

ANDRZEJ DRAGAW / WARSAW

FILIP KIAŁKA / WIENNA ($\xi = \frac{L}{2\pi}$)

ALEX SMITH / WATERLOO

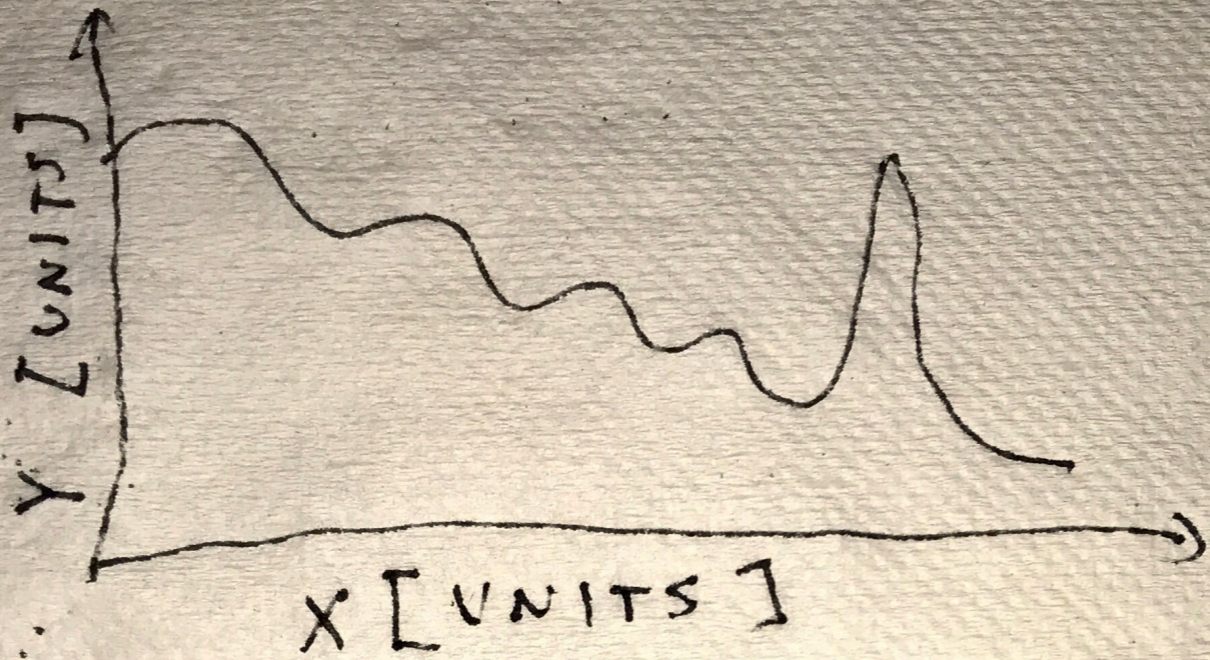
MEHD AHMADI / CALGARY

ABSTRACT

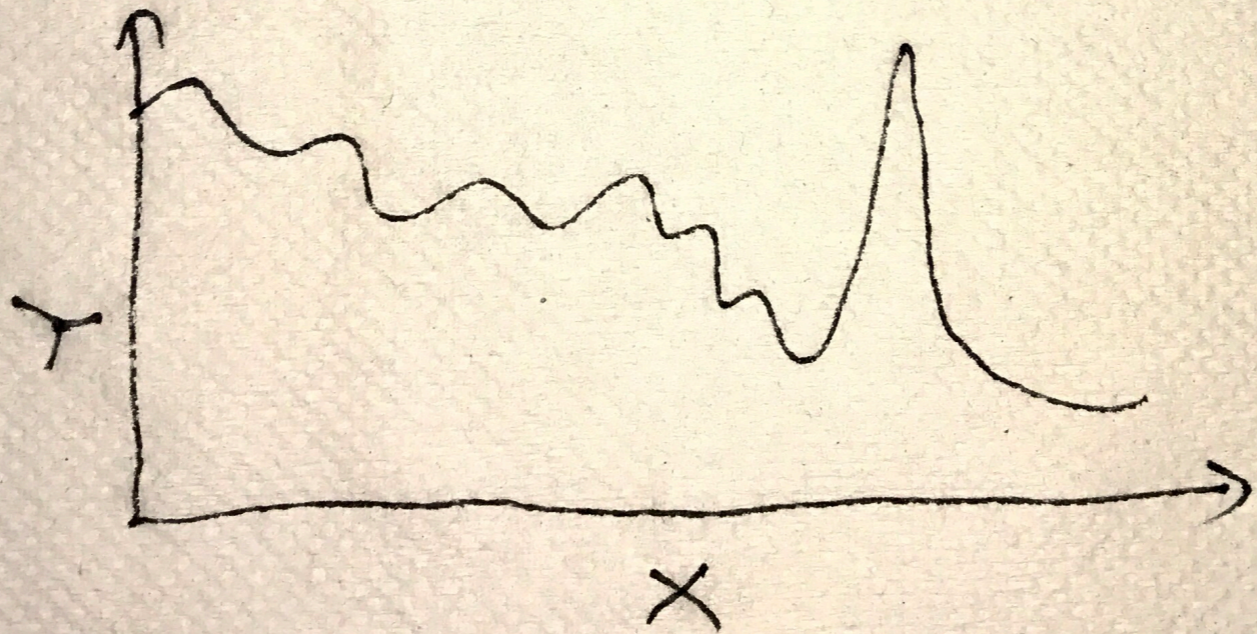
THE UNRUH EFFECT FOR MASSIVE
FIELDS WILL NOT BE MEASURED.

MASSIVE UNRUH PARTICLES CAN
ONLY BE FOUND IN A TINY LAYER
ABOVE THE EVENT HORIZON
THAT IS ONLY COMPTON
WAVELENGTH THIN.

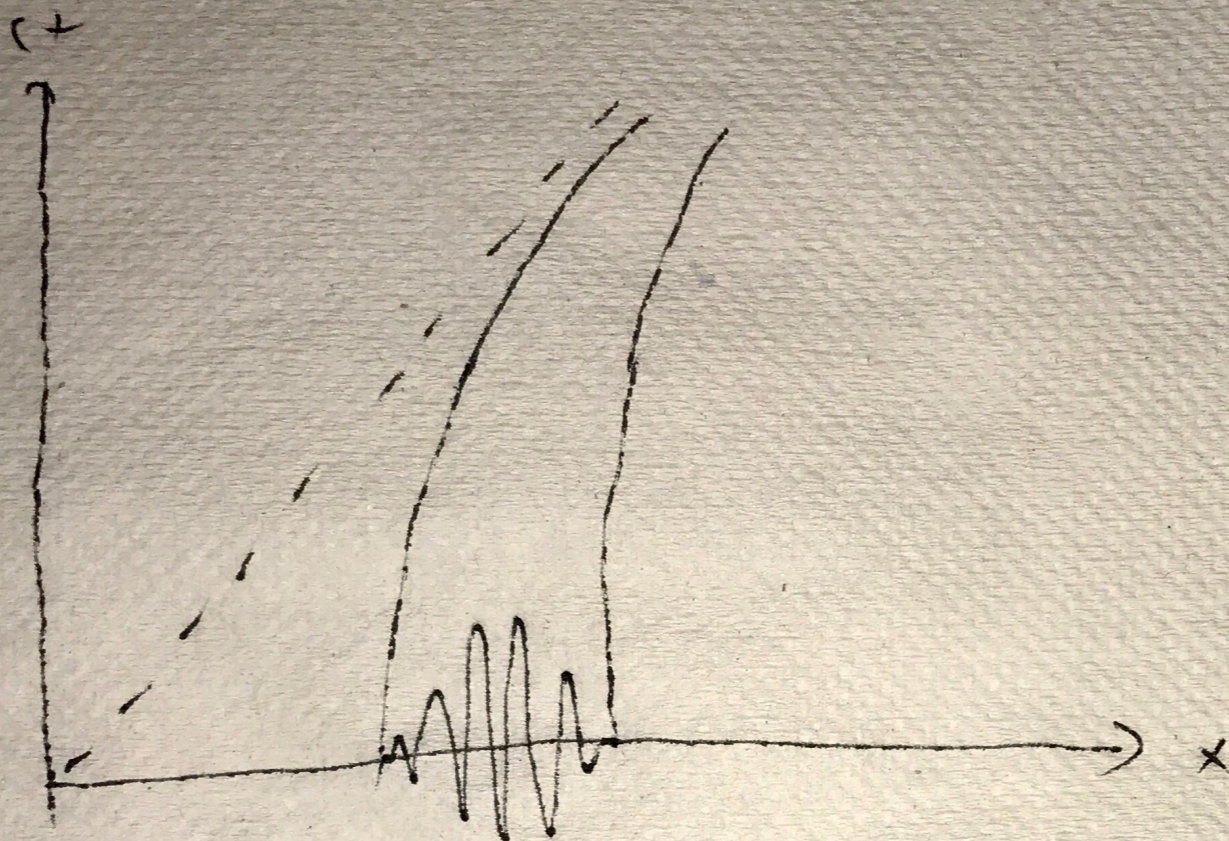
A TYPICAL PLOT IN A PHYSICS PAPER:



A TYPICAL PLOT IN AN RQI PAPER:



WITHIN A SINGLE WAVEPACKET:

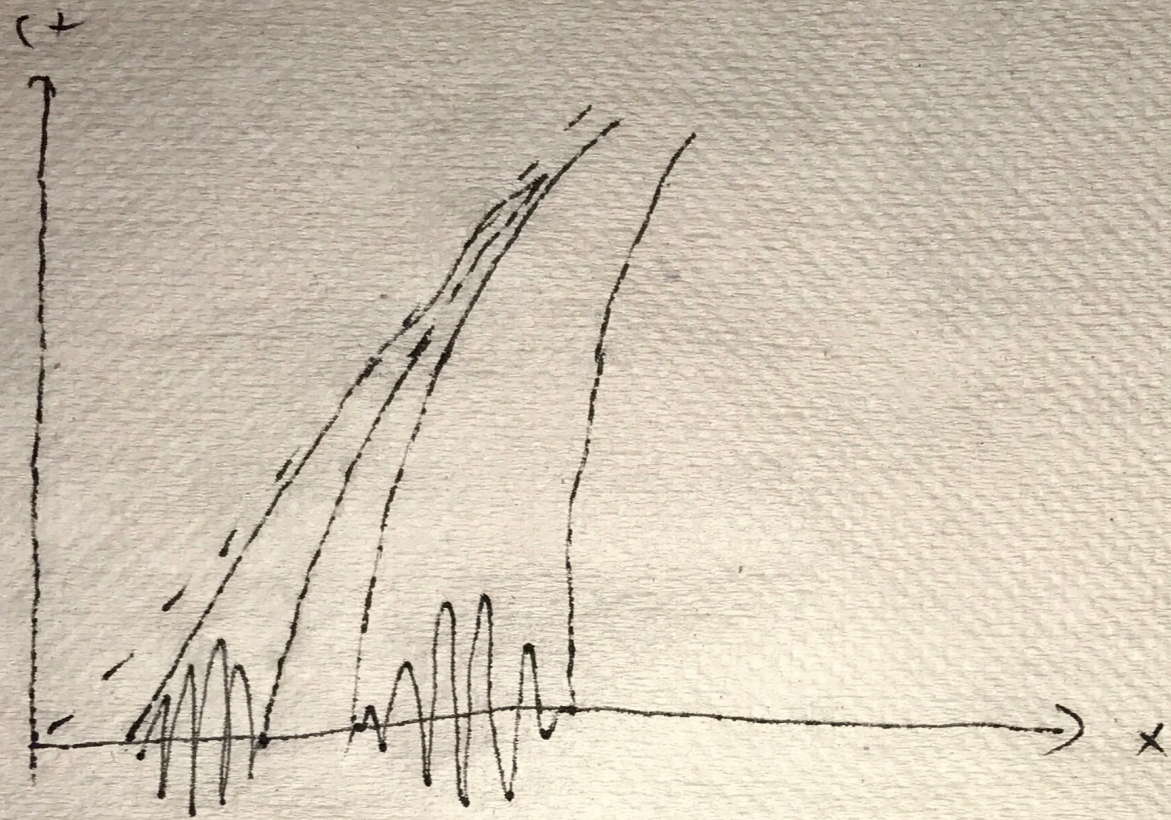


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Restoring the powers of \hbar, c , gives $a_1 \gtrsim mc^3/\hbar$, which

WITHIN A SINGLE WAVEPACKET:



HOW MANY UNRUH PARTICLES
CAN BE FOUND IN A 1m^3 BOX?

$$\hat{\phi}^+ \equiv \int d^3k \, u_k \hat{a}_k$$

$$\hat{N} \equiv \int d^3k \, \hat{a}_k^+ \hat{a}_k$$

MANDEL:

$$\hat{A} \equiv \int d^3k \, \sqrt{2\omega_k} \, u_k \hat{a}_k$$

$$N_1(V) \equiv \int_V d^3x \, \hat{A}^+ \hat{A}$$

$$u_k \rightarrow w_k, \quad \omega_k \rightarrow \Omega, \quad \hat{a}_k \rightarrow \hat{b}_k$$

IN PARTICULAR: $\hat{N}_1(\mathbb{R}^3) = \hat{N}$

BUT SUCH CONSTRUCTION ISN'T UNIQUE.

$$\begin{aligned}\hat{N} &= \int d^3k a_k^\dagger a_k = \int d^3k (\hat{\phi}^\dagger, \mu_k) (\mu_k, \hat{\phi}^\dagger) \\ &= (\hat{\phi}^\dagger, \hat{\phi}^\dagger) = \int d^3x i \hat{\phi}^- \overset{\leftrightarrow}{\partial}_t \hat{\phi}^+\end{aligned}$$

WHICH SUGGEST ANOTHER DEFINITION:

$$\hat{N}_2(V) \equiv \int_V d^3x i \hat{\phi}^- \overset{\leftrightarrow}{\partial}_t \hat{\phi}^+$$

$$\text{ALSO: } \hat{N}_2(\mathbb{R}^3) = \hat{N}.$$

EASY TO GENERALIZE.

$$t \rightarrow \tau, \quad \pm \text{ MINKOWSKI} \rightarrow \pm \text{ RINDLER}$$

$$\text{MOREOVER, } \hat{N}_1(v) = \hat{N}_2(v) \quad \forall |v\rangle:$$

$$\langle \psi | \hat{b}_{\Omega}^{\dagger} \hat{b}_{\Omega'} | \psi \rangle \sim \delta(\Omega - \Omega')$$

TAKE A 1m^3 ACCELERATING BOX

$$\langle 0 | \hat{N}_2(\nu) | 0 \rangle_M = \frac{S_{\perp}}{2\pi^3} \int d\Omega dk_{\perp} k_{\perp} \tilde{\Omega} e^{-\pi\Omega} \\ \times \int_{x_1}^{x_2} \frac{d\chi}{\chi} K_{i-\Omega}^2 \left(\sqrt{k_{\perp}^2 + m^2} \chi \right).$$

$\Omega \gg 1$ DO NOT CONTRIBUTE

$\Omega \lesssim 1 \Rightarrow \forall \chi \gg 1 \quad K_{i-\Omega}^2(x) \approx 0.$

$$\Rightarrow 1 \gtrsim \sqrt{k_{\perp}^2 + m^2} \chi \gtrsim m\chi$$

$$\Rightarrow \chi \lesssim \frac{\hbar}{mc} = \lambda_C$$



$$\Rightarrow X \approx \frac{1}{m} X = X$$

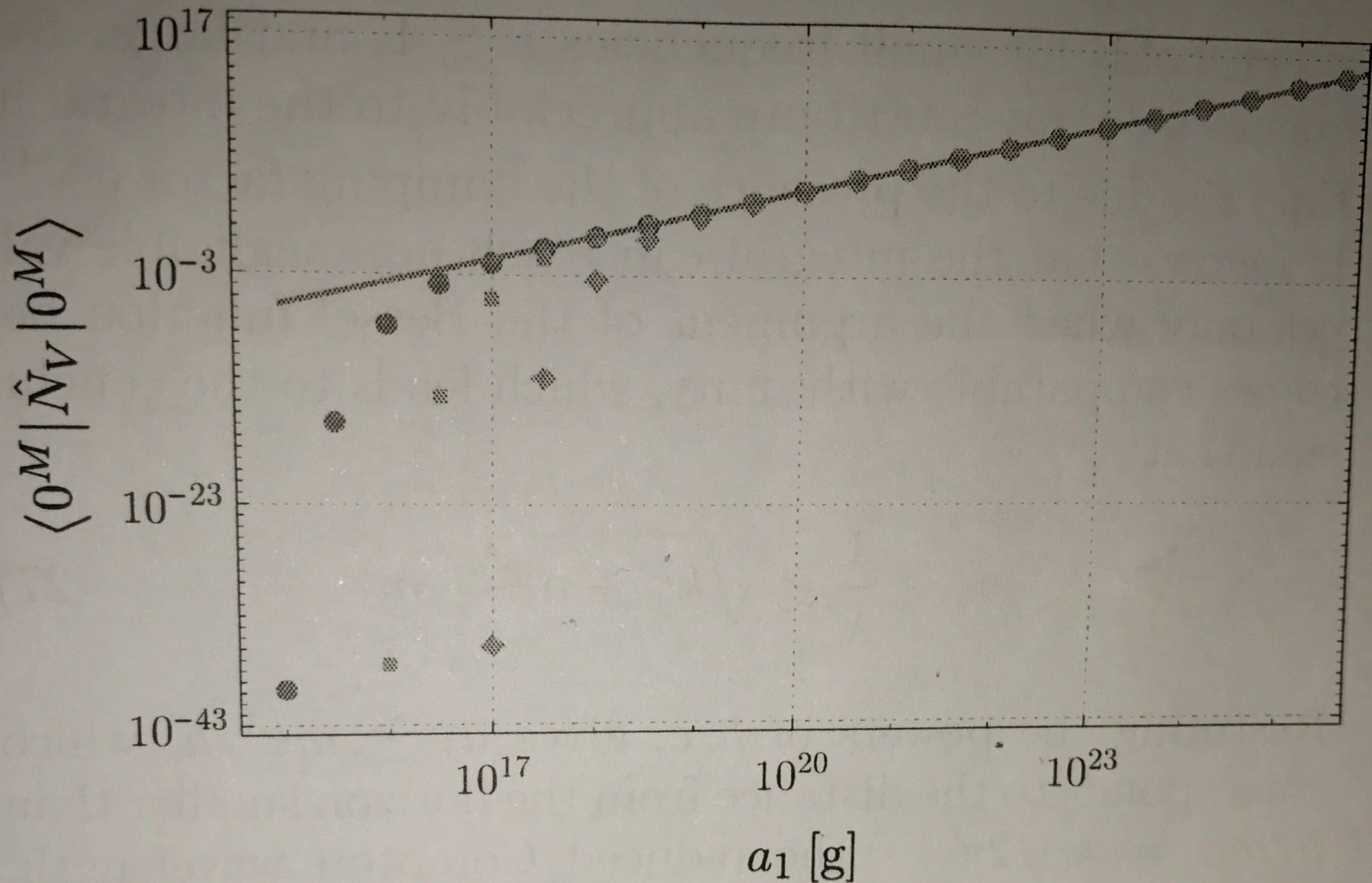


FIG. 2. Average number of massive Unruh particles in a 1m^3 box as a function of its proper acceleration. The field mass is $m = 10^{-11} m_e$ (dots), $m = 10^{-10} m_e$ (squares), and $m = 10^{-9} m_e$ (diamonds), corresponding to Compton wavelengths $\lambda_C \approx 0.2\text{m}$, $\lambda_C \approx 0.02\text{m}$, and $\lambda_C \approx 0.002\text{m}$, respectively. The continuous line is the high-acceleration limit given by Eq. (35) and (36).

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The background of the image is a dense, textured surface of crumpled, light-colored paper or fabric. The material is heavily wrinkled and folded, creating a complex pattern of shadows and highlights. The overall color is a pale, off-white or light beige. In the center of the image, the words "Thank you." are written in a bold, red, sans-serif font. The text is centered horizontally and vertically, standing out prominently against the busy, textured background. There are some faint, illegible markings on the paper, such as "no" in the bottom left and some scribbles on the right side.

Thank you.