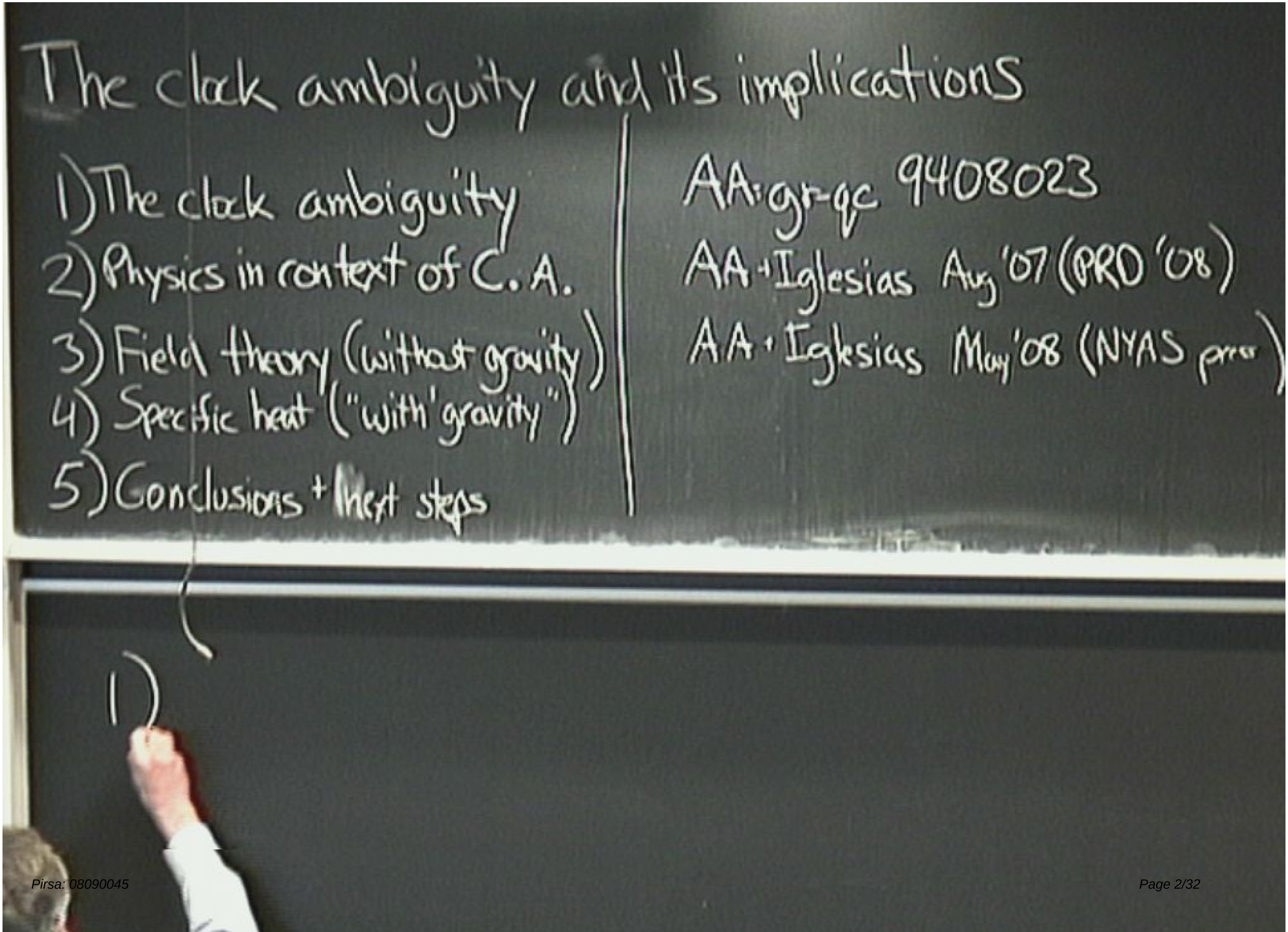
Title: The Clock Ambiguity and its Implications

Date: Sep 04, 2008 10:30 AM

URL: http://pirsa.org/08090045

Abstract:


The clock ambiguity and its implications
1) The clock ambiguity
2) Physics in context of C. A.
3) Field theory (without gravity)
4) Specific heat ("with" gravity")
5) Conclusions + next steps
AA: gr-qc 9408023
AA + Iglesias Aug '07 (PRD '08)
AA + Iglesias May '08 (NYAS proc)
1)

1) The clock ambiguity

$$H|\psi\rangle_s = 0$$

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$$S = C \otimes R$$

clock

rest

$$\{|t_i\rangle_c\}$$

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clock $\{|t_i\rangle_C\}$

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1) The clock ambiguity

$$H|\psi\rangle_S = 0$$

$$S = \underset{\text{clock}}{C} \otimes \underset{\text{rest}}{R}$$

$$\{|t_i\rangle_C\} \qquad \{|j\rangle_R\}$$

$$|\psi\rangle_S = \sum_{ij} \alpha_{ij} |t_i\rangle_C |j\rangle_R$$

$$|\phi(t_i)\rangle_R = \sum_j \alpha_{ij} |j\rangle_R$$

Prob of $|x\rangle_R$ at time t_3

$$\frac{\left|{}_R\langle x|\phi(t_3)\rangle_R\right|^2}{\left|\langle\phi(t_3)|\phi(t_3)\rangle\right|}$$

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Consider new state in $\mathbb{R}$ with new time evolution: α'_{ij}

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Consider new state in R with new time evolution: α'_{ij}

$$|\psi'\rangle_S = \sum_{ij} \alpha'_{ij} |t_i\rangle_C |j\rangle_R$$

$$M|\psi\rangle_S = |\psi'\rangle_S$$

define

$$|k\rangle_S = |t_i\rangle_C |j\rangle_R$$

$k(i,j)$

$$|\psi'\rangle = \sum_k \alpha'_k |k\rangle_S$$

$$M^{-1}|\psi'\rangle = \sum_k \alpha'_k M^{-1}|k\rangle_S$$

$$|\psi'\rangle_S = \sum_k \alpha'_k \, |k\rangle_S$$

$$M^{-1}|\psi'\rangle_S = \sum_k \alpha'_k \, \underbrace{M^{-1}|k\rangle_S}_{\equiv\, |k'\rangle_S}$$

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$$M^{-1}|\psi'\rangle_S = \sum_k \alpha'_k \underbrace{M^{-1}|k\rangle_S}_{\parallel}$$

$$|k'\rangle_S$$

$$|\psi\rangle_S = \sum_k \alpha'_k |k'\rangle_S$$

$$\equiv \sum_k \alpha'_{ij} |i\rangle_{C'} |j\rangle_{R'}$$

2) Physics w/ C. A.

Quasiseparability

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Quasiseparability $\Rightarrow$ locality

$$H = \int d^3x\, \mathcal{H}(x)$$

3 Field Theory (without gravity)

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→ Random H

$$\frac{dN}{dE} = a \frac{N_R}{E_m} \sqrt{1 - \left(\frac{E}{E_m}\right)^2}$$

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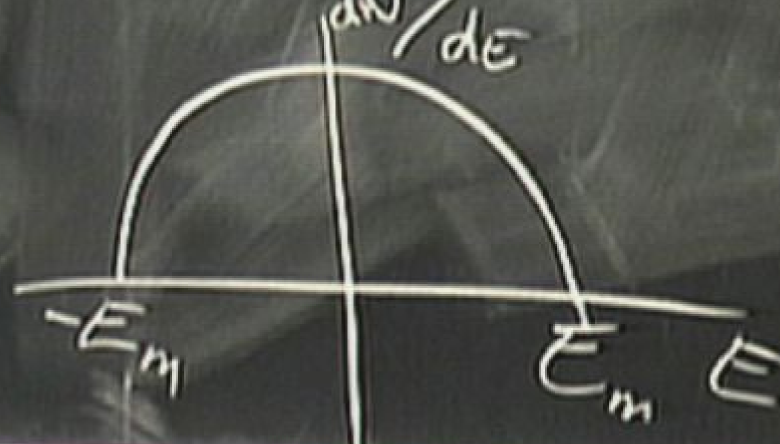
Wigner semicircle



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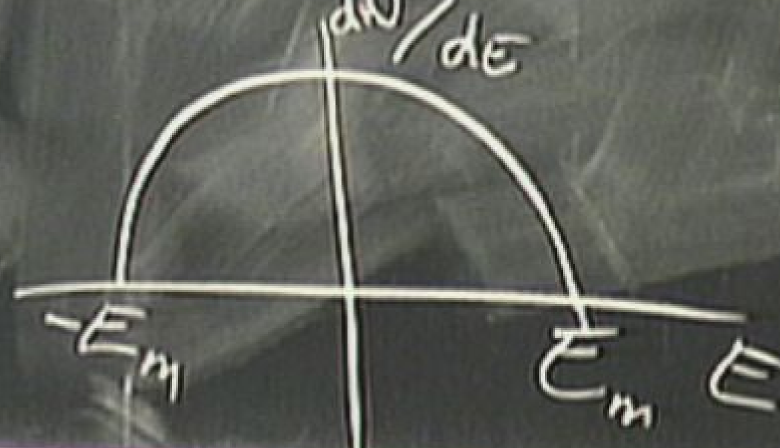

$$\left.\frac{dN}{dE}\right|_{FT} = \frac{B}{E} \exp\left\{ b \left(\frac{E}{\Delta k} \right)^{\alpha} \right\}$$

FT regulator $= \Delta k = \dfrac{2\pi}{L}$

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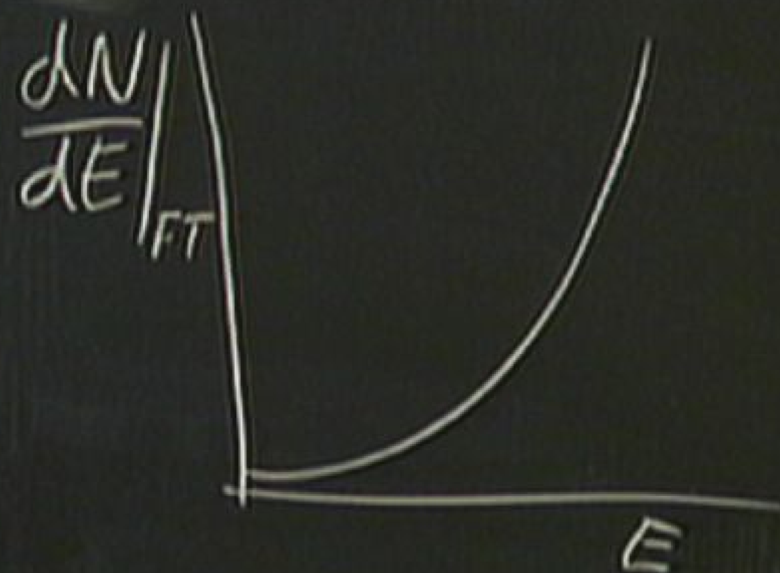
CFT: $\alpha = (d-1)/d$

Verlinde: $\alpha(d) = 1/2$



0^{th} order equality:

with new

$$N_R = \left[\frac{B}{\frac{2}{\pi}\left[1-\left(\frac{E_0-E_s}{E_m}\right)^2\right]^{1/2}} \frac{E_m}{E_0} \right] \exp\left\{ b\left(c\,\frac{E_0}{\Delta k}\right)^{\alpha} \right\}$$

1^{st} (and 0^{th}) order

$$\frac{E_0}{E_0-E_s}\,\frac{\left(\frac{E_0-E_s}{E_m}\right)^2}{\left(1-\underbrace{\left[\frac{E_0-E_s}{E_m}\right]^{\lambda}}_{\ll 1}\right)} = \alpha\Phi\left(C\frac{E_0}{\Delta k}\right)^{\alpha}$$

1^{st} (and 0^{th}) order

$$\frac{E_0}{E_0-E_S}\,\frac{\left(\frac{E_0-E_S}{E_m}\right)^2}{\left(1-\underbrace{\left[\frac{E_0-E_S}{E_m}\right]}_{\varepsilon\,\to\,1}\right)} = \alpha b\left(c\frac{E_0}{\Delta k}\right)^{\alpha}$$

$$E_S = E_0 + E_m(1-\varepsilon)$$

2nd Order

$$\frac{\left(\left.\frac{dN}{dE}\right|_{FT} - \left.\frac{dN}{dE}\right|_{R}\right)_2}{\left.\frac{dN}{dE}\right|_{E_0}} \simeq \left(\left(\frac{E_0}{\Delta_R}\right)^{\alpha} \frac{\Delta E}{E_0}\right)^2 \equiv \Delta_2$$

α	ΔK (GeV)	ΔE (GeV)	Δ_2
1/2	10^{-25}	10^{3}	$10^{-24.5}$
1/2	10^{-25}	10^{11}	$10^{-16.5}$
1/2	10^{-42}	10^{3}	10^{-16}
1/2	10^{-42}	10^{11}	10^{-8}
3/4	10^{-25}	10^{3}	$10^{1.8}$
3/4	10^{-25}	10^{11}	$10^{9.8}$
3/4	10^{-42}	10^{3}	$10^{14.5}$
3/4	10^{-42}	10^{11}	$10^{22.5}$
1	10^{-25}	10^{3}	10^{28}
1	10^{-25}	10^{11}	10^{36}
1	10^{-42}	10^{3}	10^{45}
1	10^{-42}	10^{11}	10^{53}

$$E_0 = \rho_\Lambda R_H^3 = 10^{80}\,\mathrm{GeV}$$

$$\Delta k = m_\gamma = 10^{-25} \text{ or } = H_0 = 10^{-42}\,\mathrm{GeV}$$

$$\Delta E = E_{ca} = 10^{3}\,\mathrm{GeV}$$

or

$$= E_{UHECR} = 10^{11}\,\mathrm{GeV}$$

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1/2	10^{-25}	10^{3}	$10^{-24.5}$
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3/4	10^{-25}	10^{3}	$10^{1.8}$
3/4	10^{-25}	10^{11}	$10^{9.8}$
3/4	10^{-42}	10^{3}	$10^{14.5}$
3/4	10^{-42}	10^{11}	$10^{22.5}$
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1	10^{-25}	10^{11}	10^{36}
1	10^{-42}	10^{3}	10^{45}
1	10^{-42}	10^{11}	10^{52}

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$$\Delta E \sim \frac{1}{\delta t}$$

S''

$S_U = \sum S_i$

$$S''$$

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$$S''_{wig} = -\frac{1}{8}$$

$$S''$$

with new tim

$$S_U = \sum S_i$$

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Dominated by

$$S''_{DM} = \pm 10^{-2}\ \mathrm{GeV}$$