

# Measuring Carcinogens in Yuffa's lungs

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## Contents

<b>1</b>	<b>Introduction</b>	<b>2</b>
<b>2</b>	<b>Theory</b>	<b>2</b>
<b>3</b>	<b>Experiment</b>	<b>3</b>
<b>4</b>	<b>Data Anal</b>	<b>4</b>
<b>5</b>	<b>Conclusion</b>	<b>5</b>
<b>6</b>	<b>About the author</b>	<b>6</b>

## List of Figures

1	The rectangular barrier potential of width $2\ell$ and height $V_0$ . . . . .	3
2	The setup used. Not that the gamma ray emitter looks like a CD player . . . . .	4
3	Density of carcinogens in Yuffa as a function of depth . . . . .	4
4	Dan in the first Mines jazz concert featuring accordion . . . . .	6

### Abstract

Yuffa's lungs were bombarded with high-energy radiation to detect the carcinogens present. He claims to have been smoking since he had been around the sun 12 times, but I thought he was full of crap (pardon the pun). The purpose of this is to analyse the data collected, and determine if Yuffa is, in fact, a liar or was just an unintelligible pre-teen.

## List of Tables

# 1 Introduction

## What is inverse scattering?

In the mid-1960s, an important new class of transformation techniques was discovered. This transform, called scattering transform, is capable of producing exact solutions for a small group of nonlinear evolution equations. The idea of this transform is to view the solution  $q(x, t)$  of the equation to be solved as the potential of the Schrödinger equation

$$-\frac{d^2u}{dx^2} + q(x, t)u = \lambda u \quad (1)$$

For each fixed time  $t$ , we study the scattering problem and the reflection and transmission coefficients and the bound states. Then, as time evolves, the potential  $q(x, t)$  (and hence its scattering data) evolves as well. Now, the amazing thing we discover is that there are certain equations for which the evolution of the scattering data is diagonalized, that is, the scattering data for a given frequency evolves independent of all other frequencies. Thus, instead of studying directly the evolution of  $q(x, t)$ , we study the evolution of the scattering data, which is described by separated, linear differential equations whose solutions are easily obtained, and from this information we can construct  $q(x, t)$ . To make any transformation work[2], we must know how to transform functions and also how to invert the transform. For the Schrödinger equation, we know how, at least in principle, to transform potentials  $q(x)$  by using scattering data. A natural question to ask is if one can reconstruct a potential  $q(x)$  from knowledge of its scattering data. This is an important problem, not only in the context of the Schrödinger equation, but in many other applications such as x-ray tomography, seismic exploration, radar imaging, medical imaging, etc., where the shape of an object must be determined from indirect information, such as the way waves are reflected or transmitted by the object. We will discuss only the problem of reconstructing the potential of the Schrödinger equation, with the realization that this is but a small part of the important field of inverse imaging problems in which there is still much active research and development.

## 2 Theory

$$-\frac{\hbar^2}{2m} \frac{d^2\psi}{dx^2} + V\psi = E\psi \quad (2)$$

$$V_s = \frac{V}{\frac{\hbar^2}{2mb^2}}, \quad E_s = \frac{E}{\frac{\hbar^2}{2mb^2}}, \quad x_s = \frac{x}{b} \quad (3)$$

$$-\frac{d^2\psi}{dx_s^2} + V_s\psi = E_s\psi \quad (4)$$

$$V_s(x_s) = \begin{cases} 0 & : x_s \leq -\ell \\ V_0 & : -\ell < x_s < \ell \\ 0 & : x_s \geq \ell \end{cases} \quad (5)$$

$$T = \frac{1}{1 + \frac{V_0^2}{4E_s(E_s - V_0)} \sin^2 \sqrt{E_s - V_0}} \quad (6)$$

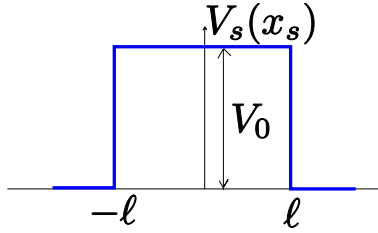


Figure 1: The rectangular barrier potential of width  $2\ell$  and height  $V_0$

$$M = \begin{pmatrix} M_{11} & M_{23} \\ M_{21} & M_{22} \end{pmatrix} \quad (7)$$

$$M = M_1 M_2 \quad (8)$$

### 3 Experiment

In this experiment, I used high energy radiation (Gamma Rays) to map the carcinogens in Yuffa's lungs. Normally, high energy radiation is not used on biological tissues because it destroys them, but that was not a concern in this experiment for obvious reasons.



Figure 2: The setup used. Not that the gamma ray emitter looks like a CD player

## 4 Data Anal

The graph below effectively illustrates the average amount of carcinogens in Yuffa's chest as a function of depth.

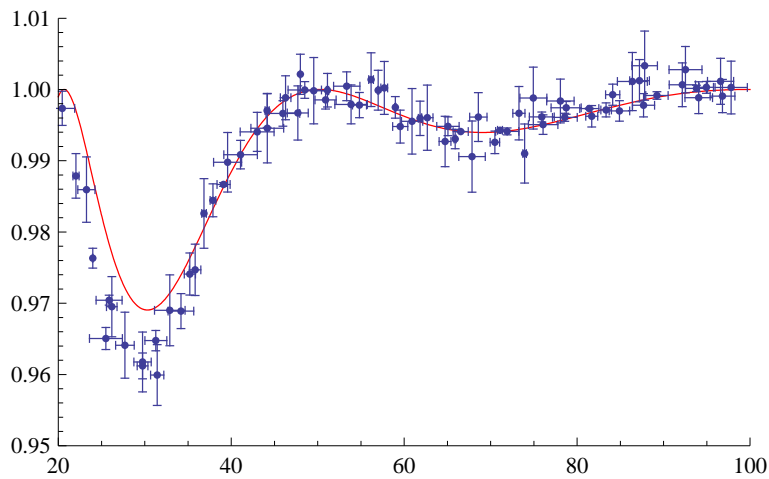


Figure 3: Density of carcinogens in Yuffa as a function of depth

The density of carcinogens is high on the surface do to poor ventiation of smoke around the time of inhalation, which explains certain smells that I often though emminated from the computer. The density becomes low in the sternum, as it is not exposed

to any smoke, and high again in the lungs, where the smoke is absorbed and contained. The best fit equation describing this, which is somewhat accurate, is equation (6) with  $V_0 = 10.8$ .

## 5 Conclusion

Alex Yuffa indeed has a high probability of having smoked since he had traveled around the sun 12 times, meaning he is telling the truth for once. The rectangular barrier potential (Yuffa's chest) could not be determined from the transmission coefficient, though the amount of tar within would probably stop and projectile from going all the way through him (that is, he would make a good shield).

## 6 About the author



Figure 4: Dan in the first Mines jazz concert featuring accordion

Dan is a narcissistic sesquipedlian. 'Nuff said.[1]

## References

- [1] James P. Keener, Principles of Applied Mathematics, (Perseus Books, 2000).
- [2] David J. Griffiths, Introduction to Quantum Mechanics, (Prentice Hall, 1995).