Fundamentos da Física Quântica

e

Eurítmica

.

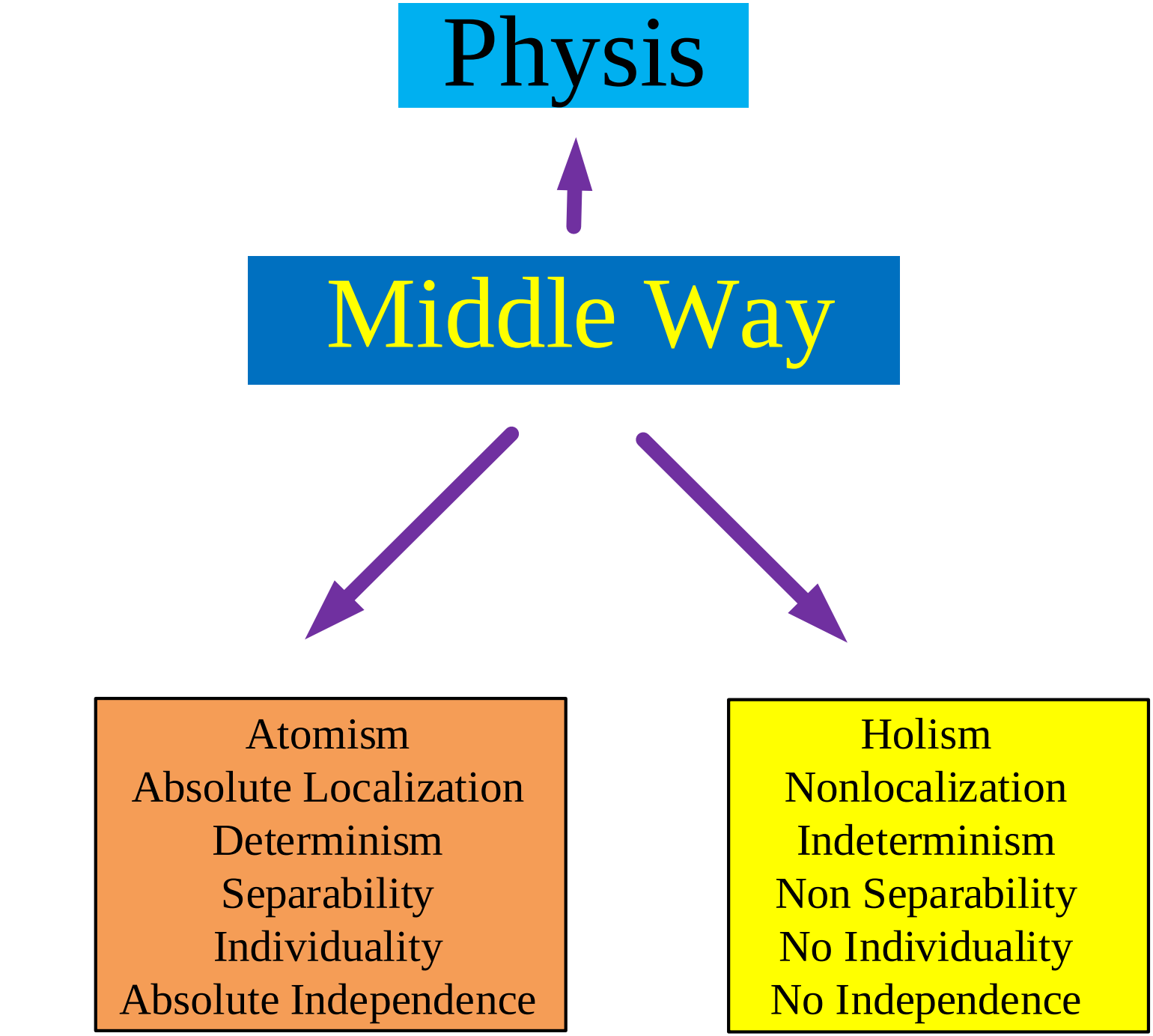
JR Croca

Departamento de Física Faculdade de Ciências
Centro de Filosofia das Ciências Universidade de Lisboa
Campo Grande Ed. C8
1749-016 Lisboa Portugal
email: croca@fc.ul.pt

Início: 19 de Janeiro de 2021

Física Eurítmica
Hiperfísica

Desenvolvida na linha
de investigação
do grande físico francês
Louis de Broglie


Physis
Middle Way
Atomism
Absolute Localization
Determinism
Separability
Individuality
Absolute Independence
Holism
Nonlocalization
Indeterminism
Non Separability
No Individuality
No Independence

Einstein, de Broglie, Schrödinger,
Max Planck e outros

sempre se opuseram ao
indeterminismo e idealismo
da Mecânica Quântica Ortodoxa

Deste vasto esforço
o mais bem sucedido foi devido ao físico
francês Louis de Broglie
que conseguiu desenvolver uma teoria
que esteve na origem da

Física Eurítmica
ou
Hyperphysica

Contendo como caso particular a

Física Quântica não-linear

Que por sua vez contém
do ponto de vista previsional a
mecânica quântica ortodoxa

No entanto todos estes
esforços para recuperar a

Causalidade, Localidade e Individualidade

Foram feitos dentro da

Ontologia de Fourier

não-local e não-temporal

por isso,

estavam
inevitavelmente condenados logo
desde o início
ao fracasso
ou, na melhor das hipóteses,
apenas a um sucesso parcial

Estes factos levam-nos a concluir que
Niels Bohr
procedeu com grande habilidade
ao promover o instrumento matemático
desenvolvido por Fourier
de uma simples regra
de composição de funções
a um estatuto fundamental

permitindo assim obter
a não-localização intrínseca
a omnipresença
dos sistemas físicos
abrindo a porta para
a possibilidade da negação
da Realidade Objectiva

Agora, que estamos distanciados no tempo

podemos compreender devidamente
as dificuldades
enfrentadas por todos aqueles
que lutaram para manter a

CAUSALIDADE

na

Física

Exemplo

Estou de carro na Praça de Espanha
Pretendo ir para o Cascais

Engano-me na saída

e quando dou por mim
estou praticamente na Ponte 25 de Abril
Sei que estou mal!!!!
Mas por mais que me esforce tenho que seguir em frente

Convém aqui referir que neste modo
de melhor procurar compreender a
Realidade

O conceito de

CAUSALIDADE

é entendido no sentido de que
qualquer acontecimento tem sempre
uma causa uma origem
ainda que não seja conhecida

Não existem Milagres

Não existem

Fenómenos Sobre Naturais

Tudo, Tudo o que acontece

faz parte de

PHYSIS

da

NATUREZA

Estando, logo desde o início

espartilhados pela aceitação **implícita**

da ontologia de Fourier
cujas reais implicações
não eram então muito claras

não era possível
construir uma verdadeira teoria causal

REJEIÇÃO DA ONTOLOGIA DE FOURIER

um sinal finito, um impulso

pode ter

uma frequência
uma energia bem definida

Do estatuto
de uma ontologia
de uma regra fundamental

a análise não-local and não-temporal de Fourier

passa a ser
uma simples regra matemática
semelhante a outras
para composição e decomposição de funções
mais ou menos apropriada
desprovida, contudo,
de qualquer conteúdo ontológico
tal como o seu criador, Joseph Fourier, o entendia

Uma breve resumo histórico do caminho seguido

1924 - De Broglie

O início de uma proposta não-linear

O modelo de partícula complexa

Onda real

Dificuldades:

Aceitação implícita e explicita da ontologia de Fourier

Ausência de equação fundamental não-linear

1927 – 1952

Aceitação (contrariado) por de Broglie
da visão linear Ortodoxa

1952

David Bohm mostrou que o teorema de
impossibilidade de von Newman
era destituído de significado físico

1952
De Broglie regresso
à teoria causal e não-linear

Anos 60 associação com J. Andrade e Silva

1971

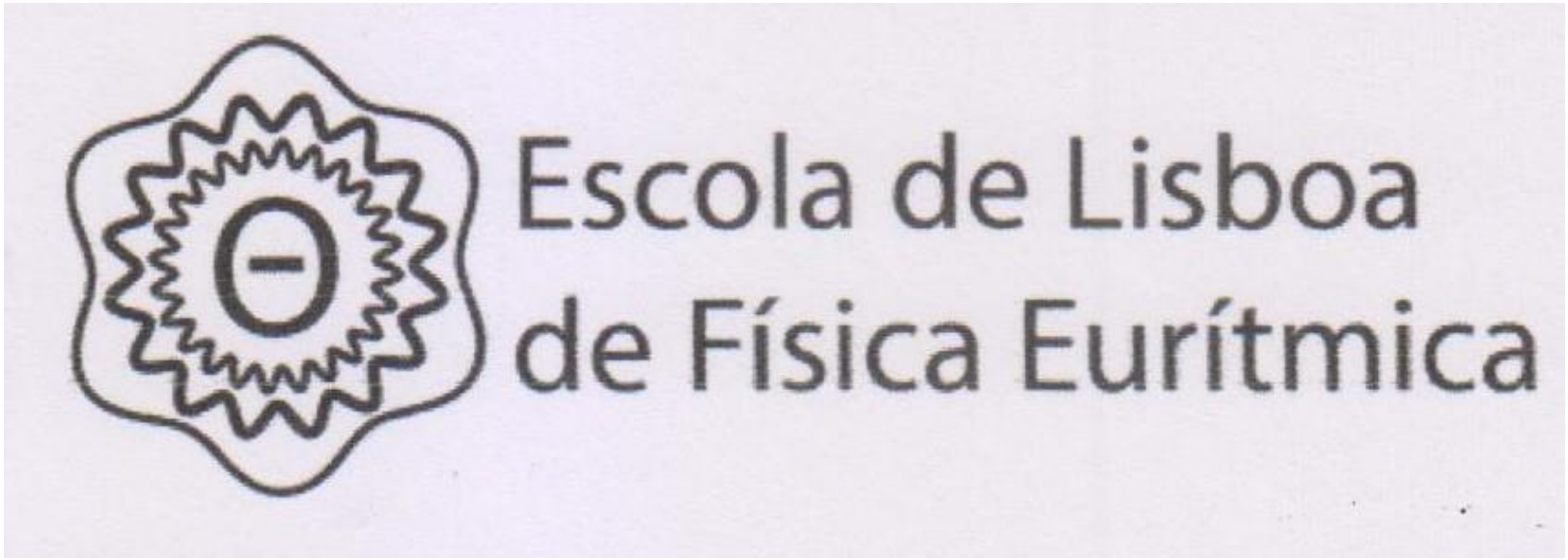
Vinda de Andrade e Silva para Lisboa

Primórdios da Escola de Lisboa

Escola de Lisboa Primórdios

Maria Helena Andrade e Silva-Maria Fernanda Palha Barros-José Nunes Ramalho Croca-Ana Isabel Seruya-João Luís Andrade e Silva ----- 1973

ELFE



Este nome foi proposto por Andrea Mazzola
Physis; Rivista Internazionale di Storia Della Scienza Vol. L(1-2):401-430, (2015)

Anos 80

primeiras propostas experimentais para decidir da completude da Mecânica quântica ortodoxa

Fala-se de reinterpretação causal da Mecânica quântica

Anos 90

Primeiras realizações experimentais das experiências propostas (inconclusivas)

1996
Primeira prova experimental dos limites de aplicabilidade da Mecânica Quântica Ortodoxa

Limites de adequação das relações de Heisenberg (apresentação em Oxford 1996)

J.R. Croca,
Experimental Violation of Heisenberg Uncertainty Relations,
Invited talk at the
5th UK Conference on the
Conceptual and Philosophical Problems in Physics,
at Oxford, Sept. 1996.

Ano 2003

A Física Quântica Não-Linear
J.R. Croca
Towards a Nonlinear Quantum Physics,
World Scientific, London, 2003)

Já não se trata de
uma reinterpretação do
formalismo quântico Ortodoxo

Mas de uma nova Física Quântica

Ano 2006

O Princípio organizacional da **Euritmia**

J.R. Croca,
The Principle of Eurhythmy
a Key To The Unity Of Physics,
in the First Lisbon Colloquium
for the Philosophy of Science - Unity of Science,
Non traditional Approaches,
Lisbon, October, 25-28, 2006.

Ano 2009

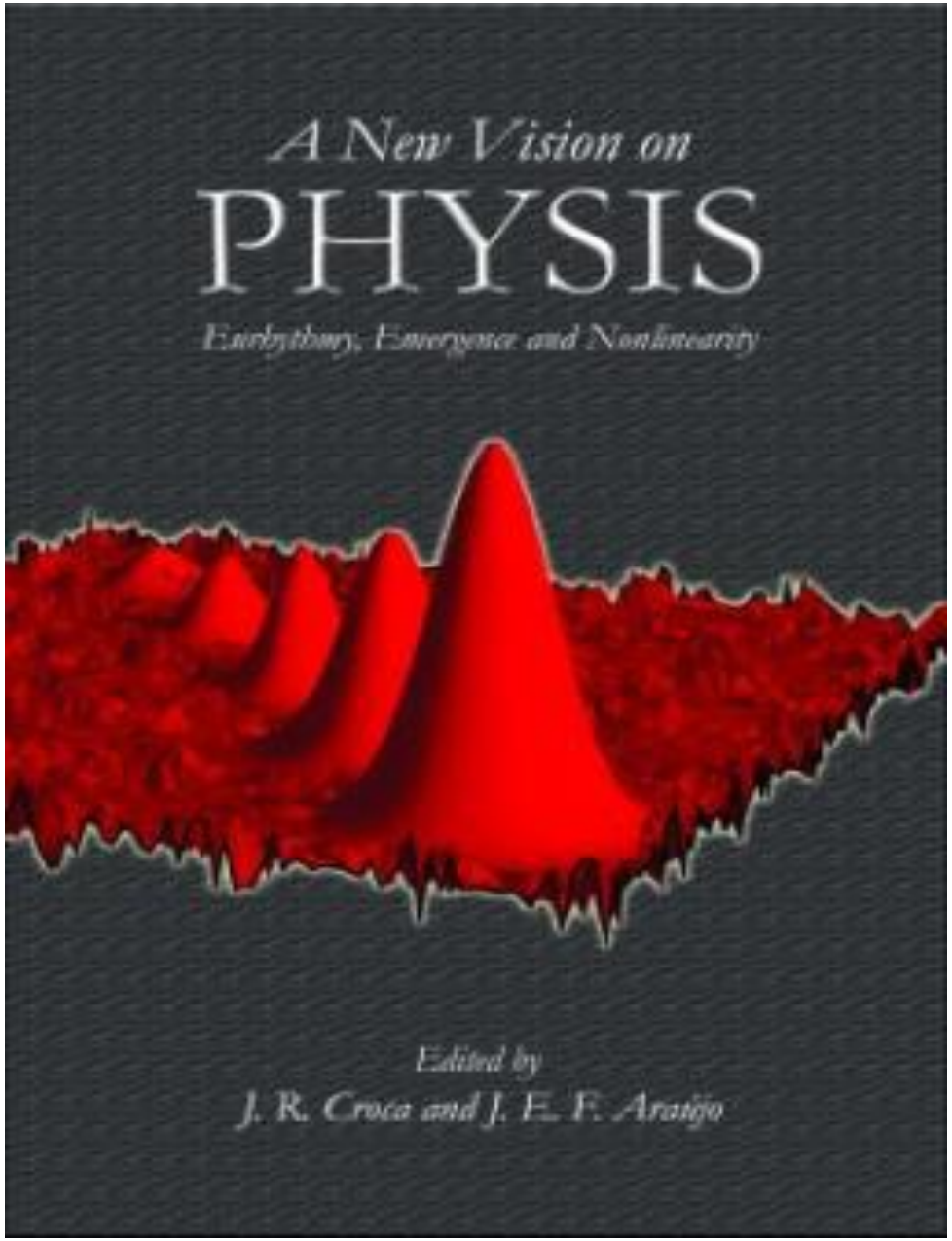
Aparecimento de uma física global do complexo e não-linear

Física Eurítmica
ou
Hyperphysica

Capaz de integrar num todo único a
física tradicional linear cartesiana,
clássica (Mecânica e electromagnetismo),
quântica e relativista.

Manifesto
por uma Nova Física

A New Vision on Physis


A New Vision on
PHYSIS
Embythony, Emergence and Nonlinearity
Edited by
J. R. Croca and J. E. F. Araújo

2010

Ano 2010

Publicação do Manifesto por uma Nova Física

A New Vision on Physis

Trabalho coletivo da

Escola de Lisboa de Física Eurítmica

sobre as diversas aplicações da nova física

Com o desenvolvimento
da Física Eurítmica

A física quântica não-linear
tornou-se assim um capítulo, uma secção,
de uma
ciência do complexo
unificadora e mais global.

Passou a possuir uma
equação fundamental não-linear

$$-\frac{\hbar^2}{2\eta}\nabla^2\theta+\frac{\hbar^2}{2\eta}\frac{\nabla^2(\theta\theta^*)^{\frac{1}{2}}}{(\theta\theta^*)^{\frac{1}{2}}}\theta+U\theta=i\hbar\frac{\partial\theta}{\partial t}$$

A onda theta
solução desta equação:

É uma onda real e necessariamente finita

Região organizada do meio subquântico

Rejeição da Ontologia de Fourier

O conceito de frequência natural

Intuitivamente o conceito de frequência corresponde

conceito de frequência natural

Taxa com que um dado padrão se repete
num dado processo de medida.

Seja o padrão
espacial ou temporal ou outro.

Uma vez que estamos a descrever
entidades físicas reais observáveis
Esta taxa de repetição é finito
podendo eventualmente
ser muito grande,
mas em qualquer dos casos finito

Qual a frequência
de uma onda finita?

Conclusão

Uma onda física observável:

1 **-** é finita

2 – pode ter um frequência bem definida,

k, ω,

tal que

$$\Delta k = \Delta \omega = 0$$

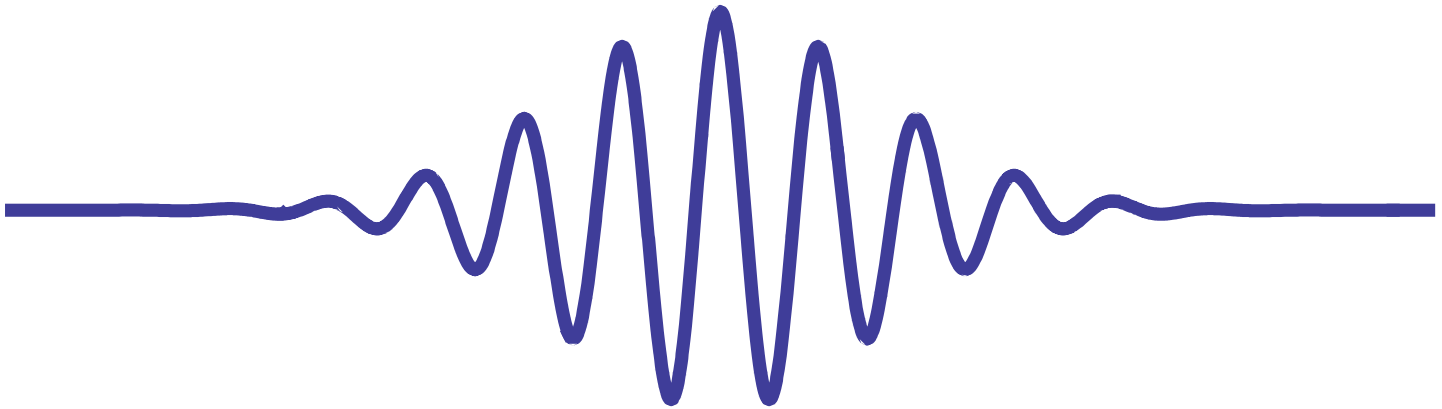
ONDULETAS

Descobertas pelo Geofísico Jean Morlet, nos anos 80 do século XX

Jean Morlet
1931 – 2007

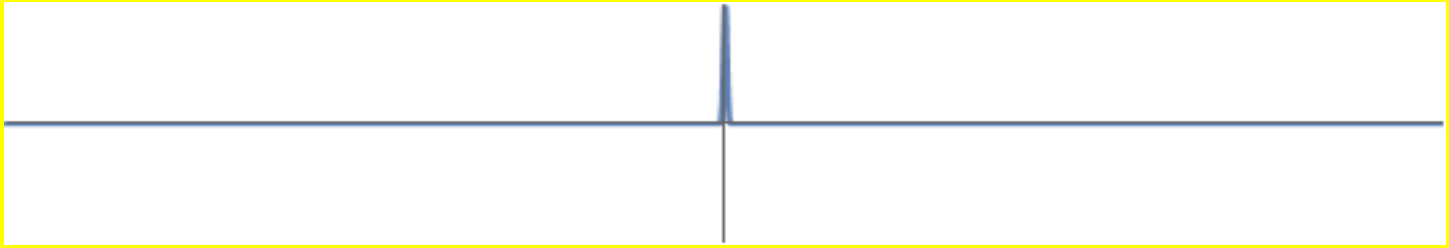
Morlet wavelet

$$\theta(x) = \theta_0 e^{-\frac{x^2}{2\sigma^2}+ikx}$$

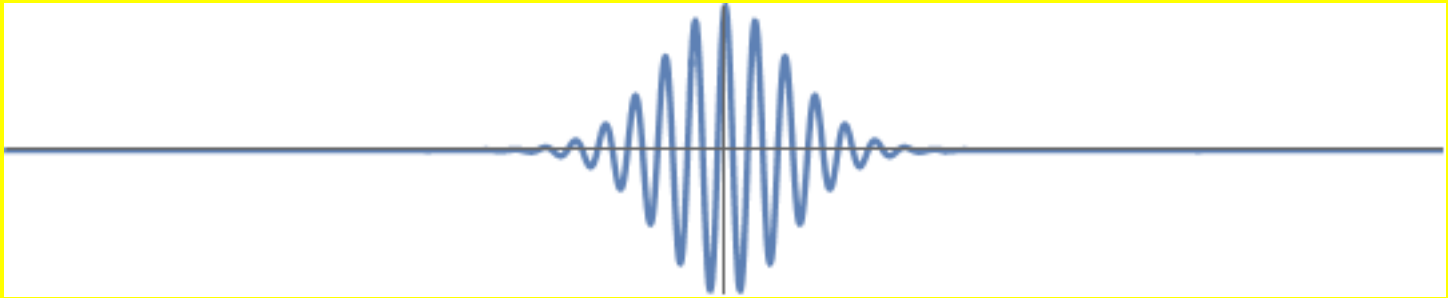


Δk=0

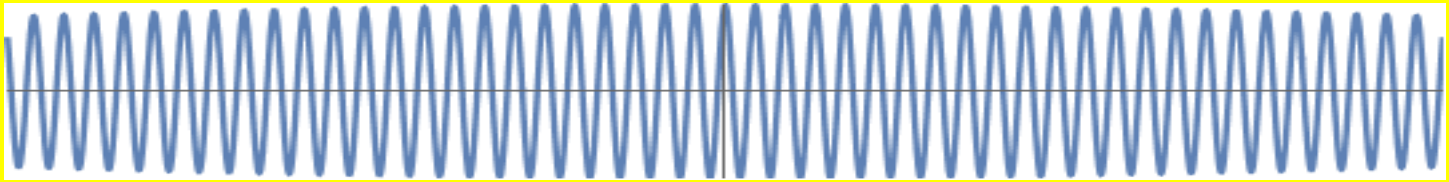
$\Delta x \to 0$



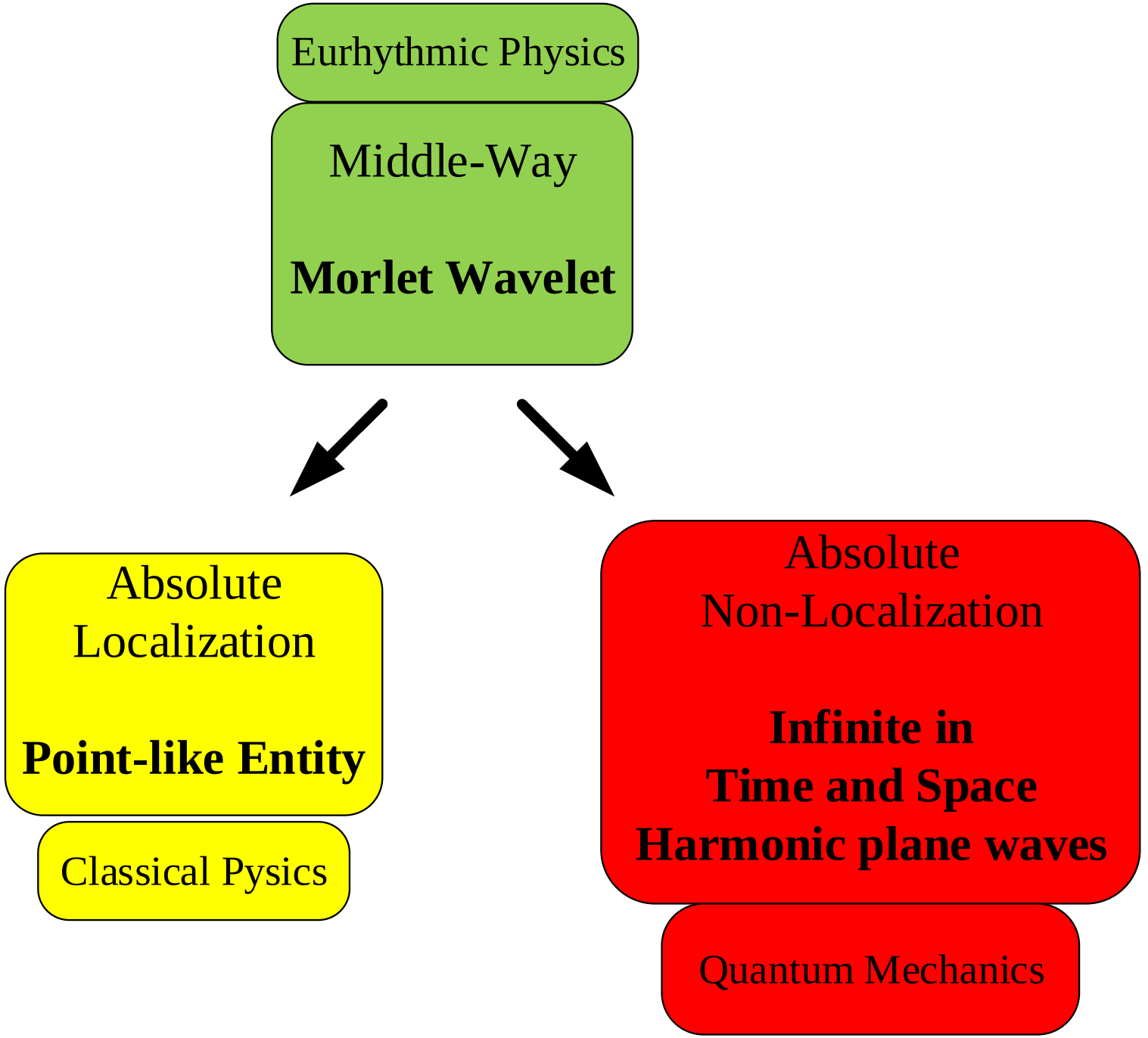
$\sigma \to 0$



$\Delta x \to \infty$



$\sigma \to \infty$


Eurhythmic Physics
Middle-Way
Morlet Wavelet
Absolute
Localization
Point-like Entity
Classical Pysics
Absolute
Non-Localization
Infinite in
Time and Space
Harmonic plane waves
Quantum Mechanics

As partículas complexas
e outras entidades
podem agora ser representadas
por uma
ou eventualmente mais ondas finitas

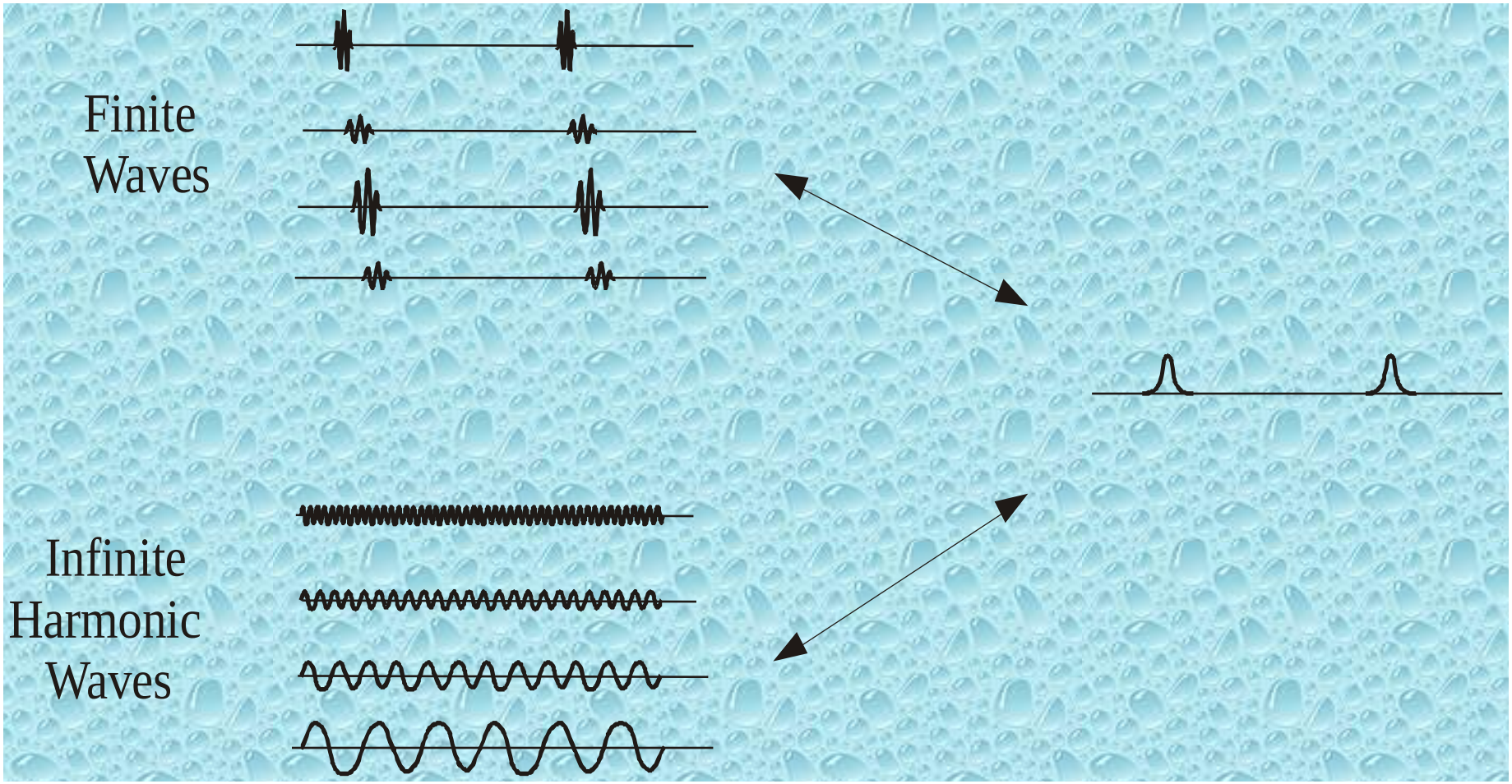
Comparar
a análise local por onduletas
com a
análise não-local de Fourier

Consideremos a seguinte figura

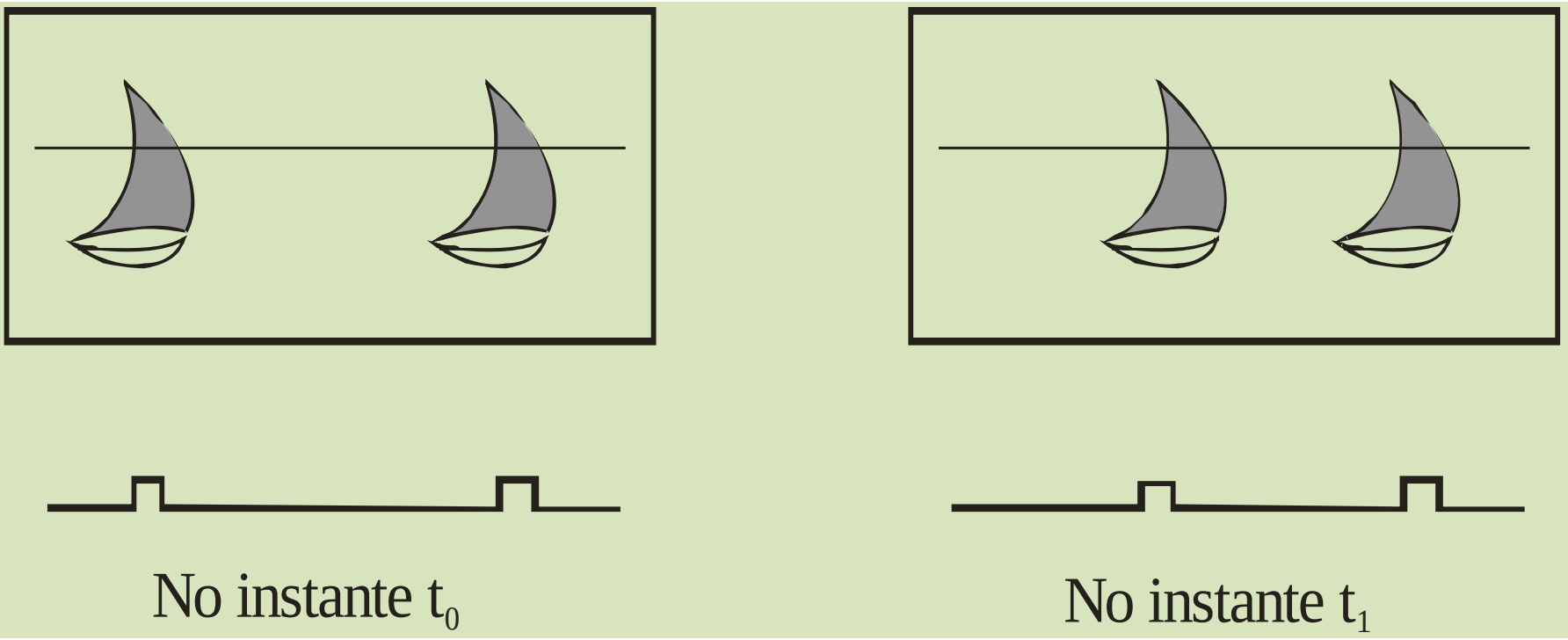
O mesmo sinal original
pode ser composto:

Quer pela soma
de ondas finitas
ou
de ondas harmónicas infinitas

As duas análises lado a lado



Exemplo concreto



No instante t_0

No instante t_1

Aplicações práticas das Onduletas

Aplicação das Onduletas

Original

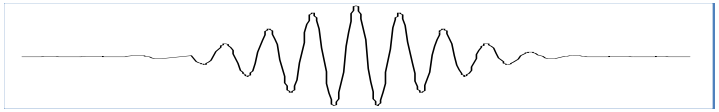
3%

Cortesia do Prof.
Amaro Rica da Silva

10%

Vantagem
a análise finita por onduletas gaussianas
contêm como um caso particular
a análise infinita de Fourier

$$\theta = a\, e^{-\frac{x^2}{2\sigma^2}+ikx}$$



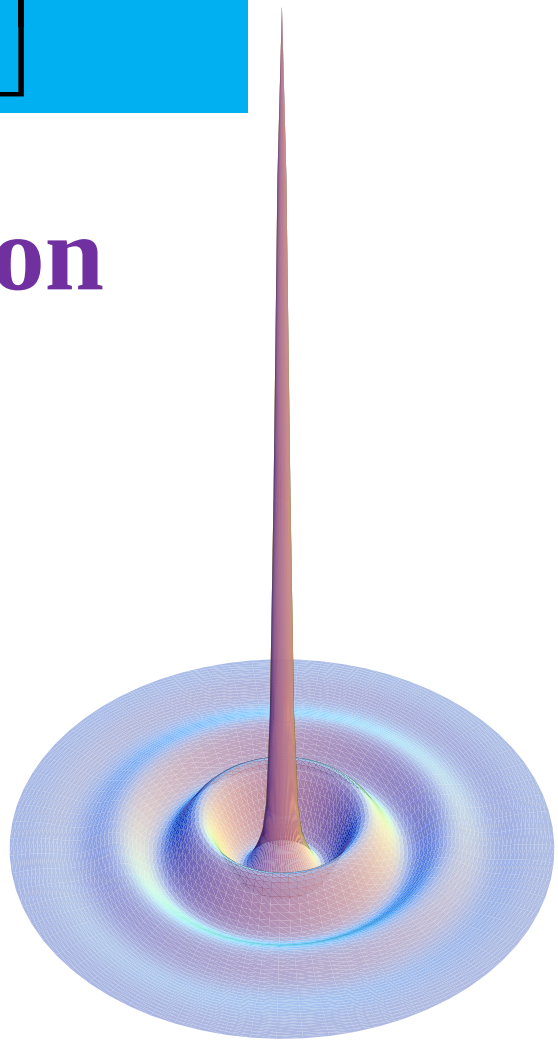
$$\phi(r) = \left[A_\theta \, e^{-\frac{r^2}{2\sigma_\theta^2}} + A_\xi e^{-\frac{(r-\delta)^2}{2\sigma_\xi^2}} \right] e^{+ikr}$$

Modelo Matemático
para a partícula quântica

ONDA Λ ACRON

Acron

Onda Theta



Para efeitos práticos

a energia da partícula quântica é a do acron

A energia da onda theta é tão pequena que os detectores comuns não a conseguem detectar

Questão!

Como estão o acron e a onda theta relacionados?

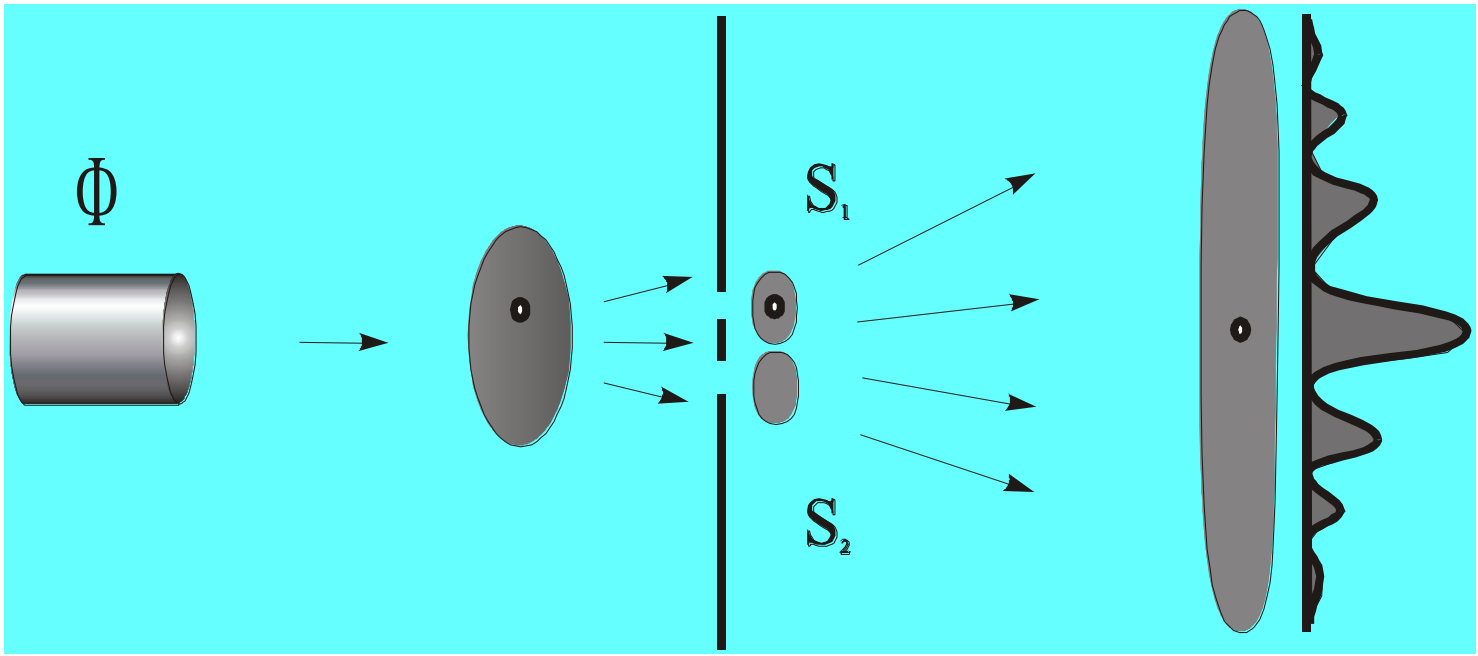
A resposta a esta questão é o

PRINCÍPIO DE EURITMIA

Este principio diz-nos que a probabilidade de localizar, um corpúsculo, o acron
é proporcional à intensidade da onda theta

$$P(\xi) \propto |\theta|^2$$

Explicação natural causal da experiencia das duas fendas



a aparente contradição enfrentada pelos físicos
No primeiro quartel do século vinte
Da partícula quântica ter de passar por:

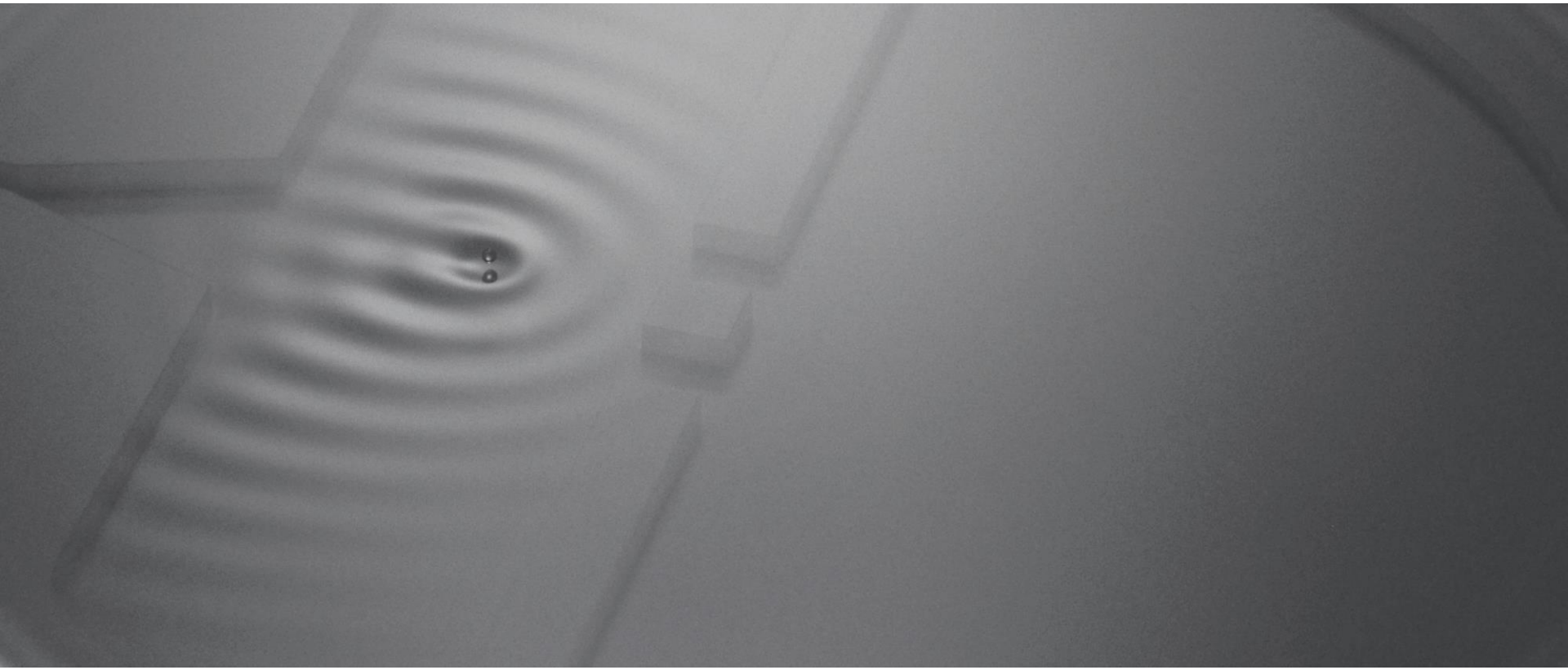
1 – uma fenda **ou** pela outra
2 – uma fenda **e** pela outra

Foi satisfatoriamente resolvida
esta explicação, bela e intuitiva

Pode ser resumida do seguinte modo:

1 – o acron passa por ---------- uma fenda **ou** pela outra
2 – a onda theta passa por ----- uma fenda **e** pela outra

Droplets



síntese

da física clássica e da física quântica não-linear

existência de uma realidade objectiva
independente do observador

o observador interage
com essa mesma natureza de que faz parte
e pode, eventualmente, modificá-la em maior ou menor grau

física clássica e física quântica não-linear

corresponde apenas a diferentes níveis de descrição
a diferentes escalas de observação da realidade

Exemplo: Água

ao nível de descrição clássica

sistemas locais - os corpúsculos

e

sistemas extensos – as ondas

são considerado como entidade independentes

deste modo, são descritos
do ponto de vista matemático
por equações diferentes

a escala de quântica
esta dicotomia
do local e do extenso
perdeu todo o sentido
localização e extensão
são integrados num único todo
esta entidade complexa

Onda-corpúsculo

é agora descrita por
equação não-linear

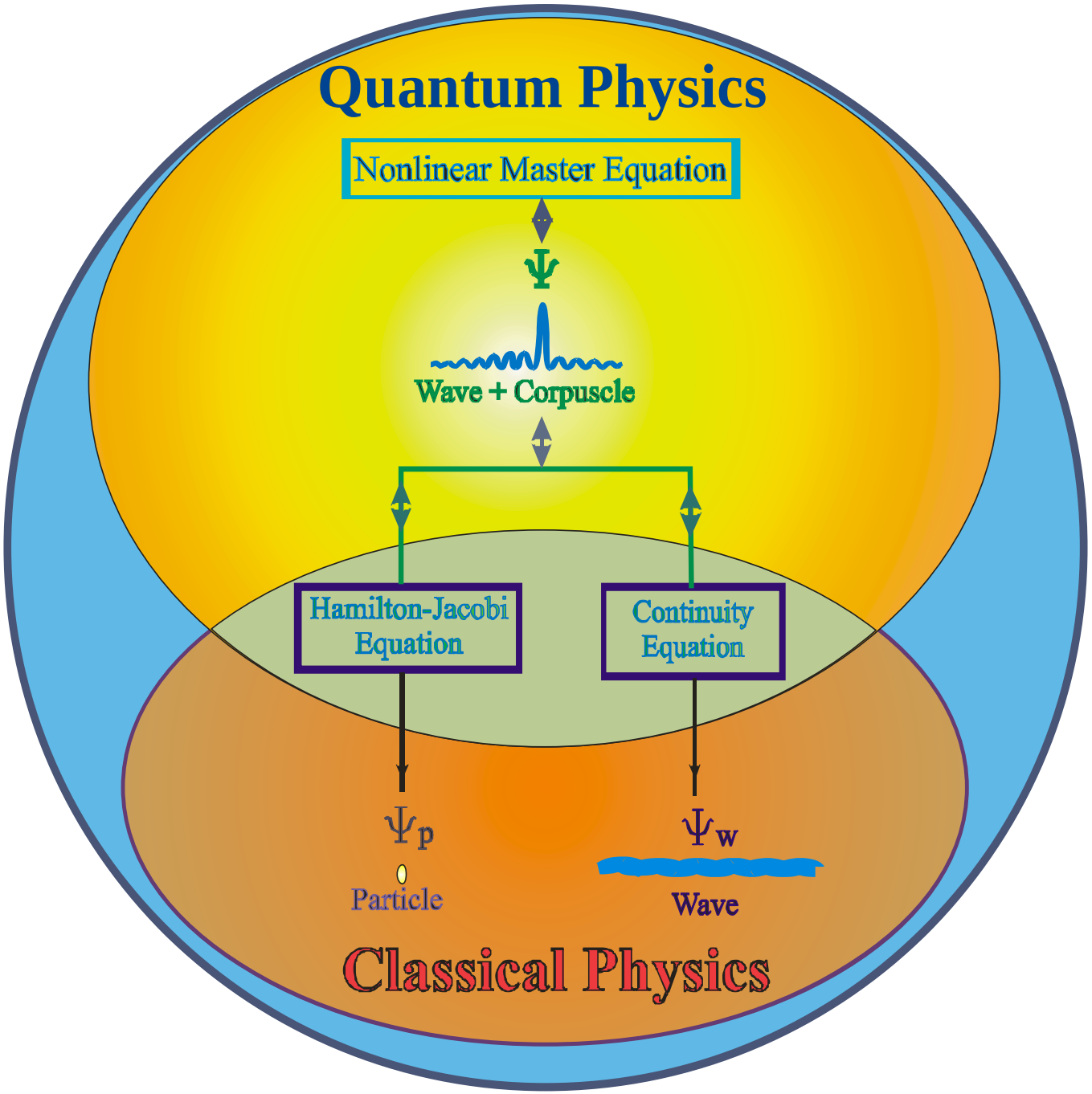
Da fusão das duas equações clássicas :

Corpúsculos - Hamilton-Jacobi

$$T + V = E \quad \Leftrightarrow \frac{1}{2m}(\nabla\varphi)^2 + V = -\varphi_t$$

Ondas - Equation da Continuidade

$$\nabla J + \frac{\partial\rho}{\partial t} = 0$$


Quantum Physics
Nonlinear Master Equation
Ψ
Wave + Corpuscle
Hamilton-Jacobi Equation
Continuity Equation
Ψp
Particle
Ψw
Wave
Classical Physics

A Realidade Física é Única e Objectiva

Aquilo que muda é
A maneira como descrevemos essa mesma Realidade

Ao nível quântico, à escala quântica,

Não é possível separar
o carácter extenso do local

À escala clássica:

É muito mais fácil
tratar estas duas características dos sistemas
como independentes

na física não-linear causal
as experiência conceptuais anteriormente estudadas

do gato de Schrödinger e outras
não oferece qualquer problema

todos os problemas e paradoxos desaparecem
E as respostas dadas às questões levantadas
são precisamente os correspondentes
á observação e ao bom senso

é possível explicar a fenomenologia quântica
em termos intuitivos

sem qualquer necessidade de negar

a existência da realidade objetiva
ou invocar a mágica ou o mistério

Temos duas Teorias em confronto como decidir entre elas?????

In the history of science,
This situation has happened
several times
At the beginning the different theories
even if they are
ontologically quite different
they nevertheless make
the same predictions

The theories propose
different conceptual basic entities

the quest for
the ontic nature

of some theoretically proposed entities
has a long tradition.

We have for instance
Two theories

In the end the question was and is,
weather some of the proposed entities
do have a real physical nature
or, on the contrary,
are mere conceptual helpful tools.

It is common knowledge
for those familiar with
the history of science,
that the more pragmatic researches,
traditionally maintain
that the question for the elucidation of
the nature of the proposed theoretical
entities is not relevant.

The advent of modern science
started precisely just
with one of these cases.
In 1543, **Osiander**, making a referee
revision for the publication of the book
De Revolutionibus Orbium Coelestium
(On the revolutions of the celestial spheres)
written by Copernicus,

NICOLAI COPERNICI TORINENSIS DE REVOLVTIONIbus orbium cœlestium,

Libri VI.

IN QVIBVS STELLARVM ET FIXARVM ET ERRATICARVM MOTVS, EX VETEribus atq; recentibus obseruationibus, restituit hic autor. Præterea tabulas expeditas luculentasq; addidit, ex quibus eosdem motus ad quoduis tempus Mathematum studiosus facillime calculare poterit.

ITEM, DE LIBRIS REVOLVTIONVM NICOLAI Copernici Narratio prima, per M. Georgium Ioachimum Rheticum ad D. Ioan. Schonerum scripta.

Cum Gratia & Priuilegio Cæs. Maiest.

BASILEAE, EX OFFICINA HENRICPETRINA.

net, in quo terram cum orbe lunari tanquam epicyclo contineri diximus. Quinto loco Venus nono mense reducitur. Sextum deniq; locum Mercurius tenet, octuaginta dierum spacio circũ currens. In medio uero omnium residet Sol. Quis enim in hoc

pulcherrimo templo lampadem hanc in alio uel meliori loco ponere, quàm unde totum simul possit illuminare? Siquidem non inepte quidam lucernam mundi, alij mentem, alij rectorem uocant. Trimegistus uisibilem Deum, Sophoclis Electra intuentẽ omnia. Ita profecto tanquam in solio regali Sol residens circum agentem gubernat Astrorum familiam. Tellus quoque minime fraudatur lunari ministerio, sed ut Aristoteles de animalibus ait, maximam Luna cum terra cognationẽ habet. Cõcipit interea à Sole terra, & impregnatur annuo partu. Inuenimus igitur sub hac

De Revolutionibus Orbium Coelestium, l'oeuvre majeure de Copernic ...

made an assumption of the same nature.
In the preface he said that
the theoretical model,
proposed by Copernicus,
in which the Sun was still
and the Earth moving,
was not necessarily true, or even probable,
but was useful tool
for computational purposes.

About two hundred years later
another controversy of this type occurred.
This relatively long controversy was
related with
the ontic nature of the atoms.
To some thinkers, namely,
Mach, Ostwald, Avenarius and many
others,
the so-called positivist and neopositivists,
the atoms were only mere conceptual
useful tools and nothing more.

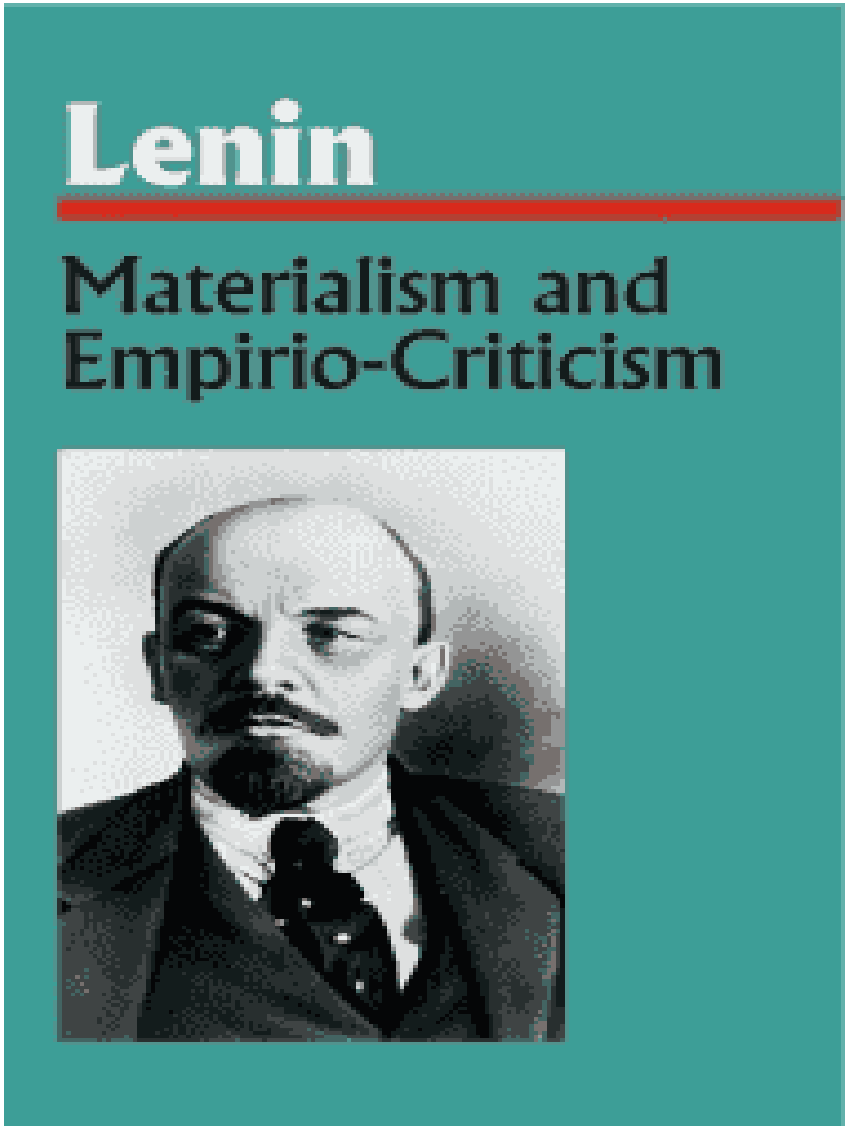
Another group of scholars believed that the
atoms were more than
mere conceptual tools
and indeed do have physical reality.
From these, we may point out,
Boltzmann, Maxwell, Einstein and Lenine

Still, at the time there were no experiments
that could allow the decision
on the ontic nature atoms.

Ludwig Boltzmann

Born	February 20, 1844 Vienna, Austrian Empire
Died	September 5, 1906 (aged 62) Tybein, Triest, Austria-Hungary
Cause of death	Suicide by hanging

Busto de Boltzman na Universidade de Viena

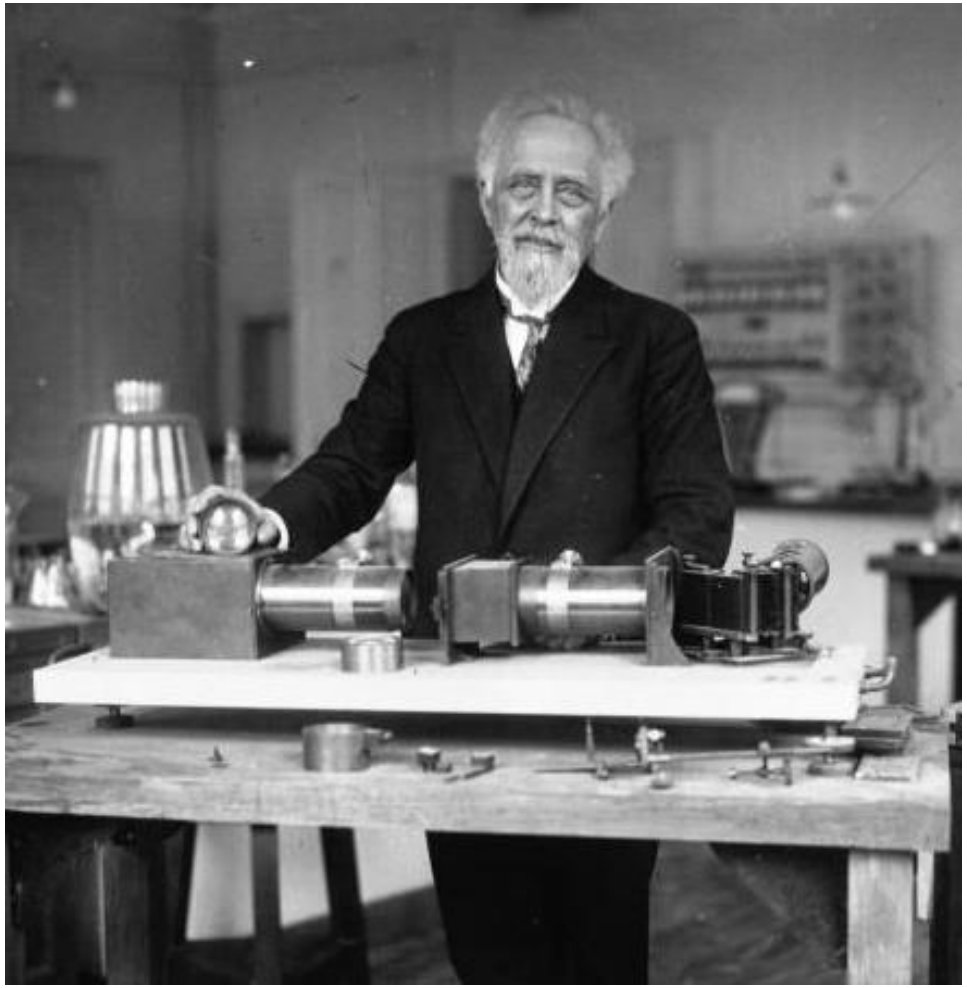


Vladimir Ilyich Ulyanov - Lenine
(22 April [O.S. 10 April] 1870 – 21 January 1924),

Things changed radically
when in 1905 Einstein
published a work in which he
explained the observed Brownian motion
assuming the physical reality of the atoms.

These ideas were experimentally confirmed by
the very important experiments that, in 1909,
Jean Perrin performed.
Since then on, for the scientific community the
atoms are assumed
to have a real physical existence.

Jean Baptiste Perrin



Born: September 30, 1870, Lille
Died: April 17, 1942, New York

Now, everybody agrees that without
the belief in
the real nature of the
Copernicus model
or of the in
the real existence of the
atoms and molecules
our modern science and technology
would be impossible.

A similar controversy started about the first quarter of the last century

related with nature of quantum waves.

Orthodox quantum mechanics
claims that
quantum waves,
solution to the
Schrödinger equation,
are conceptual tools,
mere probability waves
devoid of any physical reality.

De Broglie and
his nonlinear causal school,
maintain that
quantum waves,
or as they may now be named,
subquantum waves, guiding waves,
pilot waves, empty waves, zero-
point field waves, theta waves,
are real physical entities.

De Broglie and
his nonlinear causal school,
maintain that
quantum waves,
or as they may now be named,
subquantum waves, guiding waves,
pilot waves, empty waves, zero-
point field waves, theta waves,
are real physical entities.

Now, just as before,
to the great majority of physicists,
having a more practical pragmatic
attitude before science,
this controversy on
the ontic nature of the quantum waves,
whether they are
mere probability waves
or, on the contrary,
do have physical reality
is devoid of any sense.

They say
that
they don’t care,
because
the issue is not relevant
to do the
actual quantum
calculations

We believe that the
clarification of the nature
of the quantum waves
is a very important issue.
If indeed quantum waves do have real
physical existence,
as some experiments seem to indicate
then a whole new universe
of theoretical and
technological possibilities will be open.

O que diz a Praxis?
O que dizem as Experiências?

Temos duas teorias em confronto

Não-Linear e Linear (Ortodoxa)

Como poderemos decidir entre as duas?

as teorias físicas podem ser
validadas ou invalidadas
pela evidência experimental

Há provas experimentais que podem decidir entre elas?

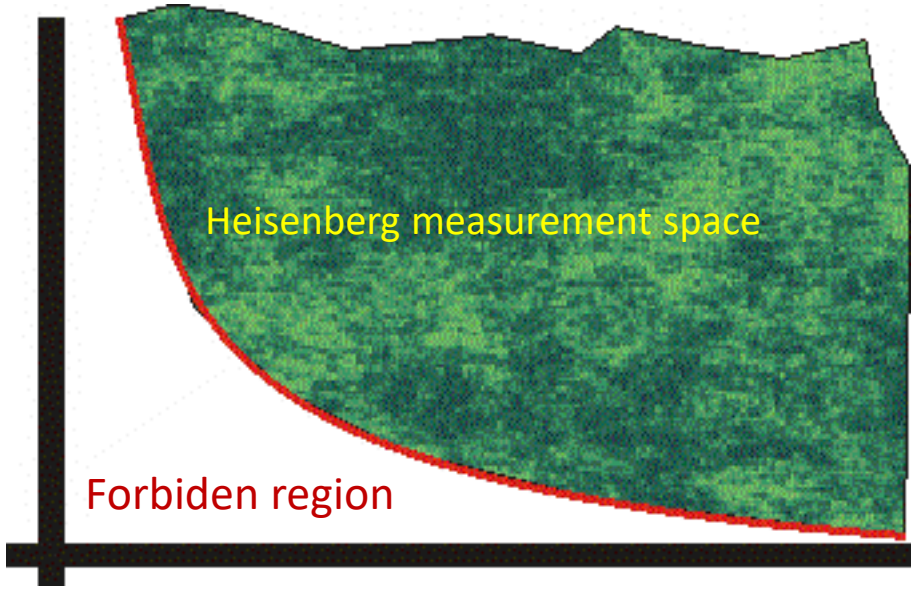
SIM

Relações de Heisenberg

Realidade das ondas subquânticas

Relações de Heisenberg

$$\Delta x \geq \frac{h}{\Delta p_x}$$

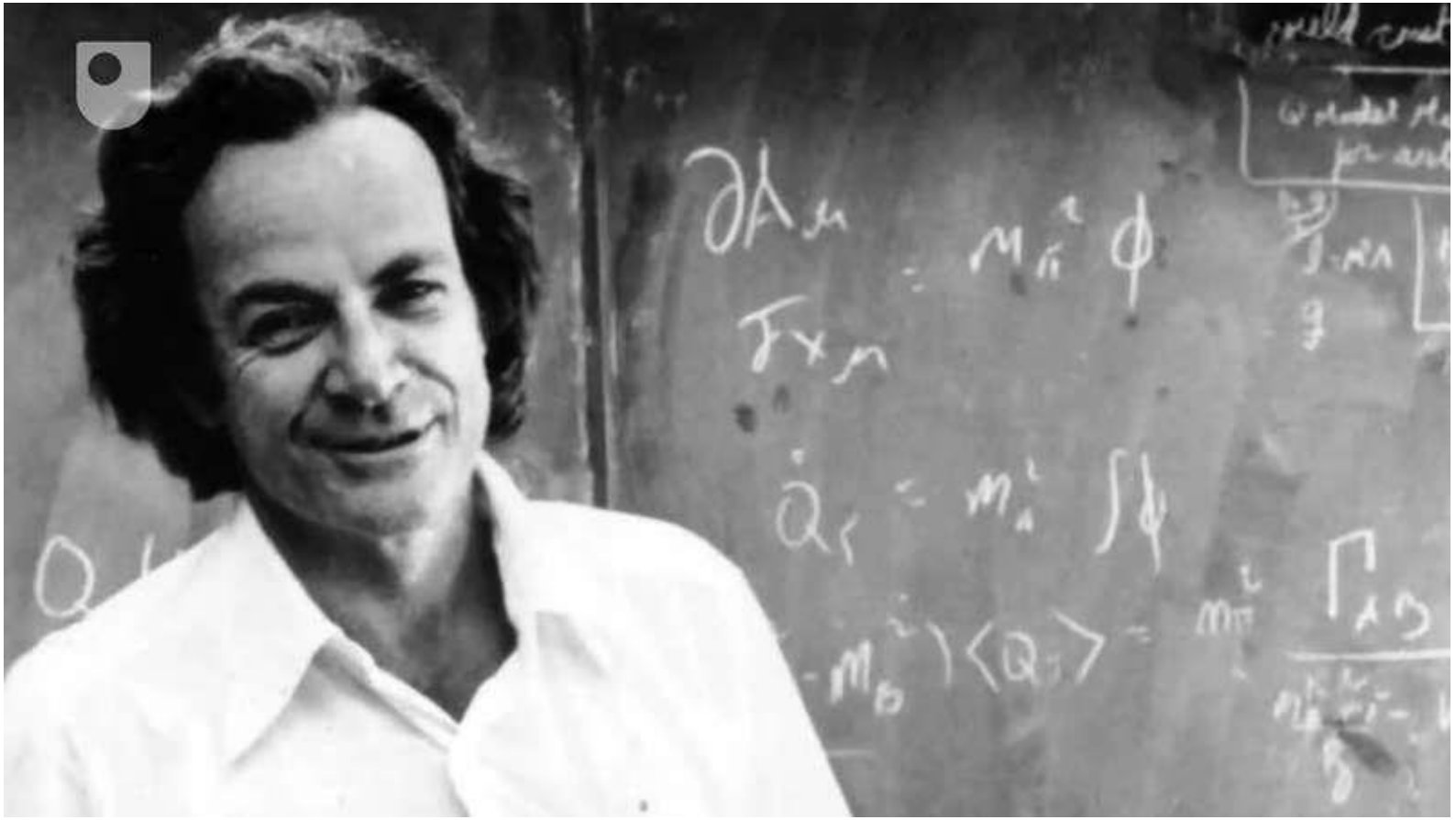


It is well-known, the
famous
Richard Feynman
statement in his
Lectures on Physics

The Uncertainty principle

“protects”

quantum mechanics



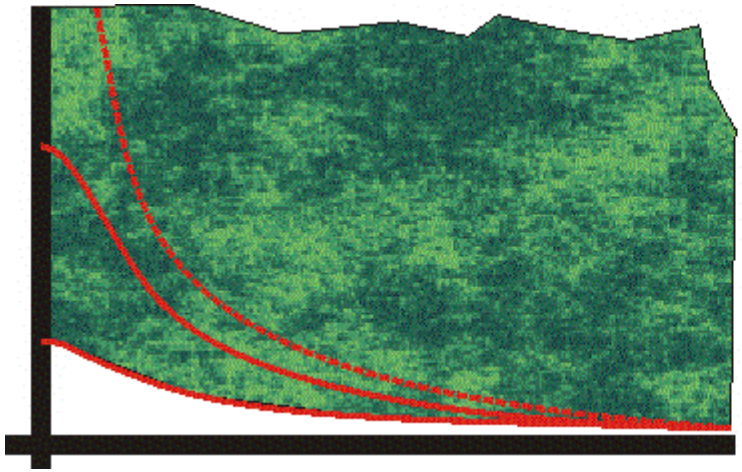
Richard Feynman

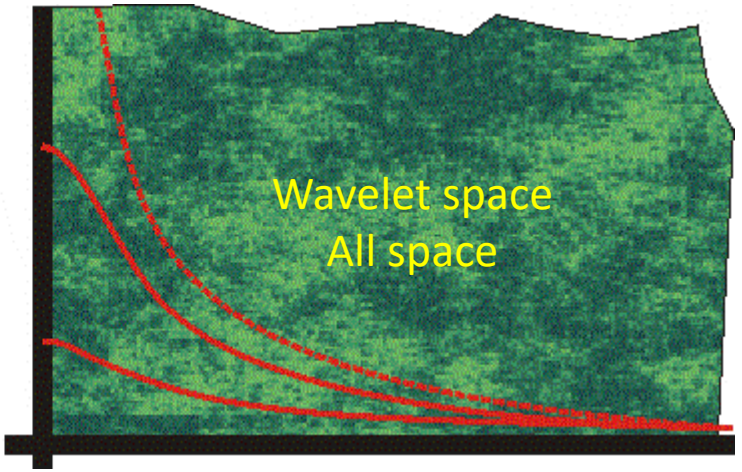
Born: May 11 1918, New York City
Died: February 15, 1988, Los Angeles

Is it true?
It is really impossible to make predictions for measurements beyond Heisenberg limits?

RELAÇÕES GERAIS INCERTEZA

$$\Delta x^2 = \frac{h^2}{\Delta p_x^2 + \frac{h^2}{\sigma_0^2}}$$





General Uncertainty Relations
contain
Heisenberg relations
as a particular case
when the size of the
mother wavelet $\sigma \to \infty$

$$\Delta x^2 = \frac{h^2}{\Delta p_x^2 + \frac{h^2}{\sigma_0^2}}$$

$$\sigma \to \infty$$

$$\Delta x \geq \frac{h}{\Delta p_x}$$

$$\theta(x) = \int_D g(k)\, e^{-\frac{x^2}{2\sigma^2} - ikx}\, dk$$

$$g(k) = Ae^{-\frac{(k-k_0)^2}{2\sigma_k^2}}$$

$$\theta(x) = \sqrt{2\pi}\, A\sigma_k\, e^{-\frac{x^2}{2/(\sigma_k^2 + 1/\sigma^2)} - ik_0 x}$$

$$\theta(x) = \sqrt{2\pi}\, A\sigma_k\, e^{-\frac{x^2}{2\sigma_x^2} - ik_0 x}$$

$$\sigma_x^2 = \frac{1}{\sigma_k^2 + \frac{1}{\sigma^2}}$$

WAVELETS

Error in Position X Error in Velocity $\lesseqgtr$ Quantity

CAUSAL UNCERTAINTY RELATIONS

HEISENBERG INDETERMINATION RELATIONS

As relações gerais de incerteza

não têm qualquer estatuto ontológico especial

apenas refletem
a simples e circunstancial impossibilidade

inerente a qualquer medida física

onde devido à recíproca interação
existe sempre
um erro associado a qualquer medida

Numa medida concreta

os erros a ela associados
resultam em última análise
dos instrumentos usados
na determinação das
quantidades envolvidas

Uma melhoria
na construção
dos aparelhos de medida
pode eventualmente
reduzir os erros
e melhorar a
previsão dos resultados

Microscópios comuns

Conhecidos como

Microscópios de Fourier

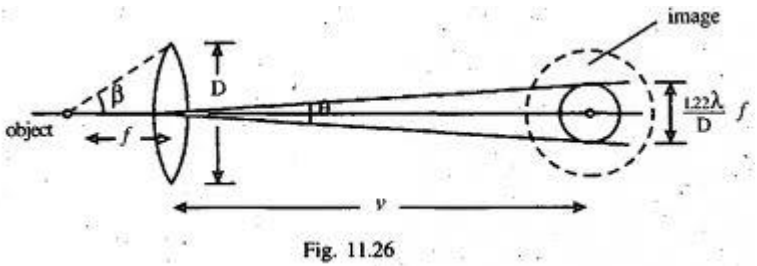


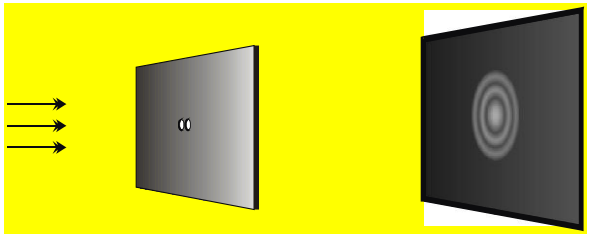
Fig. 11.26

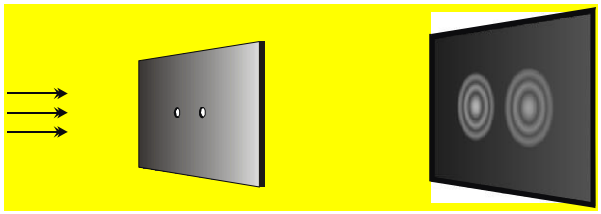
$$\Delta x \geq \frac{1}{2}\lambda$$

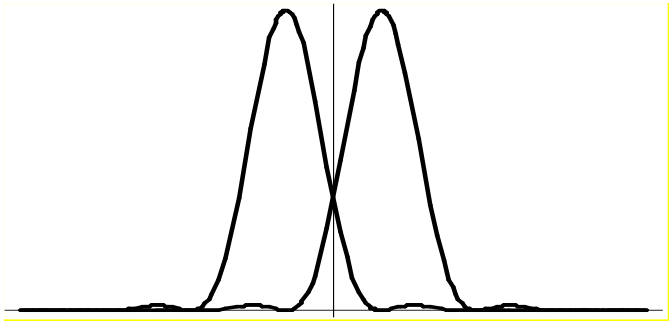
Critério de Abbe

Resolution: meio comprimento de onda

Resolution of imaging devices







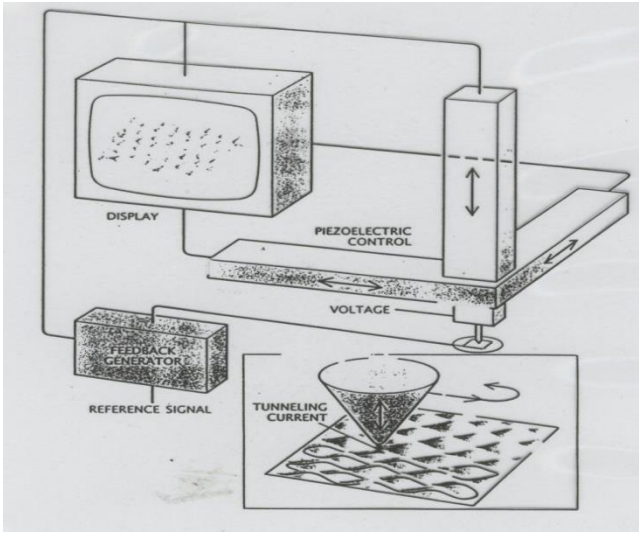
Abbe's rule

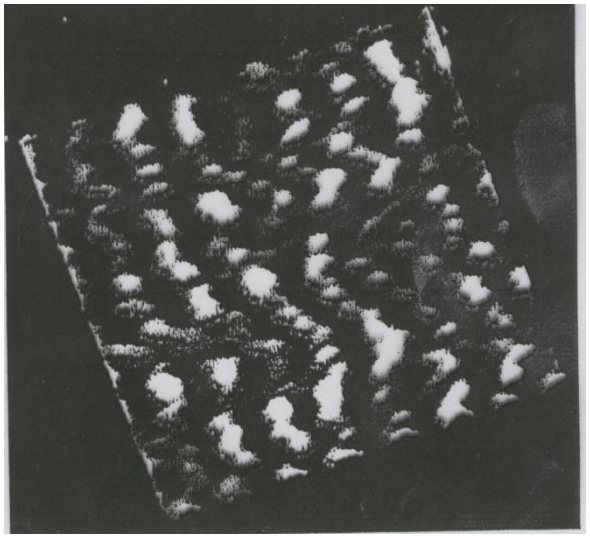
$\Delta x \geq \lambda/2$

Microscóspio de Super-Resolução

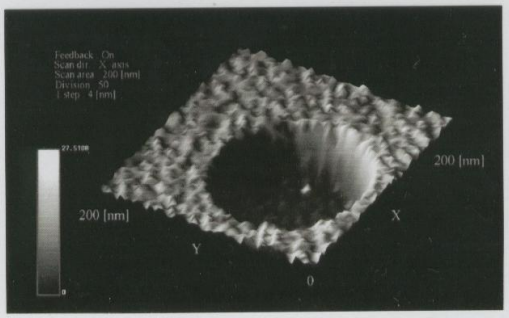
Desenvolvido nos anos 80 por dois investigadores da IBM
Binning e Roher Binning
ganharam mais tarde o Prémio Nobel

Os microscópios comuns de Fourier têm um limite de resolução teórica
de cerca de meio comprimento de onda
Resolução de um sistema óptico é a capacidade de separar dois pontos

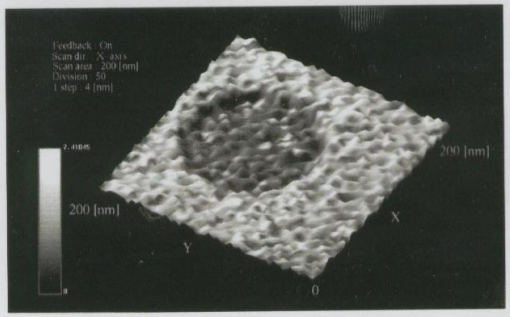




SNOM image taken by Prof. T. Kataoka (Osaka Univ.) group.



SNOM image of the standard sample. The diameter and the depth of the pit are 100 nm and 20 nm, respectively.



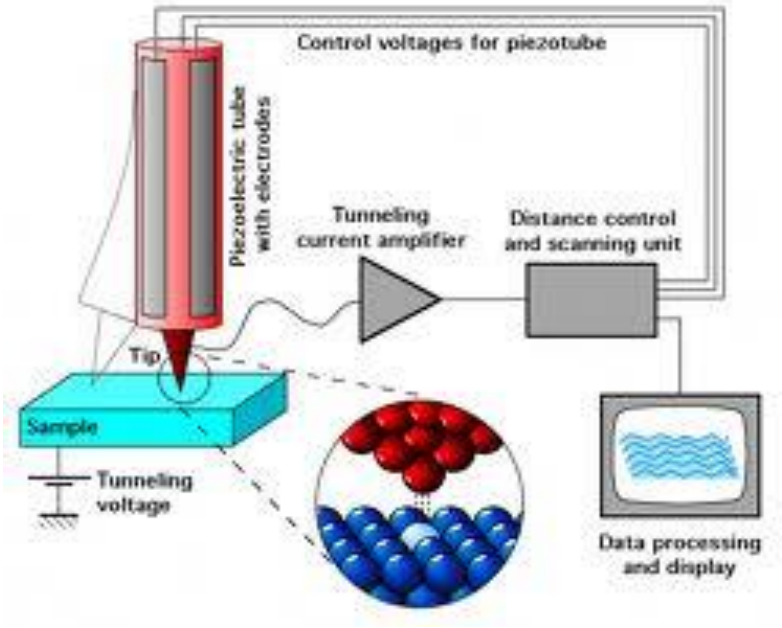
SNOM image of the standard sample. The diameter and the depth of the pit are 100 nm and 5 nm, respectively.

Judging from the width of the edge of the pit, the lateral resolution of the SNOM is about 10 nm, and the vertical resolution is about 1 nm.

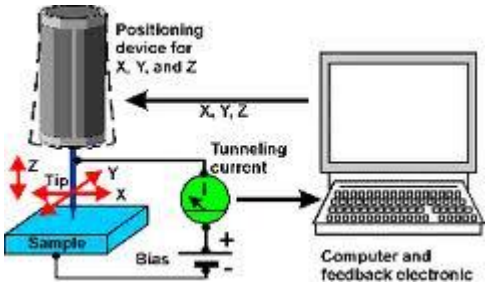
$\lambda \sim 700$ nm Lateral $\Delta x \sim \lambda/70$

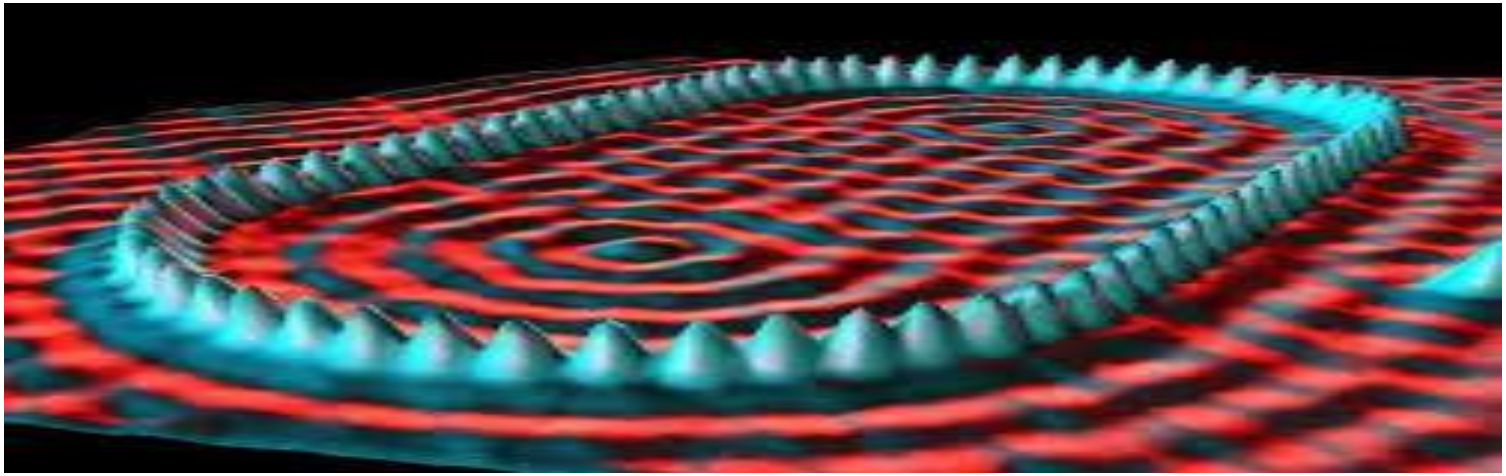
vertical $\Delta x \sim \lambda/700$

Super-microscope – based on tunnelling



$$\Delta x = \frac{1}{500}\,\lambda \leq \frac{1}{2}\,\lambda$$



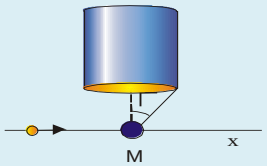


Falsification of Heisenberg Relations

Mesurement of Velocity and Position of a Particle

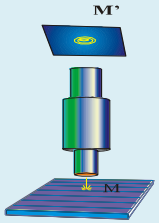
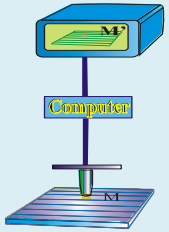
PREVISIONS

Uncertainty (error) of Velocity



$$\Delta \upsilon = \frac{2}{m\lambda} h$$

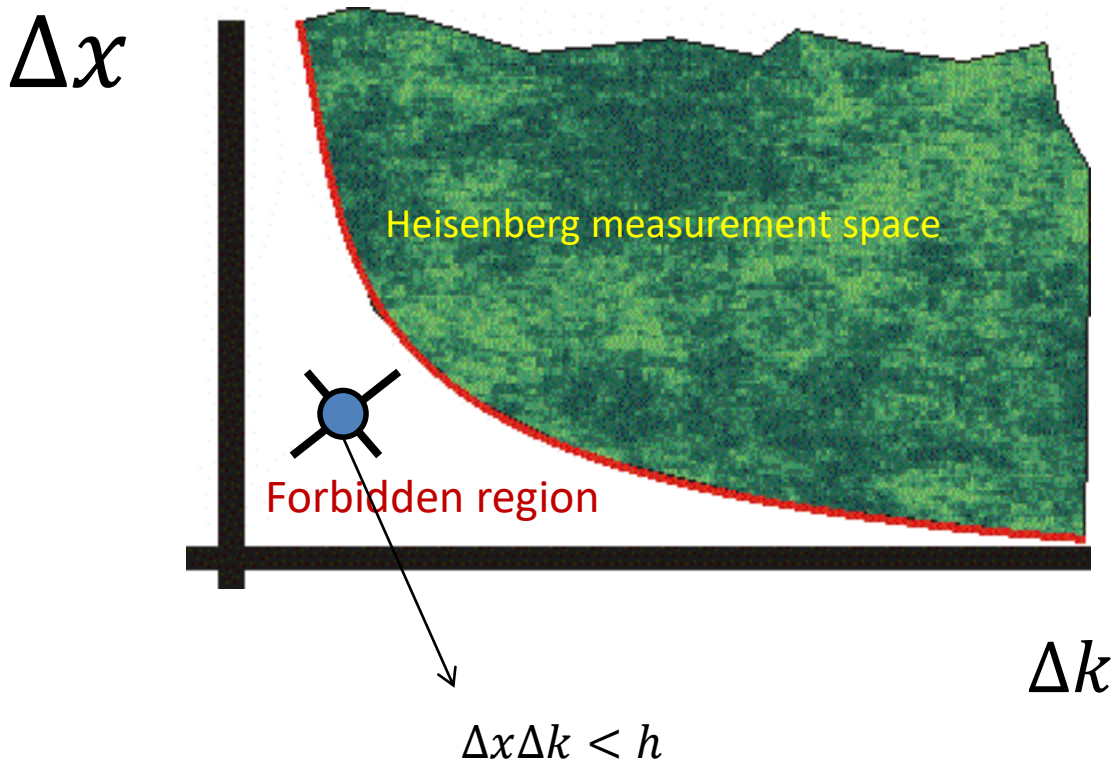
Incertainty (error) of Position

Fourier common Microscope	Super-microscope
	
Maxima theoretical Resolution	Practical Resolution
$\Delta x = \frac{\lambda}{2}$	$\Delta x = \frac{\lambda}{50}$

Product of the uncertainties

$\Delta x \, \Delta \upsilon = \frac{h}{m}$	$\Delta x \, \Delta \upsilon = \frac{1}{25} \times \frac{h}{m}$

This means that we are making predictions for simultaneously measurements in the forbidden region



These results
show to the evidence
that

orthodox quantum mechanics
no longer is

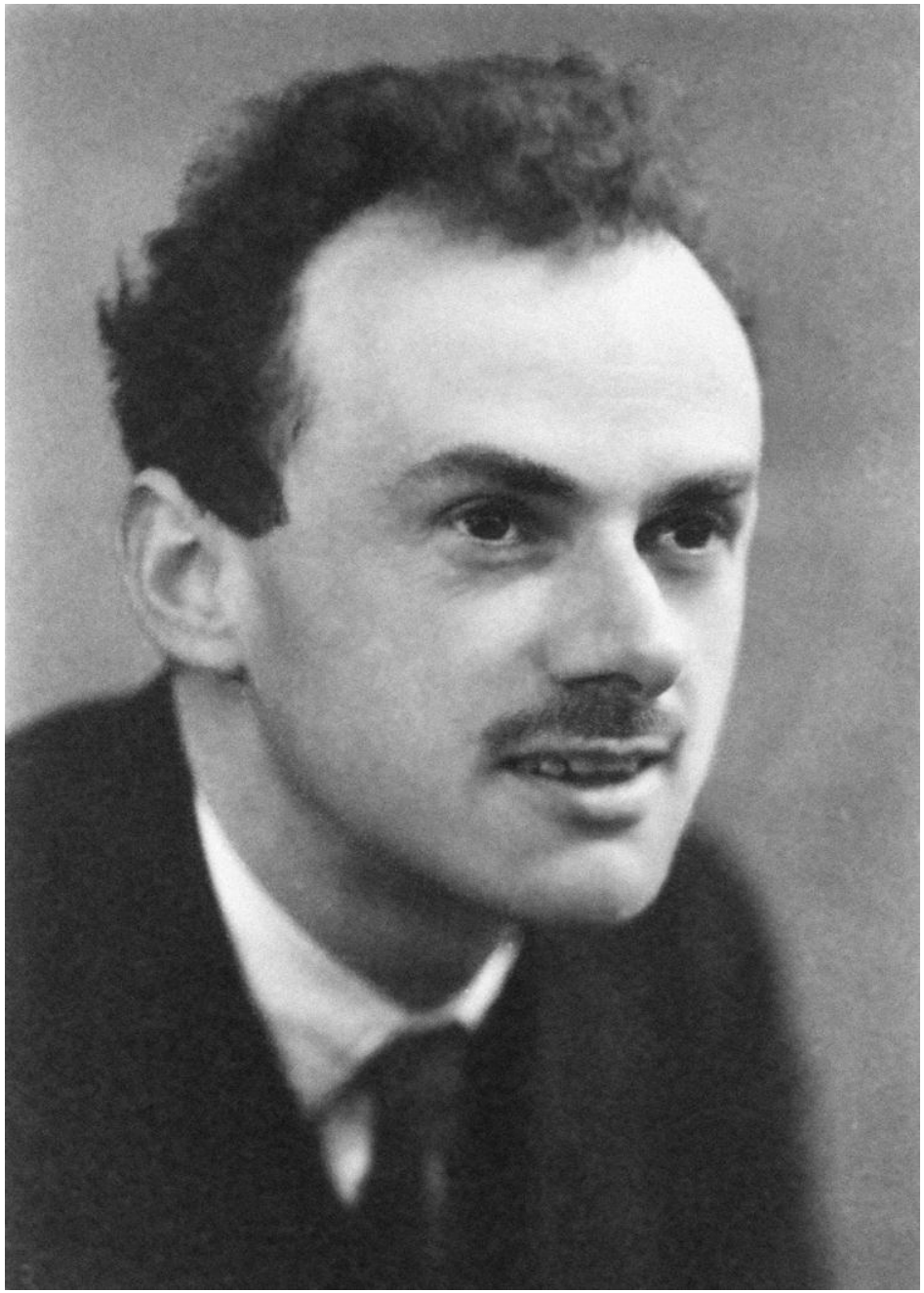
“Protected”

and have attained its limits of adequacy in describing
natural phenomena

Este facto concreto não é surpreendente
Em 1927 quando as
relações e de Heisenberg -Bohr
foram derivadas os microscópios existentes
eram os tradicionais de Fourier.

Ou seja ao nível de descrição da Realidade
então conhecida as relações de incerteza
tradicionais eram mais do que adequadas.

Aquilo que está errada afirmar a sua pretensa
validade universal em toda e qualquer
circunstância interativa
agora e para todo o sempre



Paul Dirac
Theoretical physicist
(1902-1984)

SCIENTIFIC AMERICAN

May 1963, Volume 208 Number 5 Pag. 49

The Evolution of the Physicist's Picture of Nature

I think one can make a safe guess that the uncertainty relations in their present form will not survive in the physics of the future.

Natureza ontológica das ondas quânticas

Gerador de ondas theta

Ortodox Quantum Mechanics

A solução da equação de Schrödinger
é uma onda de probabilidade

$\Psi \rightarrow$ Probability wave

desprovida de realidade física

Nonlinear Quantum Physics

A solução da equação mestra não-linear

Procura descrever uma onda física real

$$\theta \rightarrow \text{Real wave}$$

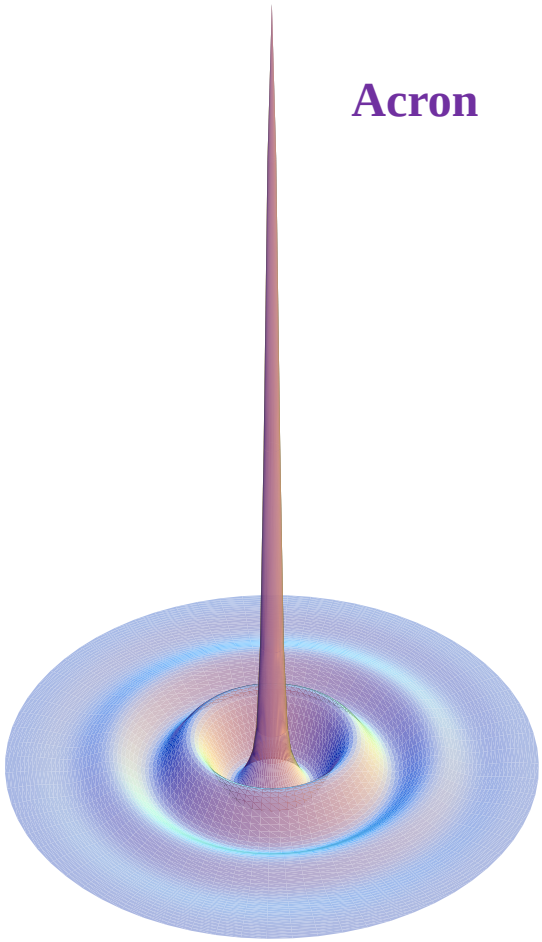
De Broglie
causal quantum particle
solution to the
nonlinear master equation

$$\phi(r) = \left[A_\theta \, e^{-\frac{r^2}{2\sigma_\theta^2}} + A_\xi e^{-\frac{(r-\delta)^2}{2\sigma_\xi^2}} \right] e^{+ikr}$$

Wave+acron

The energy of the particle is for all purposes the one of the acron

$$E_\xi >> E_\theta$$



Não foi tarefa fácil
encontrar um processo
experimental que permitisse
esclarecer a questão da
natureza das ondas quânticas

Tanto quanto sabemos
A primeira ideia para contribuir para o esclarecimento desta questão
foi apenas apresentada
em 1972 por
Paulo Neves
praticamente meio século
depois da sua formulação

P. Neves, *Incerteza e Indeterminação, Interpretação das Relações de Heisenberg*, Seminário do Departamento de Física da Faculdade de Ciências da Universidade de Lisboa, 1972.

1980, Andrade e Silva e sua mulher Maria Helena Andrade e Silva, desenvolveram a idea, em

J. Andrade e Silva and Maria Andrade e Silva - *Une experience possibile concernant la nature du dualismo onde-corpuscule*, C. R. Acad. Sc. Paris, t. 290, 1980.

1983, Andrade e Silva, F. Selleri e J.P. Vigier, apresentaram de modo ainda conceptual, o trabalho,

J. Andrade e Silva, F. Selleri and J.P. Vigier, *Some possible experiments on quantum waves*, Lett. Nuovo Cimento, 36, nº 15, pag. 503, 1983.

.

1985 - Primeira proposta de experiência concreta, sem que existissem aida meios tecnológicos para a realizar.

J.R. Croca, *Can the existence of de Broglie's empty waves be proven experimentally?* In Microphysical Reality and Quantum Formalism, Ed A. Van der Merwe et al., Kluwer Academic Publishers, (285-287) 1988.

The idea was presented in 1985 at the International Conference Microphysical Reality and Quantum Formalism and only published in 1988.

1990 – A primeira experiência proposta
passível de realização concreta
com a tecnologia então disponível,

J.R. Croca, A. Garuccio, V.L. Lepore and R.N. Moreira, *Quantum-Optical predictions for an experiment on de Broglie waves*, Found. Phys. Lett. Vol. 3, nº 6, (557-564) 1990.

1992 – Primeira realização experimental.

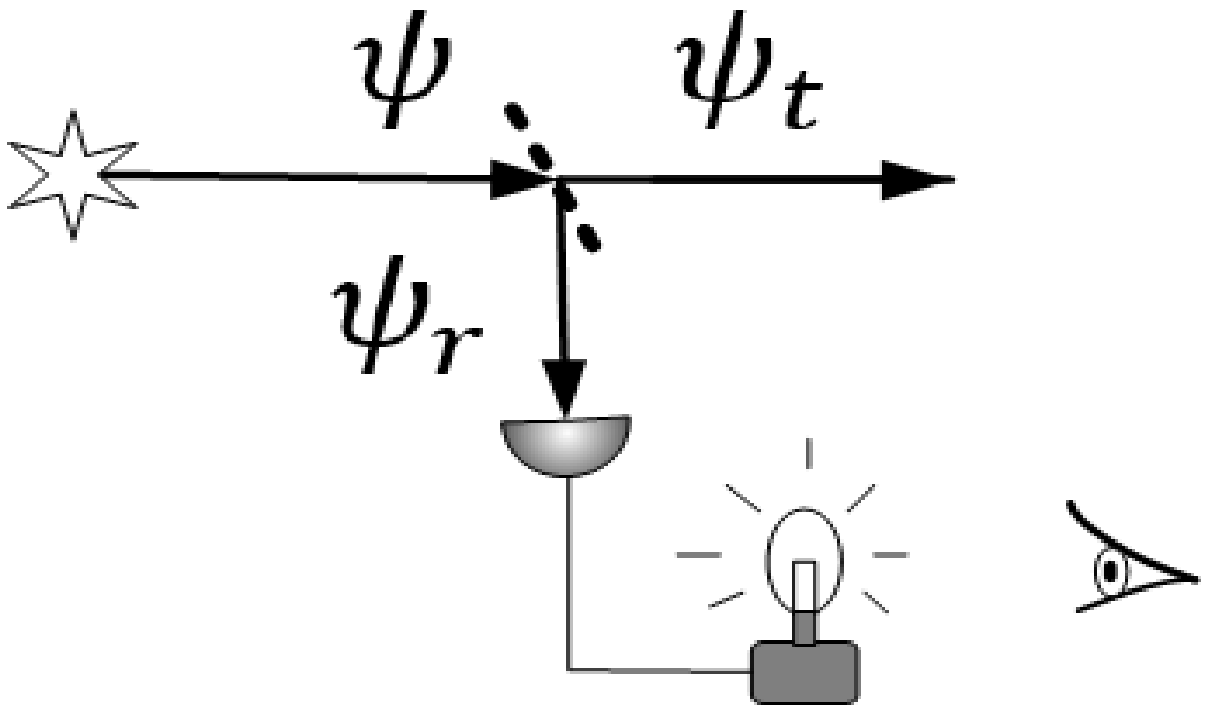
Realizada em University of Rochester USA

X. Y. Zou, T. Grayson, L. J. Wang, and L. Mandel, *Can an 'empty' de Broglie pilot wave induce coherence?* Phys. Rev. Lett. 68, 3667–3669 (1992).

.

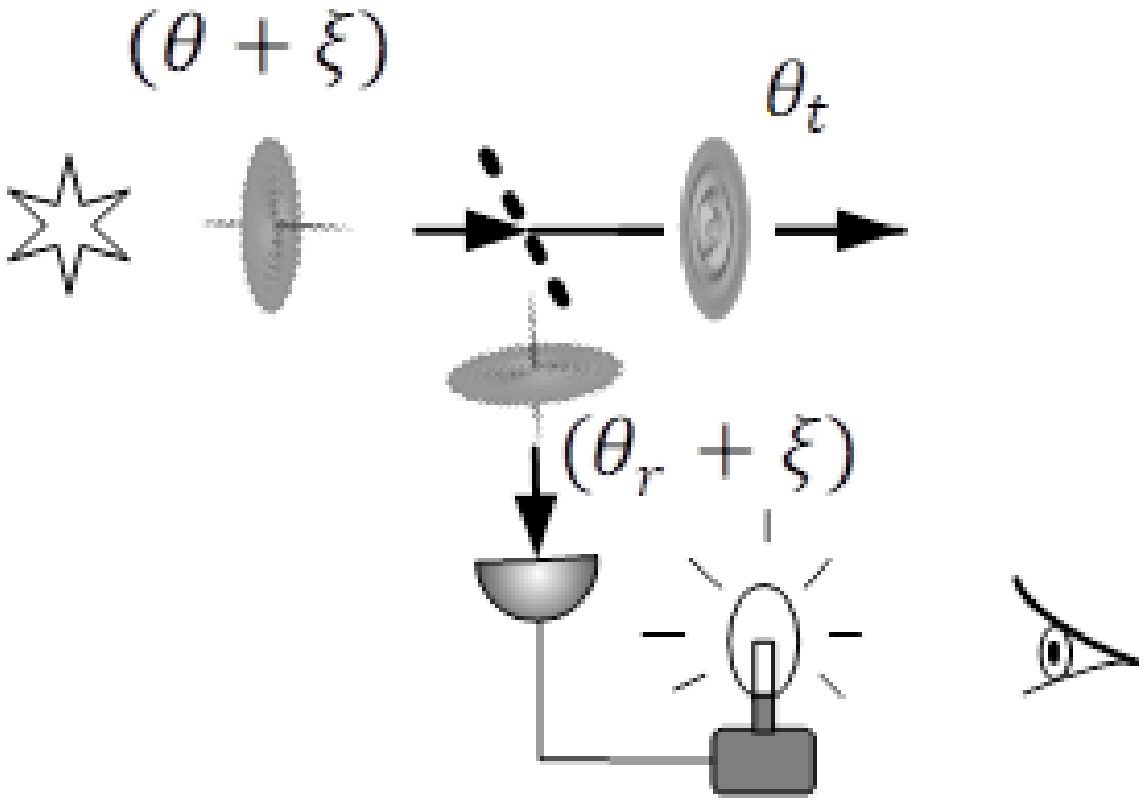
Ideia de base das Experiencias

Mecânica Quântica Ortodoxa

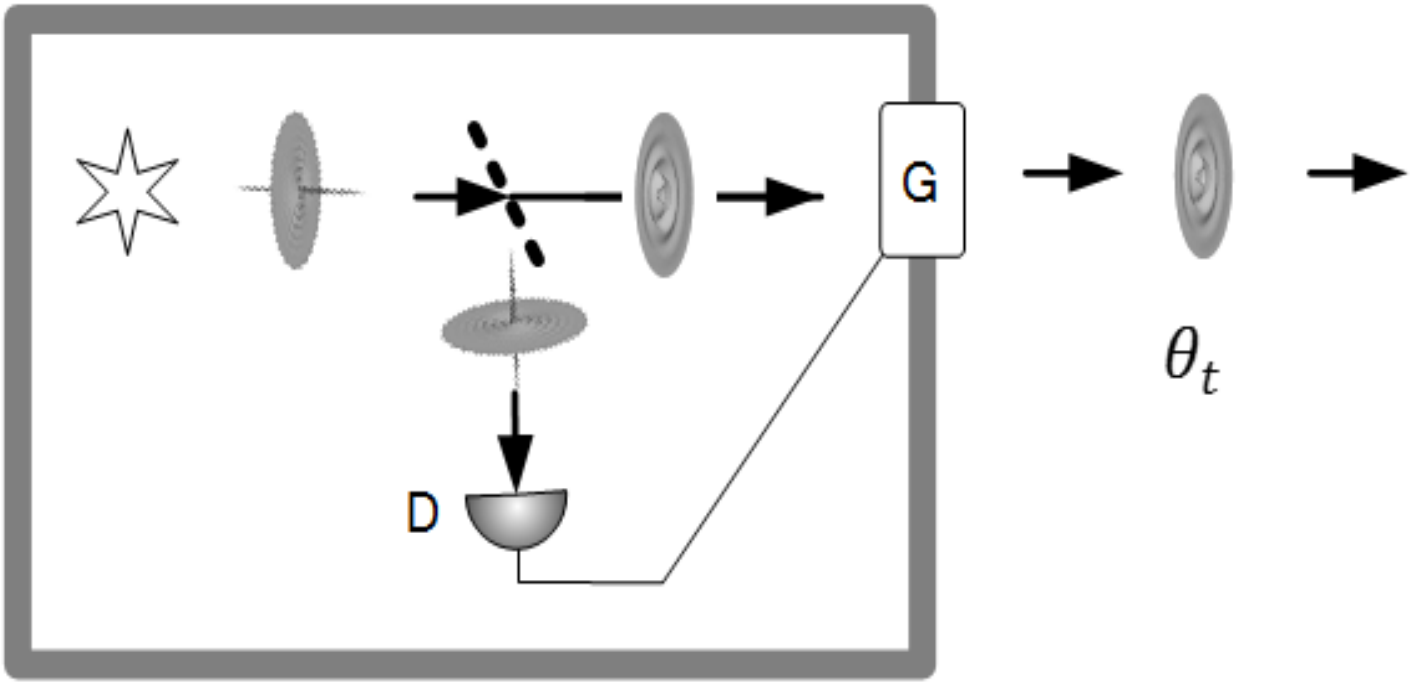


$$\psi = \psi_R + \psi_T \quad \rightarrow \quad \psi = \psi_R \quad \Rightarrow \quad \psi_T = 0$$

Física Realista
Física Eurítmica
Física Quântica Não-linear



Gerador de ondas theta

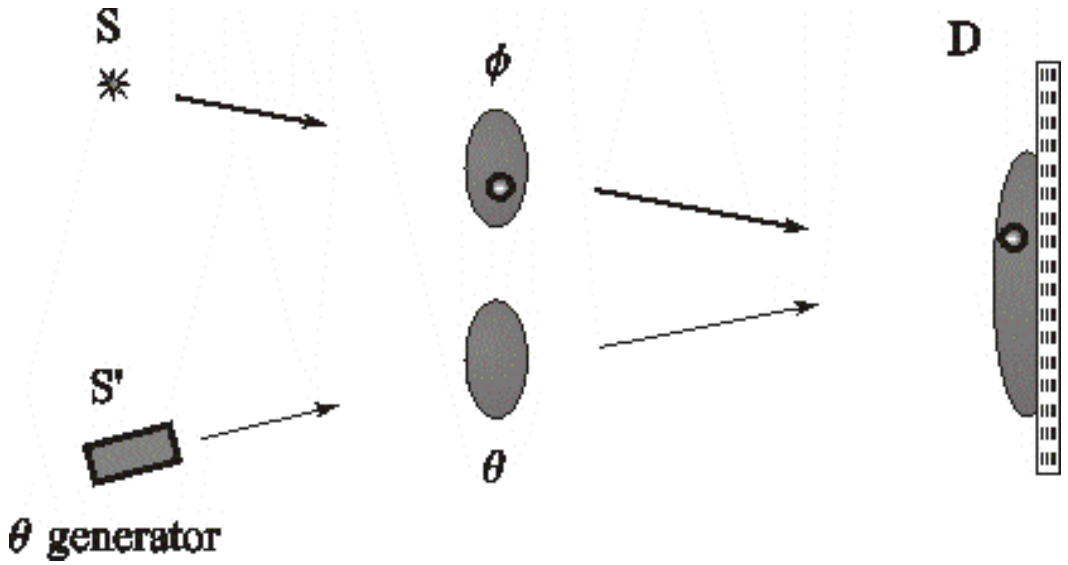


Processos deteção de

ondas theta

Entidades quase desprovidas de energia

Detecção de ondas theta



Física Eurítmica

$$I_c = |\phi + \theta|^2$$

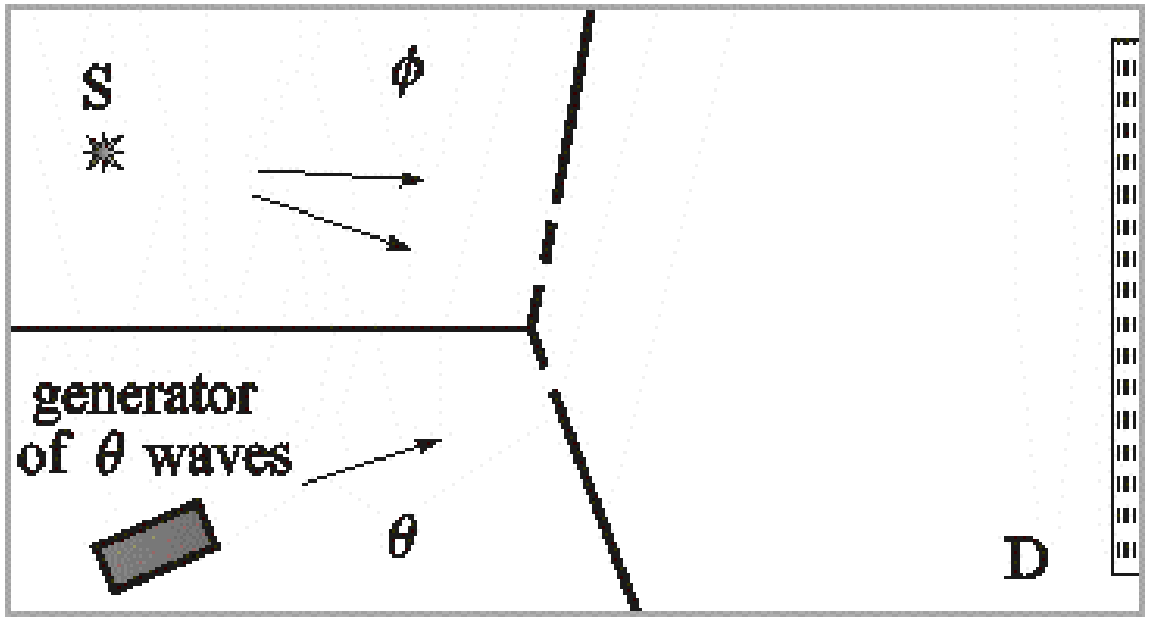
$$I_c \propto |\phi|^2 \, (1 + \cos\delta)$$

Mecânica Quântica Ortodoxa

$$I_o \propto |\phi|^2$$

Problema com este método ? Coerência!

Fontes não coerentes



$$I_c(t_i) \propto |\theta|^2 + |\phi_1|^2 + |\phi_2|^2 + 2|\theta||\phi_1|\cos\delta_{\theta,\phi_1}(t_i) + 2|\theta||\phi_2|\cos\delta_{\theta,\phi_2}(t_i) + 2|\phi_1||\phi_2|\cos\delta_{\phi_1,\phi_2}(t_i)$$

$$I_c \propto |\theta|^2 \left[n(3+2\cos\delta) + 2\sum_{i=1}^{n}\cos\delta_{\theta,\phi_1}(t_i) + 2\sum_{i=1}^{n}\cos\delta_{\theta,\phi_2}(t_i) \right]$$

Previsão Realista

$$I_c \propto (1 + \frac{2}{3}\cos\delta)$$

Visibilidade: 2/3

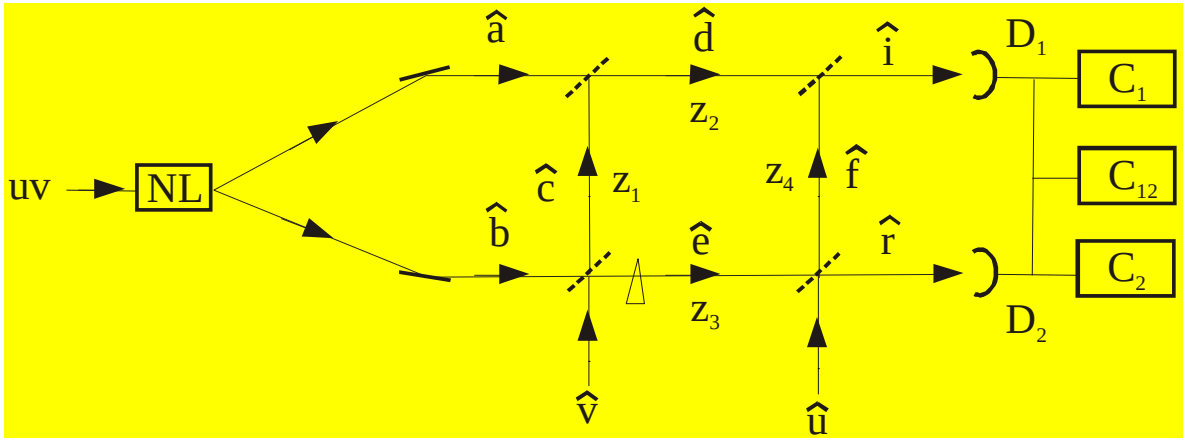
$$V = \frac{I_M - I_m}{I_M + I_m}$$

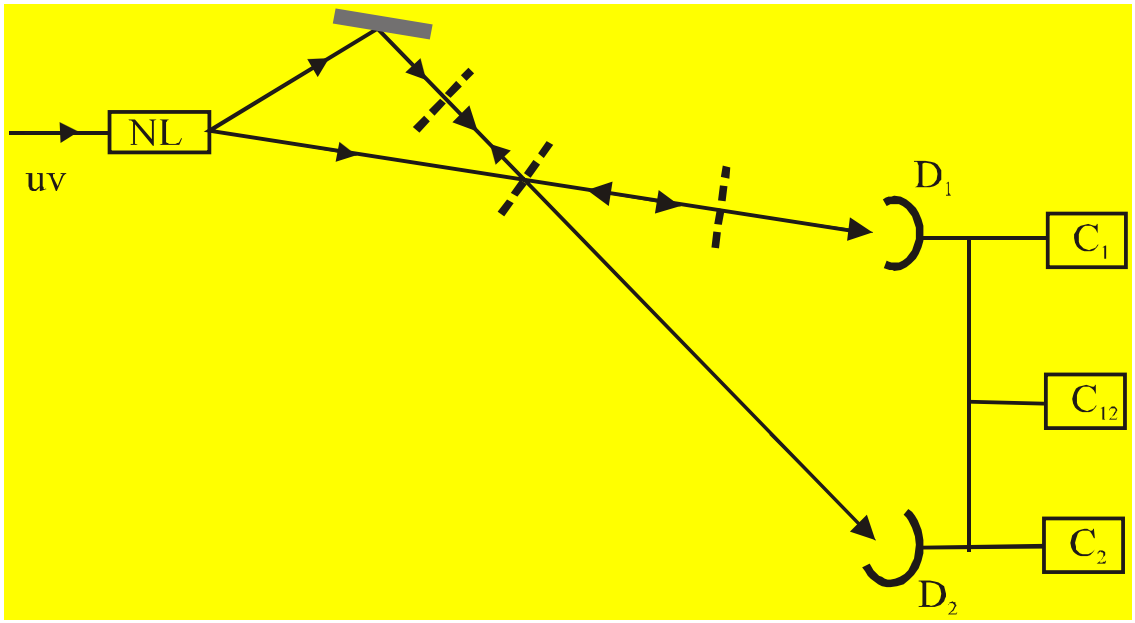
Previsão Idealista

$$I_o \propto (1 + \cos\delta)$$

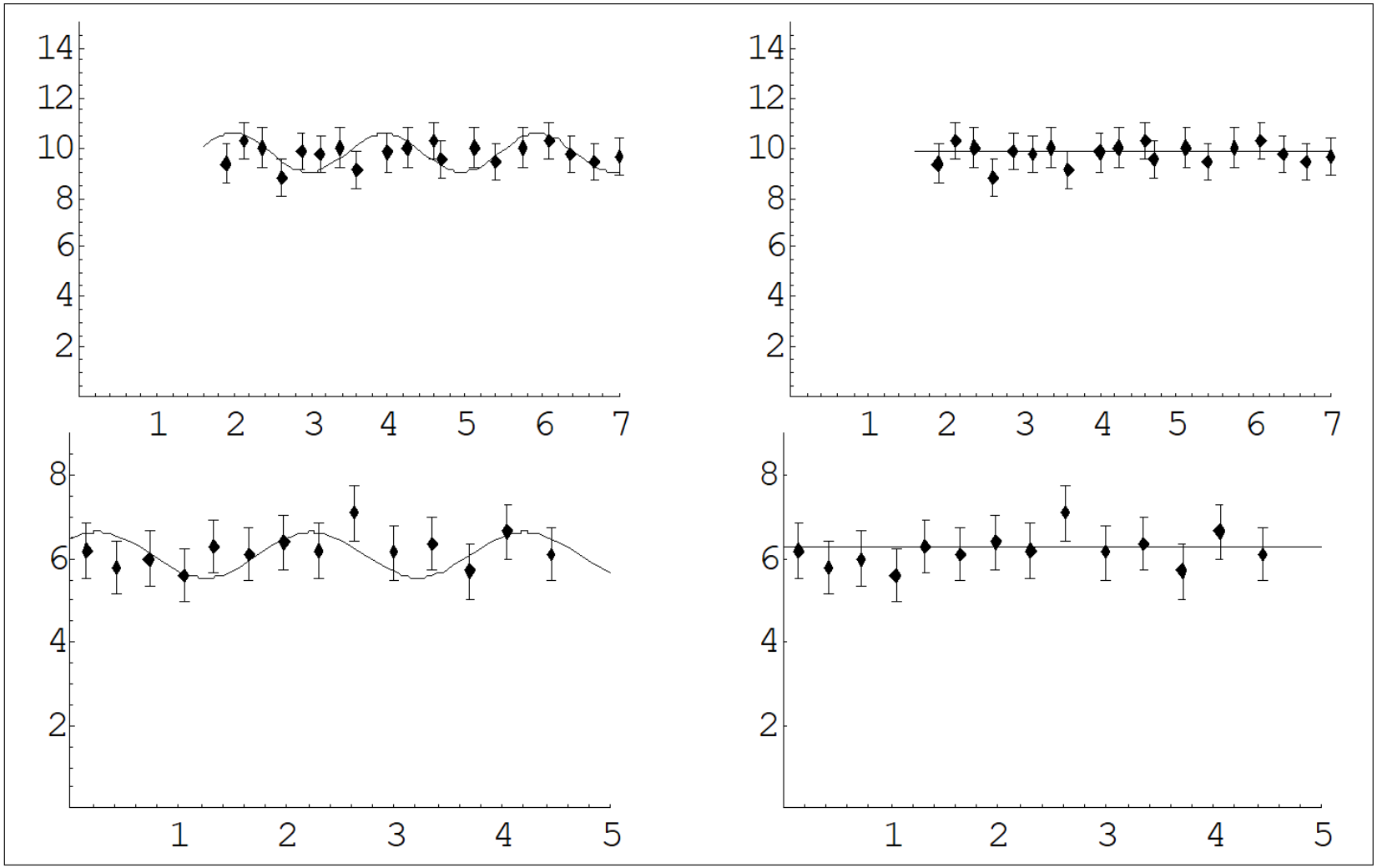
Visibilidade: 1

1996 - Experiência realizada por Mandel e seu Grupo de Ótica Quântica





Resultados



2012 - Deteção das ondas theta por outro processo

R. Menzel, D. Puhlmanna, A. Heuera, and W. P. Schleich, *Wave-particle dualism and complementarity unraveled by a different mode*, 9314–9319 | PNAS | June 12, 2012 | vol. 109 | no. 24;

R. Menzel, A. Heuer, D. Puhlmann, W.P. Schleich, *Wave-particle dualism and complementarity unraveled by a different mode*, PNAS 2012, **109,** 9314–9319

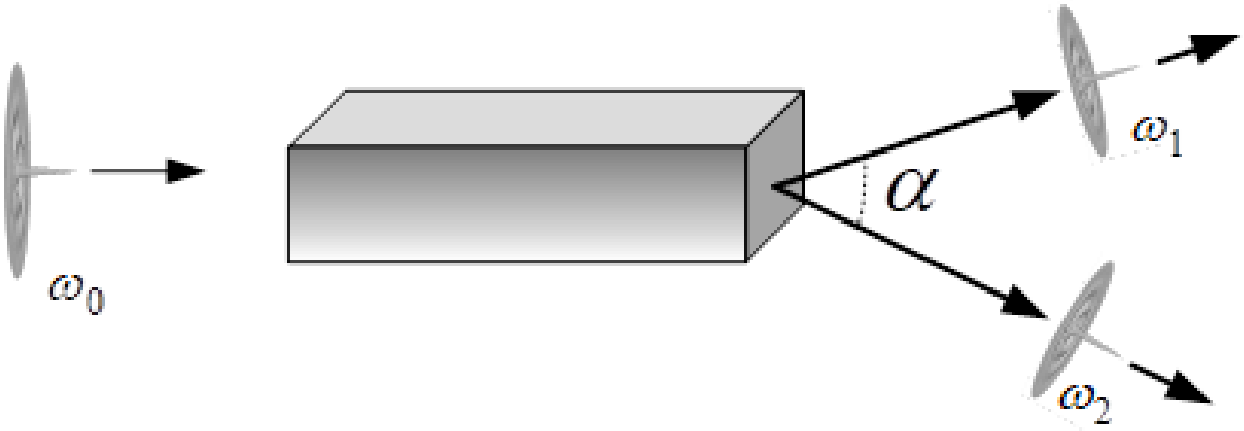
R. Menzel , A. Heuer , D. Puhlmann , K. Dechoum , M. Hillery , M.J.A. Spähn, W.P. Schleich (2013): *A two-photon double-slit experiment*, Journal of Modern Optics, 60:1, 86-94;

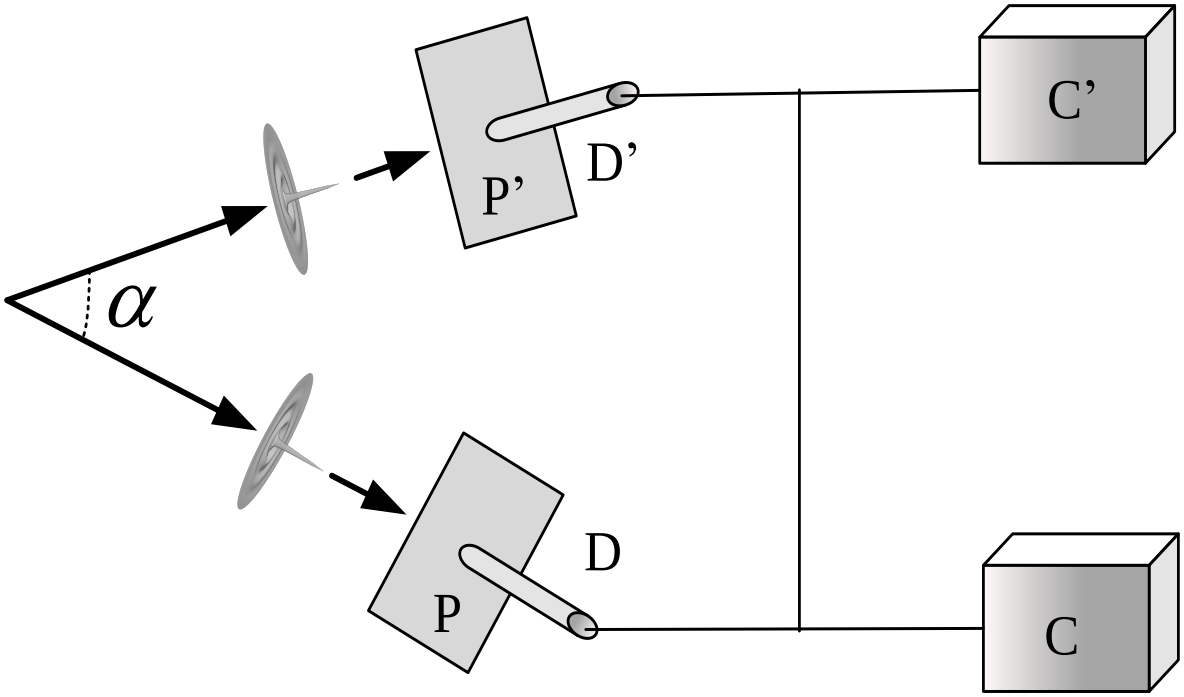
Ghost imaging

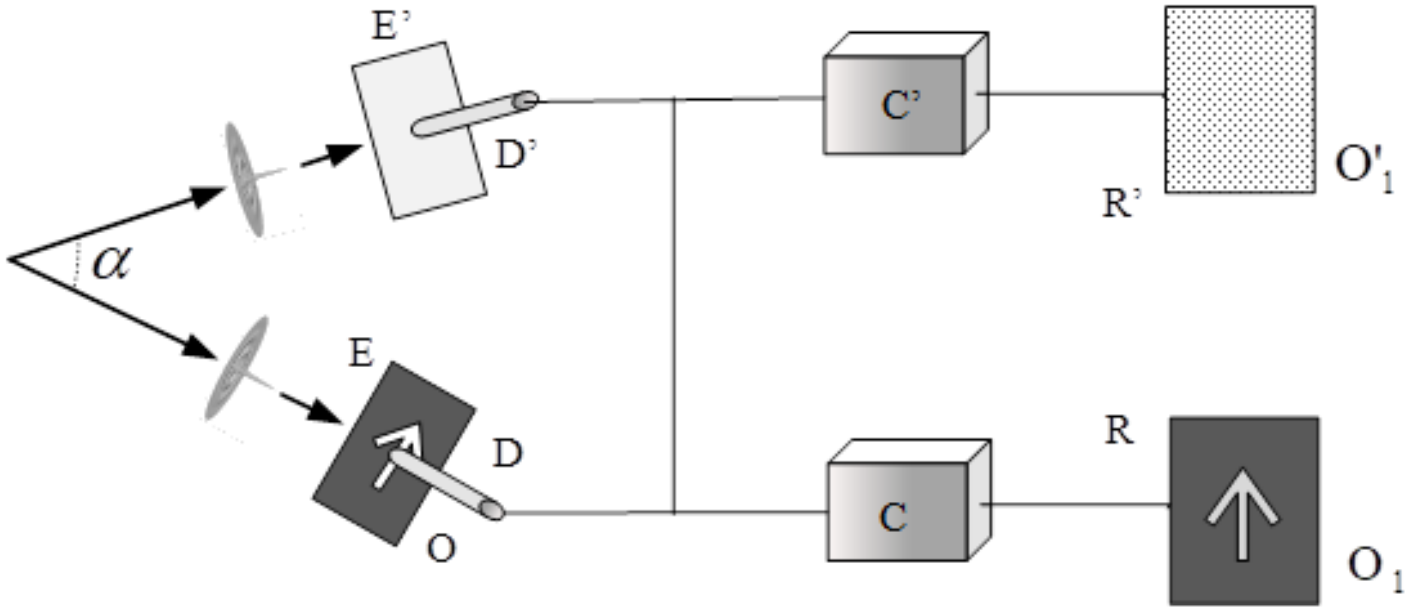
Ghost imaging is a recent technique based on the quantum nature of the light.

Specifically it is based on the temporal and spatial correlation between twin photons produced by a nonlinear crystal in a parametric down conversion.

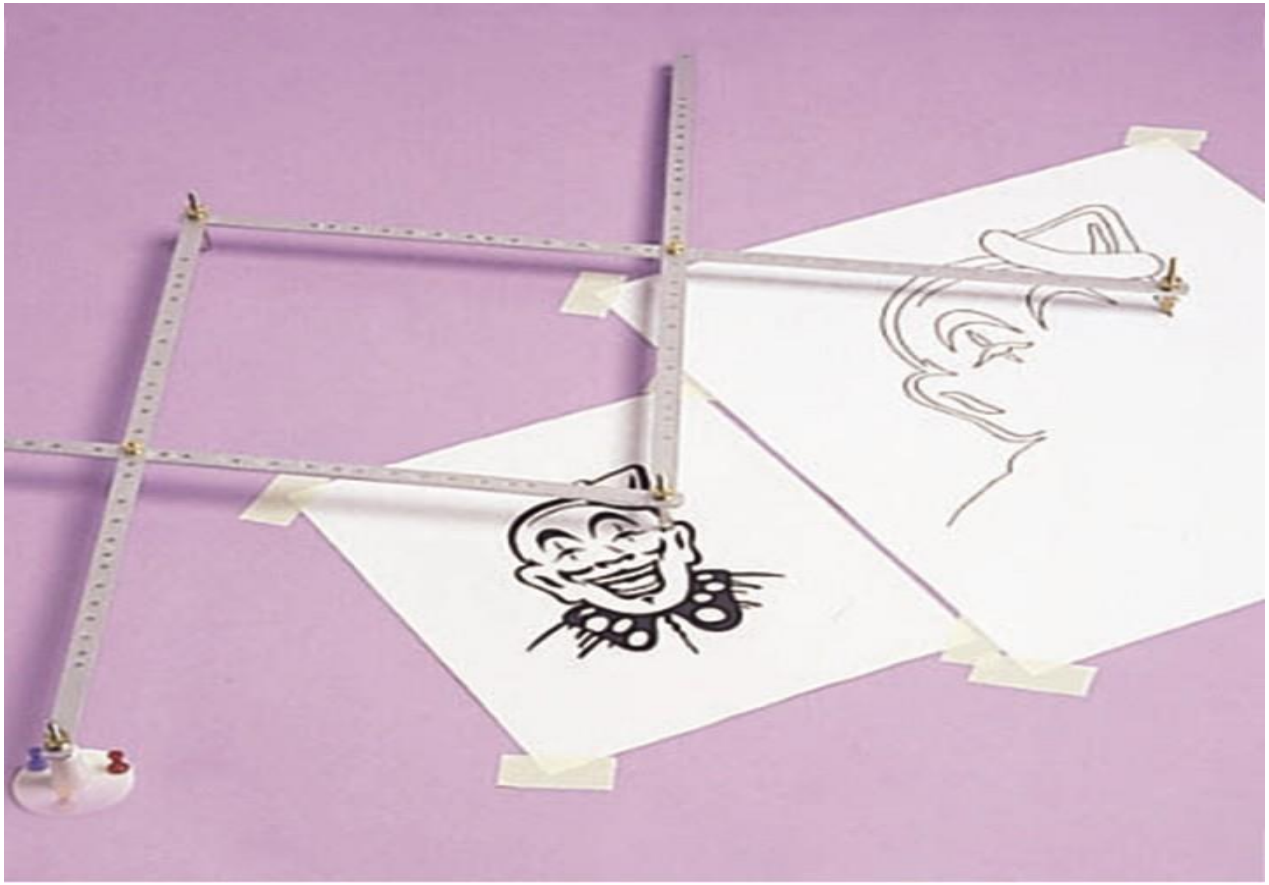
Yanhua Shih, *The Physical Principles of Ghost Imaging*, arXiv: 0805.1166v5 [quant-ph] 29 Sep 2009.


ω_0
α
ω_1
ω_2


C’
D’
P’
α
D
P
C


E'
D'
C'
R'
O'1
α
E
D
O
C
R
O 1

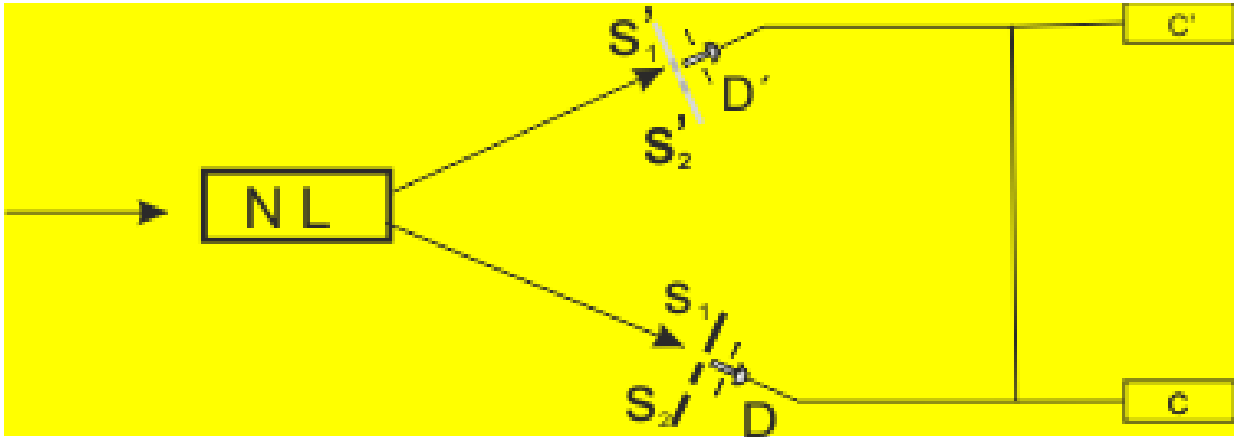
Ghost imaging technique
as some similarities with what could be called
one-to-one
Tele Pantographic technique




RDECOM
A Quantum Network with Atoms & Photons
(QNET-AP)
iqi
STRATEGIC IMPACT TO THE ARMY
RDECOM
QNET-AP
Entangle Distant Atomic Memories with Photons Between ARL & JQI
• Integrate and advance demonstrated technology components
ARL & JQI Atomic
ith Photons

Ghost imaging

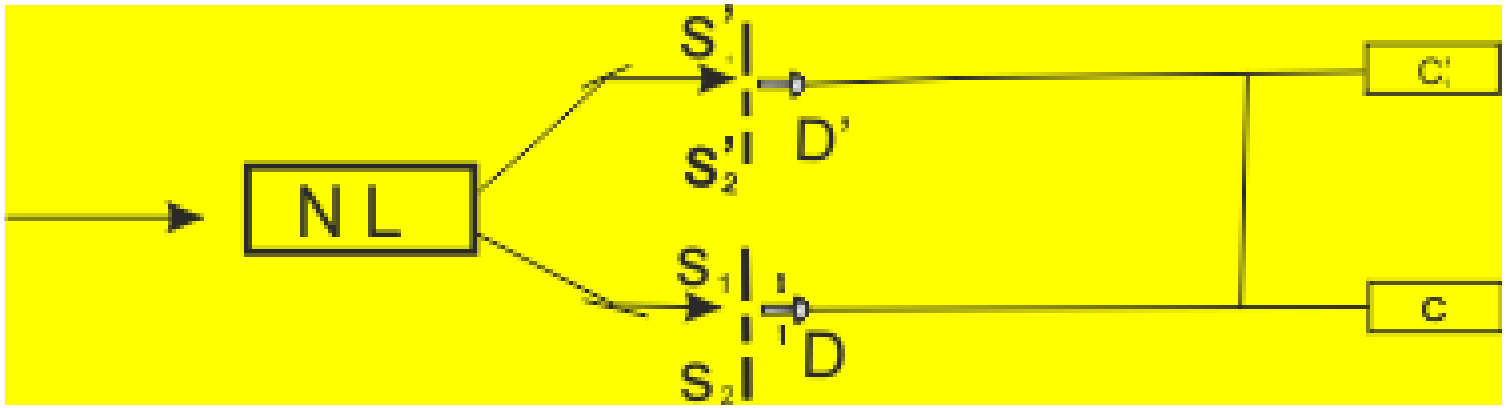
Specifically it is based on
the temporal and spatial correlation
between twin photons
produced by a nonlinear crystal
in a parametric down conversion.



Two-photon double-slit experiments

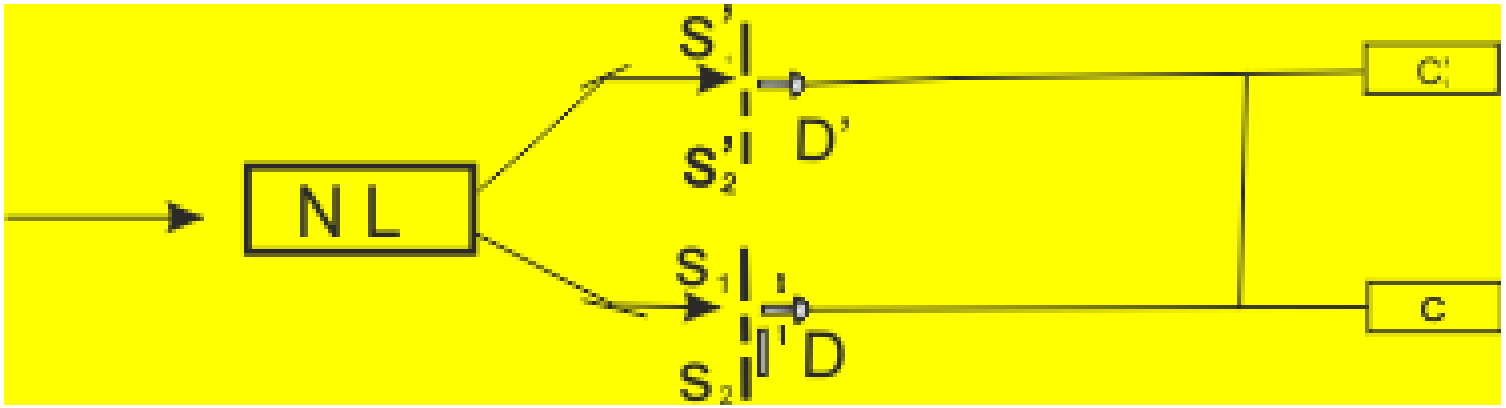
In a beautiful experiment R. Menzel, A. Heuer and other researchers have shown a very interesting result.

Basically their experiment consists in a slight modification of the typical ghost imaging technique.



Now if we close slit S_2 we are precisely

in the same physical conditions



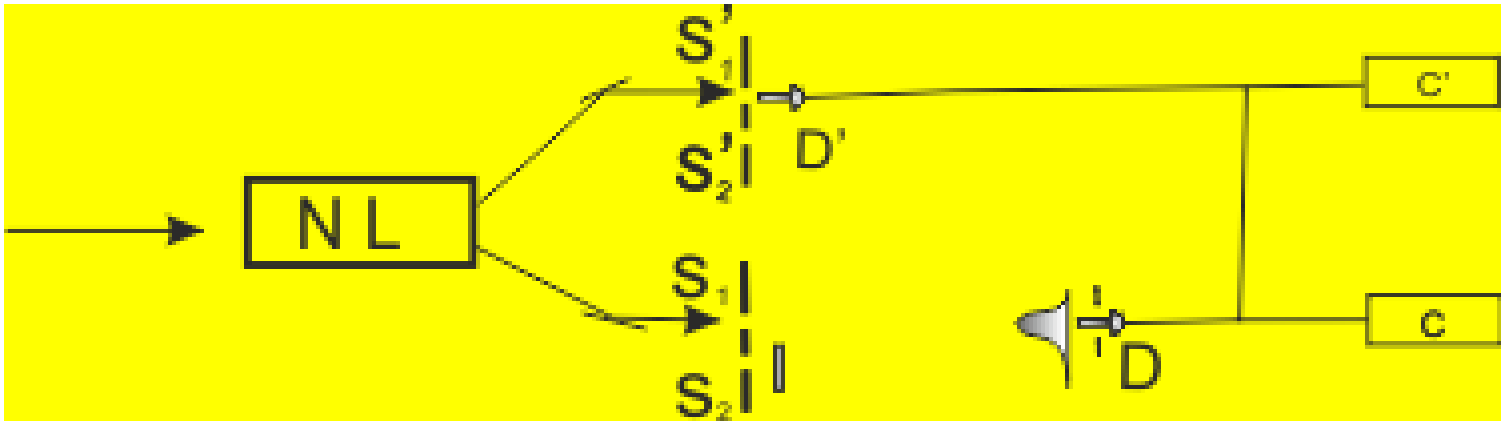
.

Now instead of making the traditional observation in the near field

for both detectors

Their idea was to fixe one detector D' in the near field at position S_1'

and put the other D at the far field

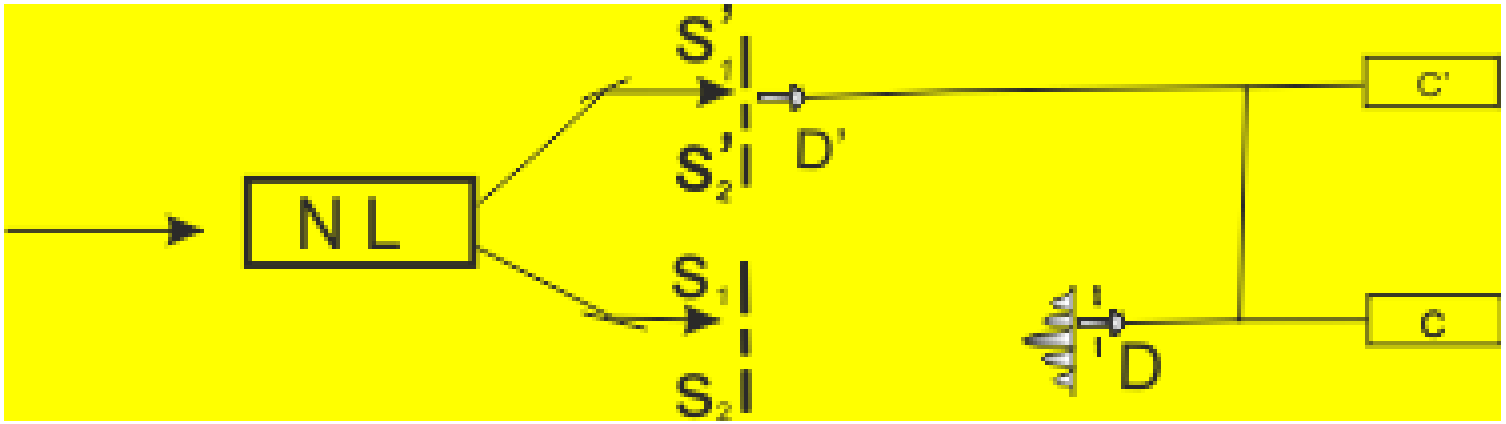


when the detector D scans the far field plane we observe a Gaussian distribution

Now by removing the shutter from slit S_2 what shall be observed

since we know that nothing goes along this slit

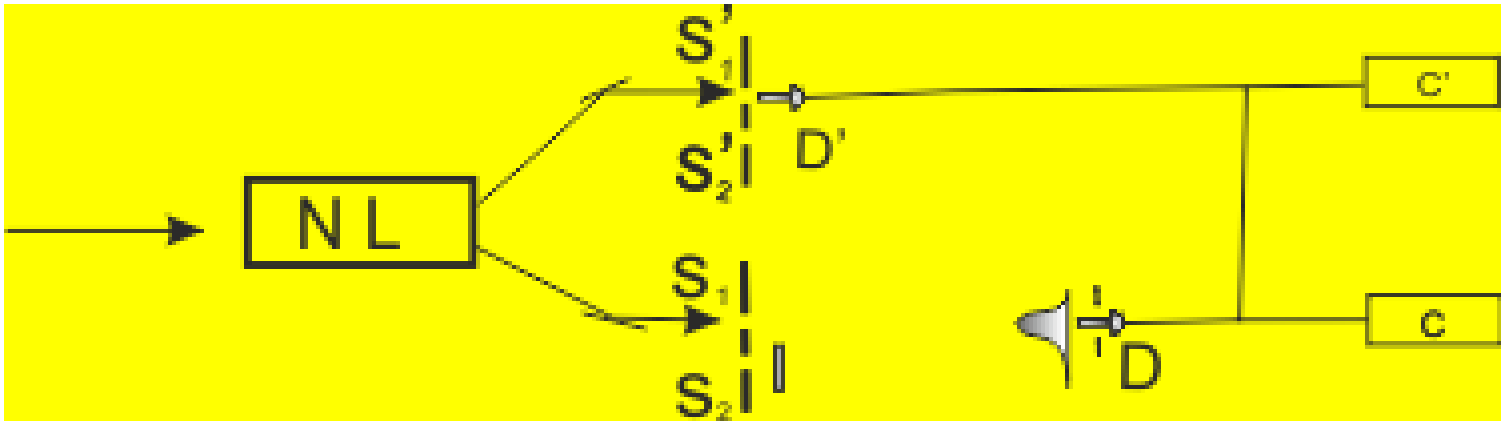
as can be easily confirmed by placing a detector in front of it?



Still surprising!

When the detector D scans the far field plane a net interference pattern appears.

Again by closing slit S_2



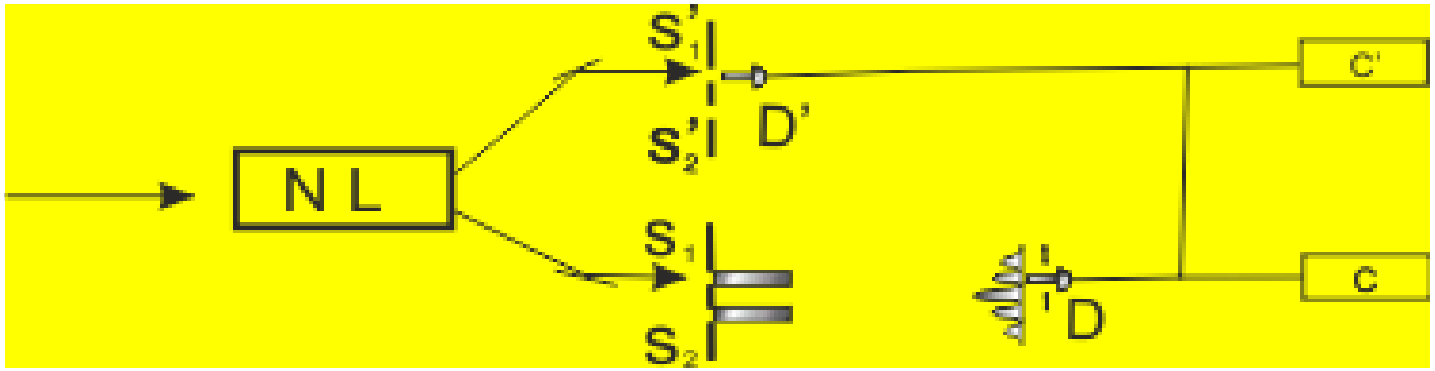
the interference pattern disappears

given way, as expected, to a Gaussian distribution.

Actually these were the experiments made by the German group.

Now it is possible to think about some minor modifications of the previous experiments:

Consider the situation in which along the slit S_1 and S_2 we place two short optical fibers



This setup is conceptually equal to the previous experiment.
Consequently, if again we scan the far field observation plane a clear interference pattern shall be expected
Naturally, if the lower fiber corresponding to exit slit S_1 is blocked no interference is to be expected.

As can be easily be seen the experimental setups, are in all equal to the ones presented before in which there were expected modifications in the counting distribution at the output ports of the upper Mach-Zehnder interferometer.

This change in the counting rate

is due to the fact that

something

had arrived by the lower input port.

In this case this something

is the real physical subquantum wave.

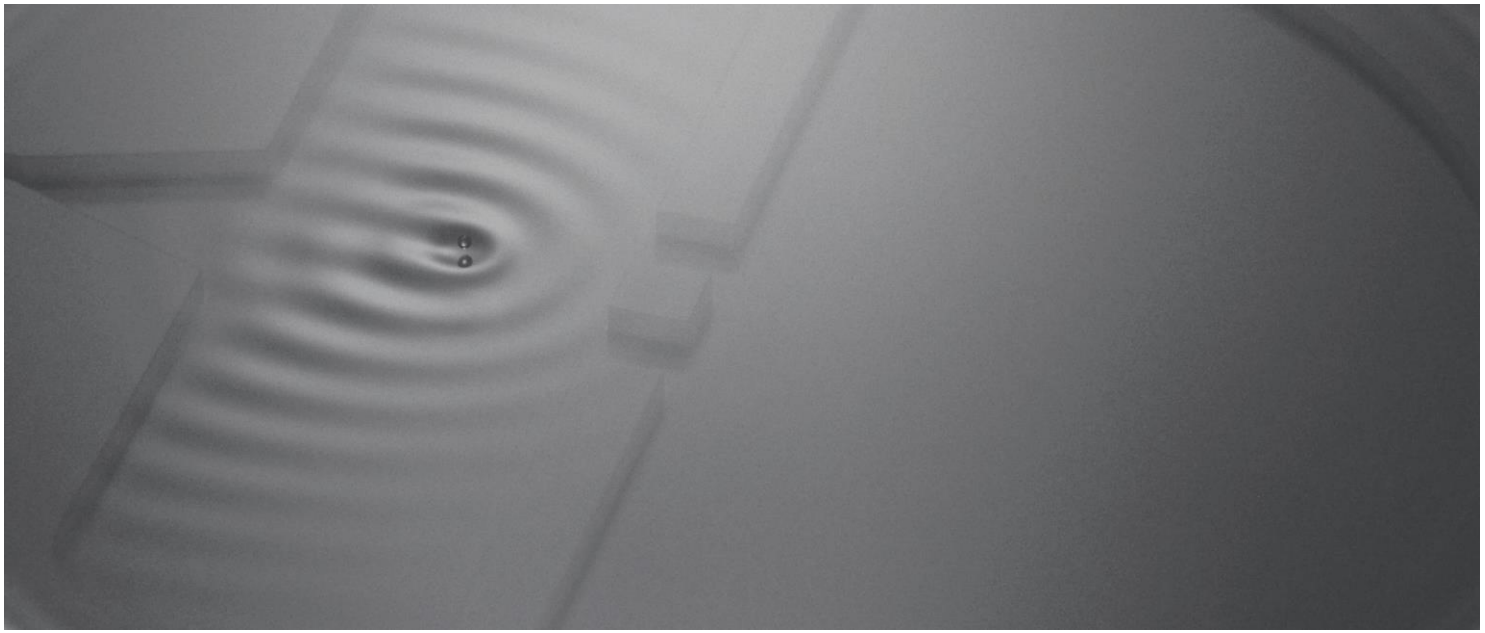
So, these facts complete
the experimental demonstration
of the real physical existence
of these so subtle
subquantum waves.

Análogo quântico macroscópico

Droplets

8 - Y. Couder, S. Protière, E. Fort, and A. Boudaoud. Walking and orbiting droplets. Nature, 437(208), 2005

9 - Bush, J.W.M., 2015. Pilot-wave hydrodynamics, *Ann. Rev. Fluid Mech.*,47, 269-292



Conclusion

From the presented experiments

we may see that the quest

for the detection of these

real physical yet so elusive subquantum waves,

after nearly a century,

has finally reach its goal.

Still, as good scientific practice teaches us,

these experiments need to be redone under the most diverse situations to confirm these results.

Yet, even more important is the fact
that these recent experimental achievements
have opened a whole new realm
for important
conceptual and technological
developments.

The confirmation of the reality of the subquantum waves, or theta waves or de Broglie waves, leads us to the conclusion that the principle of complementarity and consequently that orthodox quantum mechanics, has indeed reached it limits of adequacy in the description and prediction of the subquantum realm.

Outras experiências sobre a natureza das ondas subquânticas

Fourier ontology

The fundamental empirical formulas of quantum physics: Planck and de Broglie are:

$$\begin{cases} E = \hbar\omega \\ p = \hbar k \end{cases} \Rightarrow \quad \psi = Ae^{i(kx-\omega t)}$$

They relate the temporal and the spatial frequencies
of a wave with the energy and momentum.

Question:
To which wave they are related?

Fourier ontology claims: Harmonic plane wave infinite both in time and space.

In this ontology only the abstract physically inexistent harmonic plane waves
do have a perfect frequency

Nonlinear approach:

$$\begin{cases} E = \hbar\omega \\ p = \hbar k \end{cases} \quad \Rightarrow \quad \theta = Ae^{-\frac{(x-vt)^2}{2\sigma_0^2} + i(kx-\omega t)}$$

These fundamental formulas are related with the Gaussian or Morlet wavelet.

Here a finite wave, a finite sign may have a well definite frequency.

Naturally in the limit the gaussian wavelet approaches
the infinite harmonic plane wave

Question is it possible to distinguish experimentally
between Fourier linear ontology and the nonlinear approach?

The answer is Yes!

In practice the experiment is designed to determinate the size of the mother wavelet.
To do that we test the validity of the general uncertainty relations

$$\sigma_{\mathrm{c}\,x}^2 = \frac{1}{\sigma_k^2 + \frac{1}{\sigma_0^2}}$$

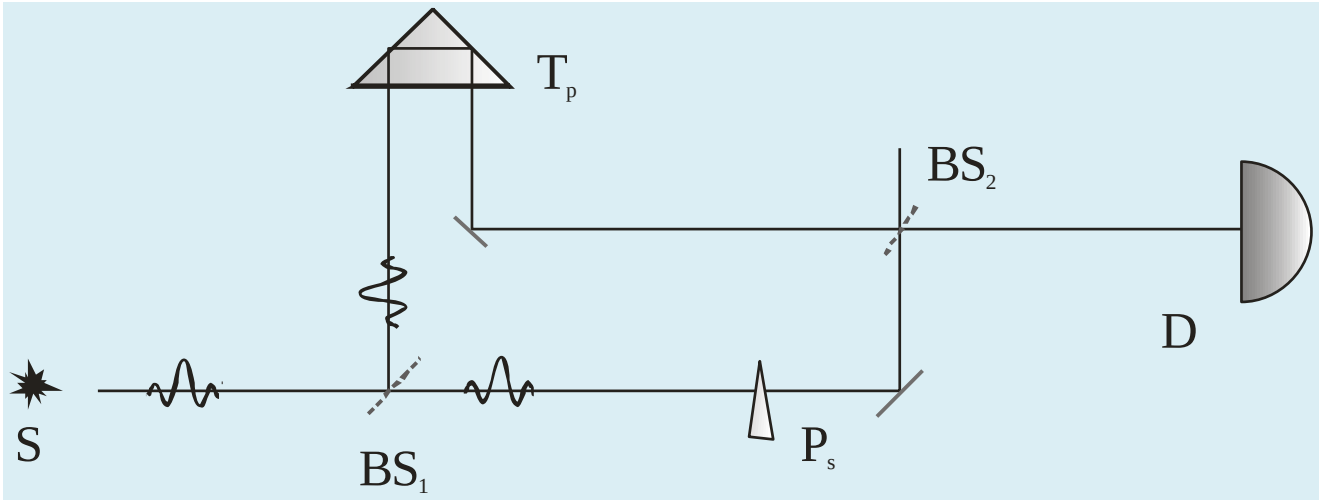
$$\sigma_0 = M\,\lambda$$

against the common Heisenberg relations.

$$\sigma_{\mathrm{orth}\,x} = \frac{1}{\sigma_k}$$

In the end to know if the waves with a single frequency, energy, are finite or infinite

Experiment



The monophotonic source, a parametric down converter, emits photons one at a time. These photons can approximately be described by a gaussian function

$$\psi = A_0\, e^{-\frac{(x-ct)^2}{2\sigma_x^2}+ik(x-ct)}$$

Upon arriving at beamsplitter BS_1 the pulse is reflected and transmitted. In such conditions, one pulse follows on the upper path, path 1, the other the lower path, path 2, mixing at the beamsplitter BS_2.

These pulses, assuming that we are dealing with 50% beamsplitter can be described by

$$\begin{cases} \psi_1^{'} = A' e^{-\frac{(x-ct-\xi)^2}{2\sigma_x^2}+ik(x-ct-\xi)} \\ \psi_2^{'} = A' e^{-\frac{(x-ct)^2}{2\sigma_x^2}+ik(x-ct)+i\delta} \end{cases}$$

The arriving waves at the detector apart from the constant coefficients are essentially the same. So, the expected intensity seen at D is given by

$$I = |\psi_1 + \psi_1|^2 = |\psi_1|^2 + |\psi_2|^2 + \psi_1^* \psi_2 + \psi_1 \psi_2^*$$

Giving after some trivial calculations

$$I = A^2 \left[e^{-\frac{(x-ct-\xi)^2}{\sigma_x^2}} + e^{-\frac{(x-ct)^2}{\sigma_x^2}} + 2\, e^{-\frac{(x-ct-\xi)^2+(x-ct)^2}{2\sigma_x^2}} \cos(\xi+\delta) \right]$$

Now the interference visibility is given by formula

$$V = \frac{I_M - I_m}{I_M + I_m}$$

After some simplifications we have for the expected generic visibility

$$V = \frac{2e^{-\frac{\xi^2}{2\sigma_x^2}}}{1+e^{-\frac{\xi^2}{\sigma_x^2}}}$$

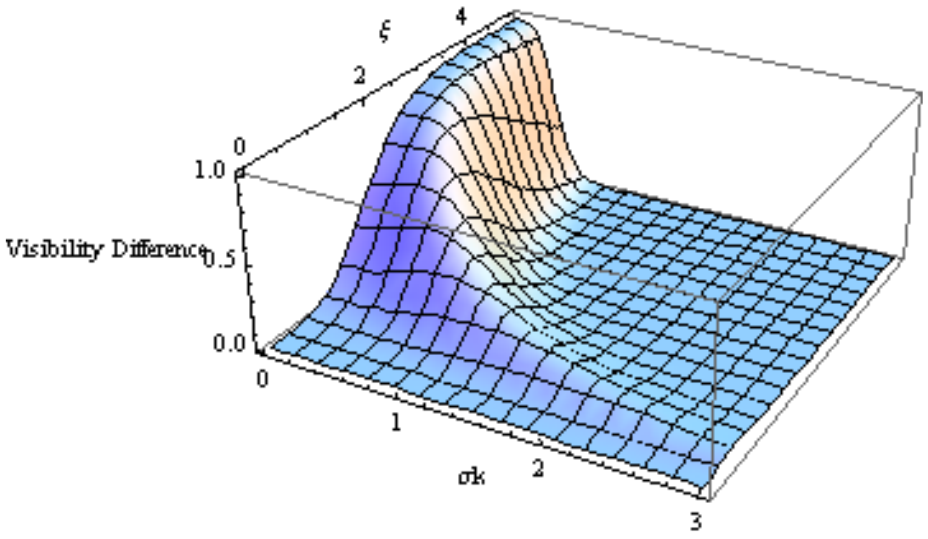
Fourier ontology, that is for orthodox quantum mechanics assumes the form

$$V_{\text{orth}} = \frac{2e^{-\frac{1}{2}\sigma_k^2\xi^2}}{1+e^{-\sigma_k^2\xi^2}}$$

The nonlinear prediction

$$V_{\text{c}} = \frac{2e^{-\frac{1}{2}(\sigma_k^2+\frac{1}{\sigma_0^2})\xi^2}}{1+e^{-(\sigma_k^2+\frac{1}{\sigma_0^2})\xi^2}}$$

Difference in predictions



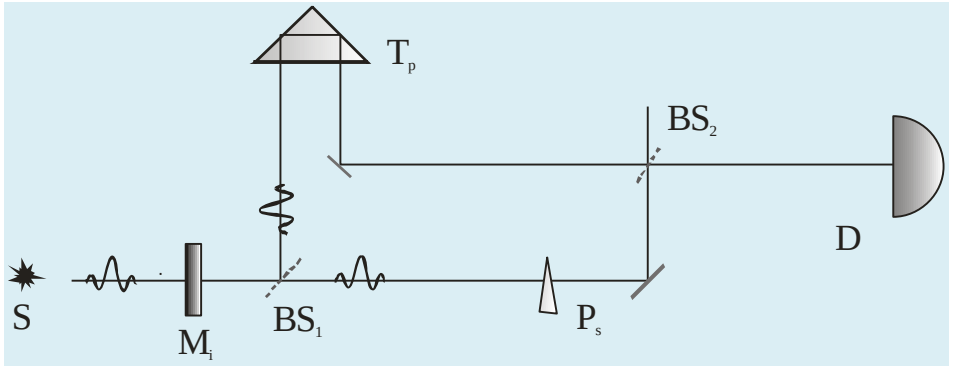
In the experimental setup we start increasing the path difference from the initial value

$$\xi_0 = 0 \quad \rightarrow \quad \xi_1$$

till the visibility changes form one to zero

$$V_0 = 1 \rightarrow V_1 = 0$$

Now a monochromator M_1 is placed before the interferometer.



In such situation we recover the visibility, since the action of the monochromator is to change the bandwidth from

$$\sigma_{0k} \rightarrow \sigma_{1k}, \quad \sigma_{0k} > \sigma_{1k}$$
$$\sigma_{0x} \rightarrow \sigma_{1x}, \quad \sigma_{0x} < \sigma_{1x}$$

This experimental procedure of placing better monochromators M_1, M_2, M_3, … M_m, decreasing the bandwidth

$$\sigma_{0k} > \sigma_{1k} > \sigma_{2k} > \cdots > \sigma_{mk}$$

increasing the path difference

$$\xi_0 < \xi_1 < \xi_2 < \cdots < \xi_m$$

Orthodox quantum physics

we can repeat the process infinitely till at the end
we have a perfect, a pure frequency, that is an harmonic plane wave which is infinite.

$$\sigma_{\mathrm{orth}\,x} = \frac{1}{\sigma_k}$$

$$\xi_0 < \xi_1 < \xi_2 < \cdots < \xi_m < \cdots < \xi_\infty = \infty$$
$$\sigma_{0k} > \sigma_{1k} > \sigma_{2k} > \cdots > \sigma_{mk} > \cdots > \sigma_k = 0$$
$$\sigma_{0x} < \sigma_{1x} < \sigma_{2x} < \cdots < \sigma_{mx} < \cdots < \sigma_x = \infty$$

So no matter the optical path difference we should always wave interference.

Nonlinear physics

when the path difference exceeds the size of the basic wavelet
no interferences are to be seen
no matter how good the monochromator is

$$\sigma_{cx}^2 = \frac{1}{\sigma_k^2 + \frac{1}{\sigma_0^2}}$$

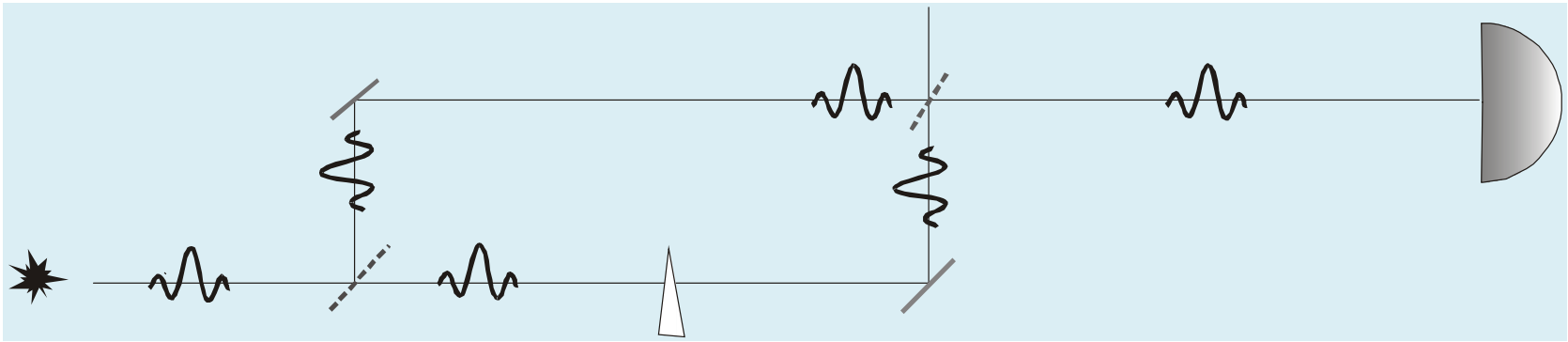
$$\xi_0 < \xi_1 < \xi_2 < \cdots < \xi_m < \cdots < \xi_\infty = \infty$$

$$\sigma_{0k} > \sigma_{1k} > \sigma_{2k} > \cdots > \sigma_{mk} > \cdots > \sigma_k = 0$$

$$\sigma_{0x} < \sigma_{1x} < \sigma_{2x} < \cdots < \sigma_{mx} \approx \sigma_0 \approx \cdots \approx \sigma_x = \sigma_0$$

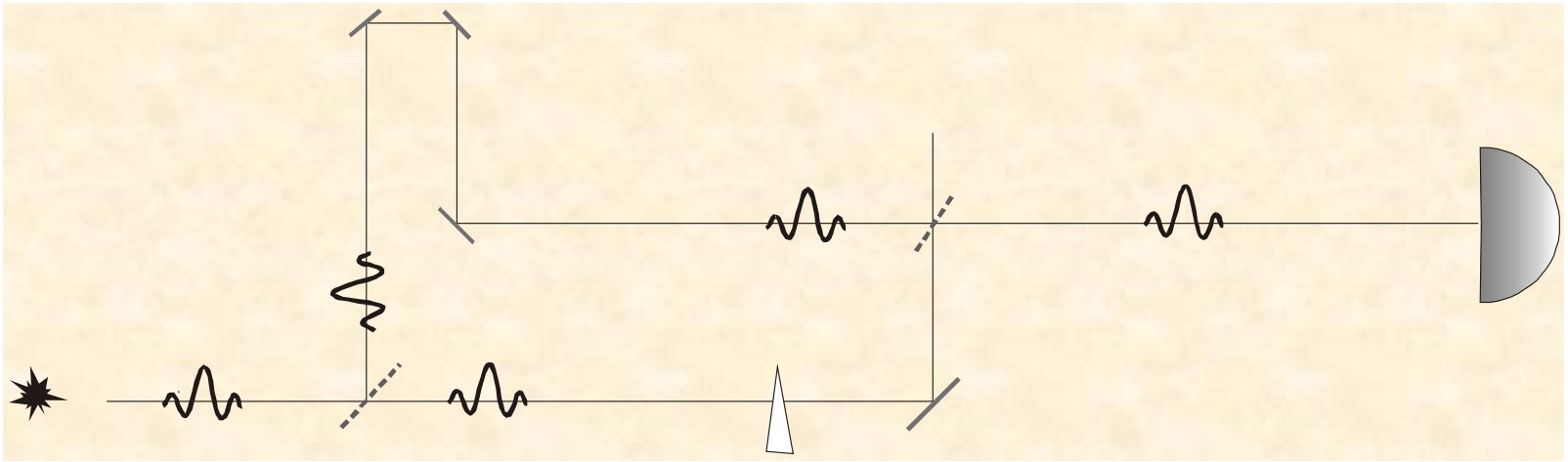
Non-Local interferometry

Consider the following interferometric experiment



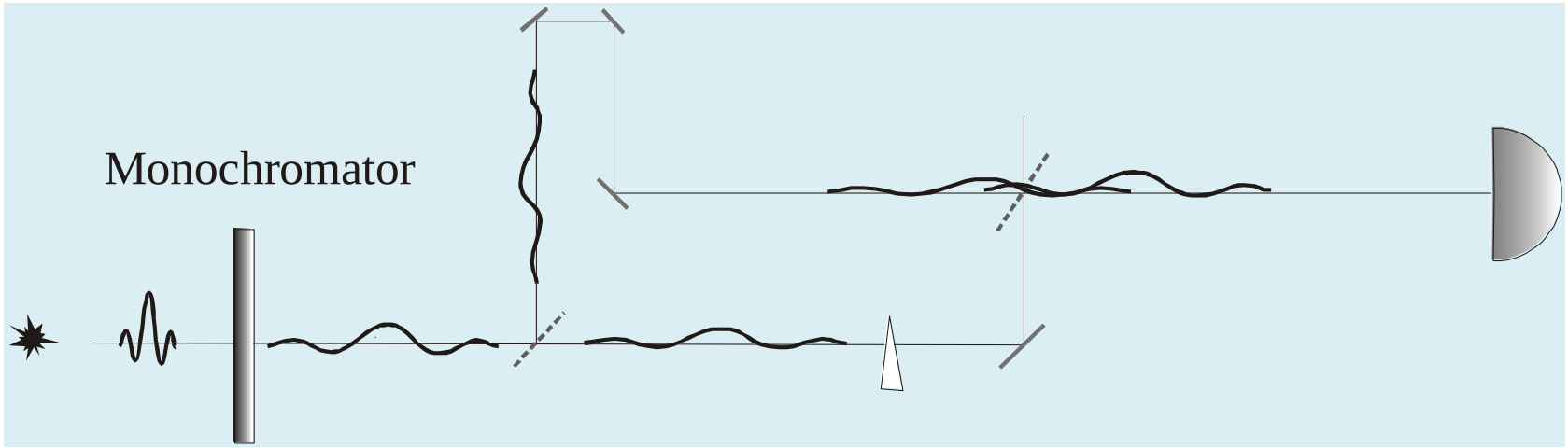
Interference is observed

Now with asymmetric arms



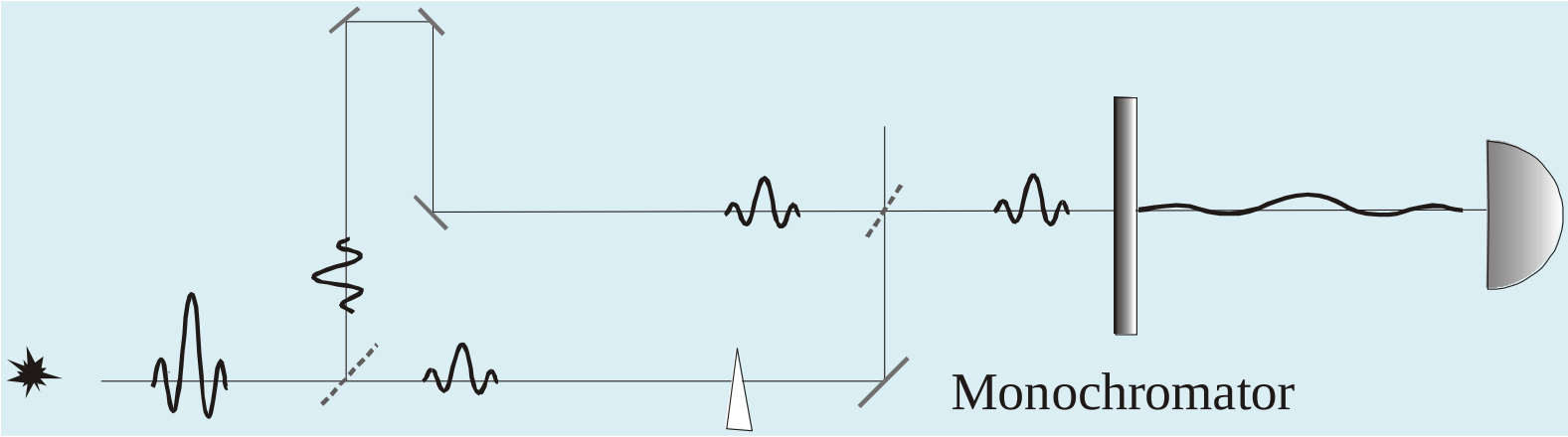
No interference is observed

With the monochromator placed **before** the interferometer



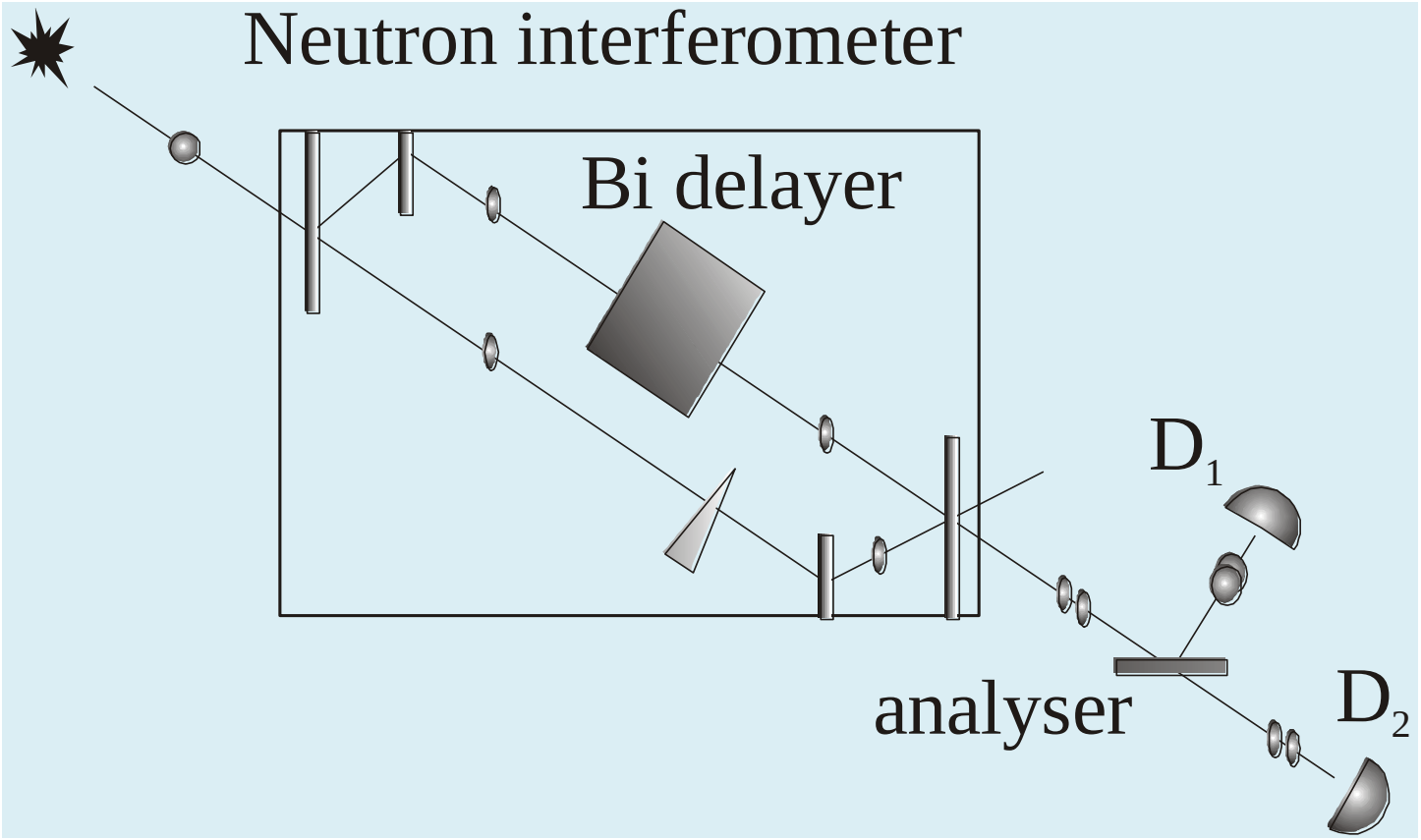
Superposition is recovered and consequently
interferences **are** observed

With the monochromator placed **after** the interferometer



What is to be expected?

Concrete experiment done by Rauch's team



Interference reappears!

How can this be explained?

Retroaction in time

A real action
in the past is done
in this particular experiment???

Wrong answer!

This explanation so dear to some is
Against orthodox quantum mechanics
Against Fourier ontology

Because all time and space are included
not only in
the conceptual framework but also in the formalism
There is **NONLOCALITY** both in time and space

Since we are dealing with
infinite harmonic waves
composing the wave packet,
there are always interference
even if we do not observe them.

In some special conditions
it will indeed be possible to observe them,
by removing the noise

Nonlinear quantum physics

No rectroaction in time

Since the wavelets, finite waves ,
are larger than the optical path difference
interference,
just like in orthodox quantum physics are expected when the noise is removed

Still this same experimental device
can be used to test both theories

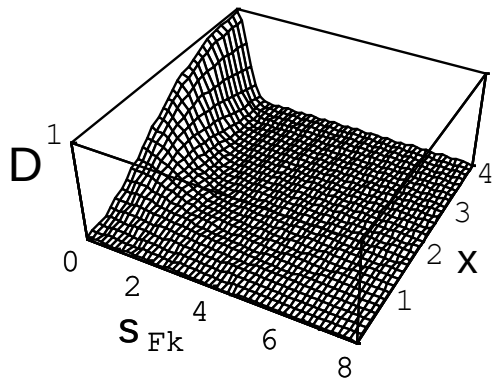
Orthodox quantum theory

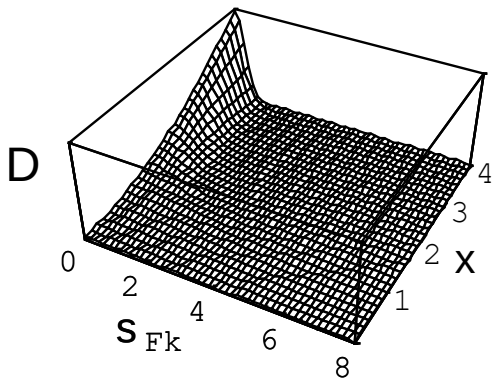
no mater the optical path difference,
since we are dealing with infinite waves,
there is superposition and consequently
for a good monochromator
interferences are to be observed

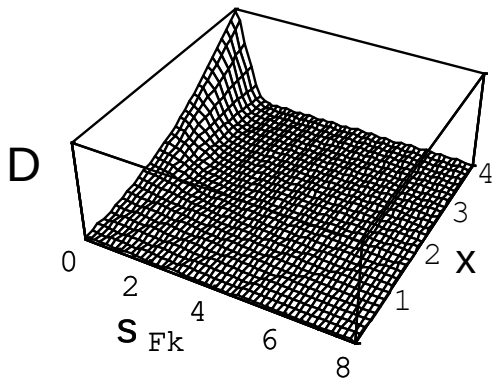
Nonlinear quantum physics

If the optical path difference
is greater than the size of the mother wavelet,
no matter how good the monochromator is
no interferences are to be seen

Plot of the difference in predictions of the two theories for different values of the size of the mother wavelet in function of the monochromator







Tunnelling Effect

A little bit of history of science

many times

Nature

surprises us

in the most unexpected ways

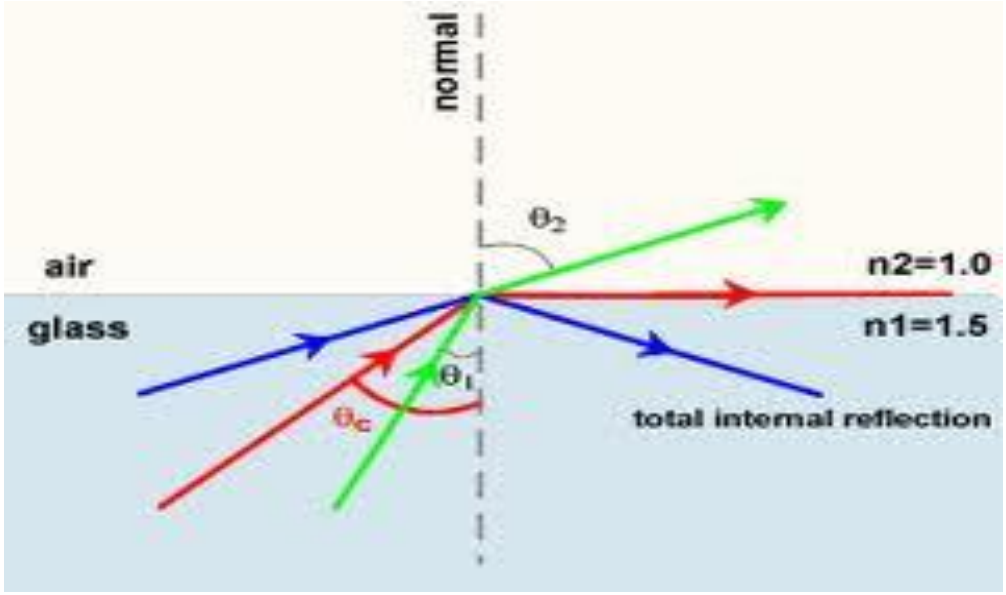
It was precisely what happened

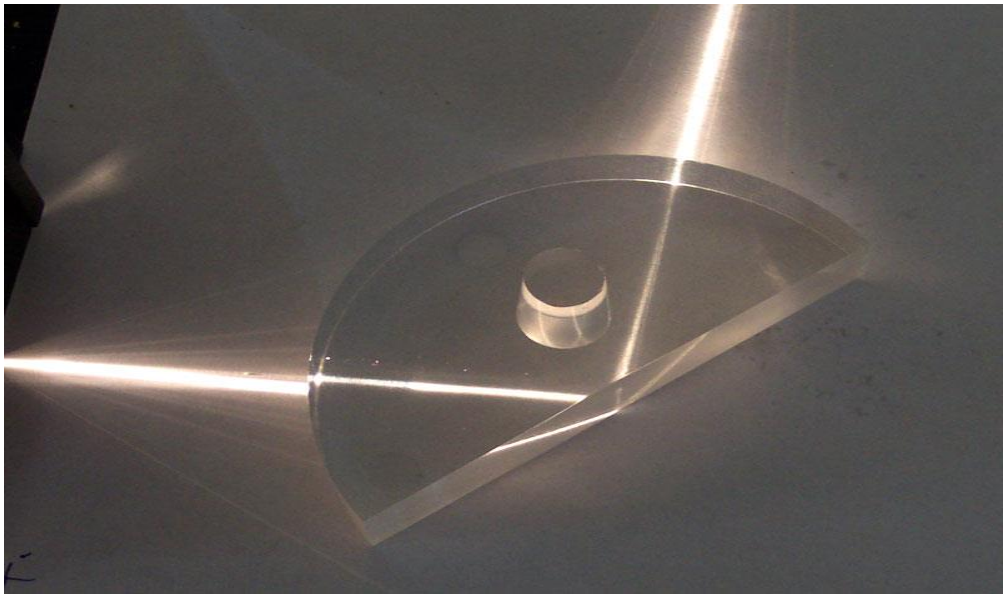
with the

total internal reflection of the light

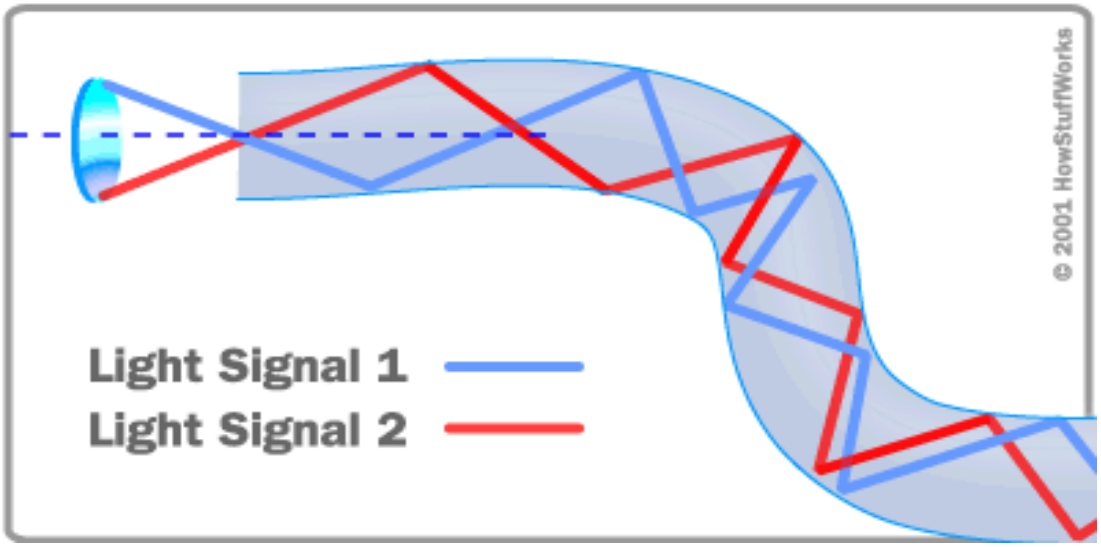
This strange
physical phenomenon
was discovered by Newton
and only mathematized
at the end of the XIX century

Total reflection





Optical fiber

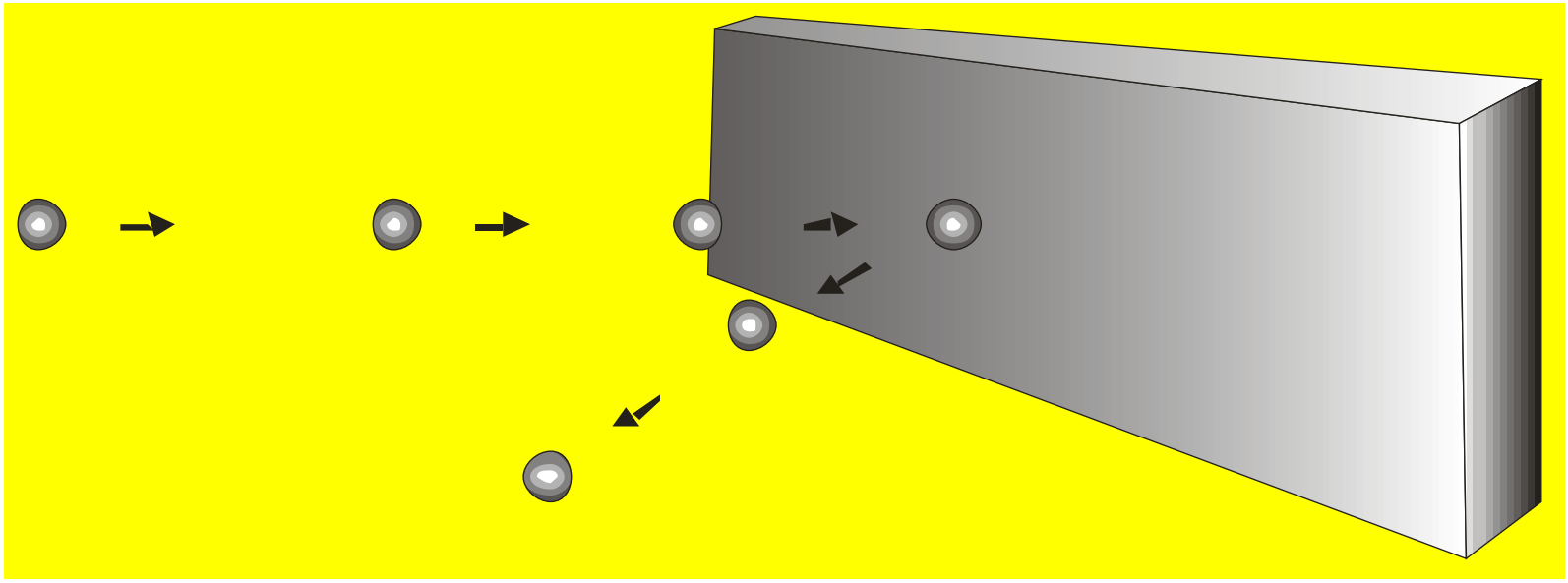


Tunnelling effect

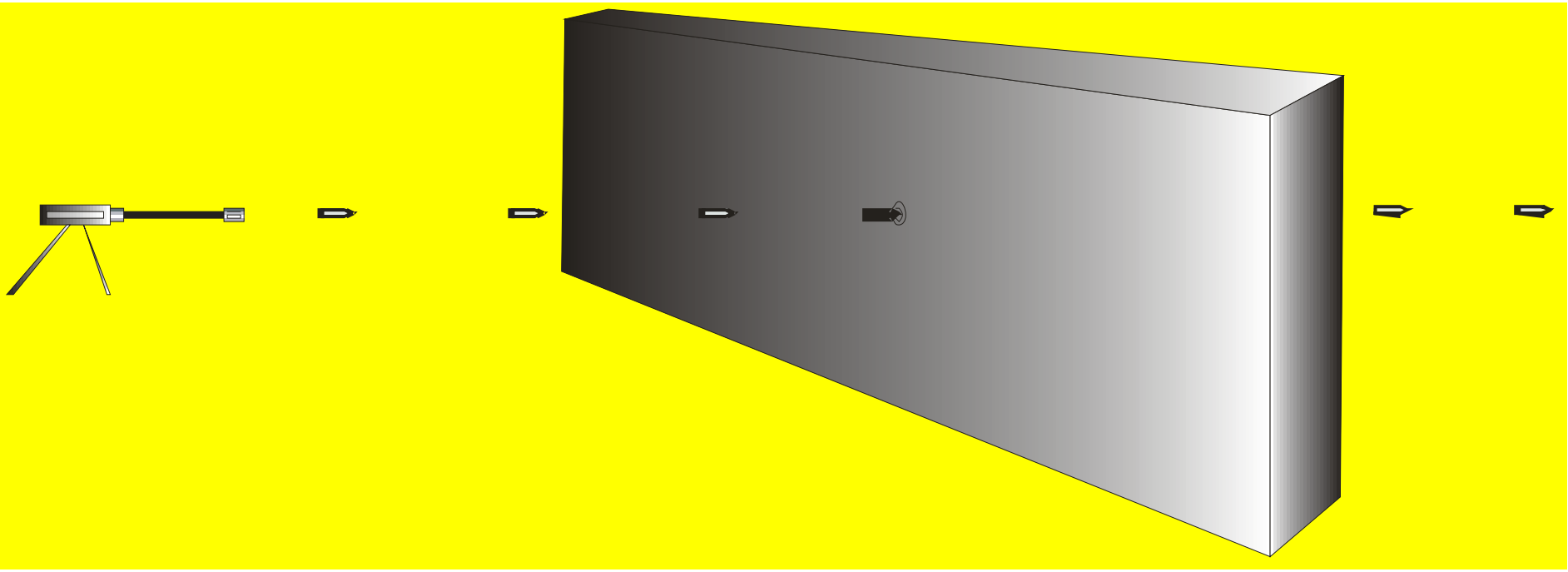
Gamow -1928

Super-microscopes - 1980

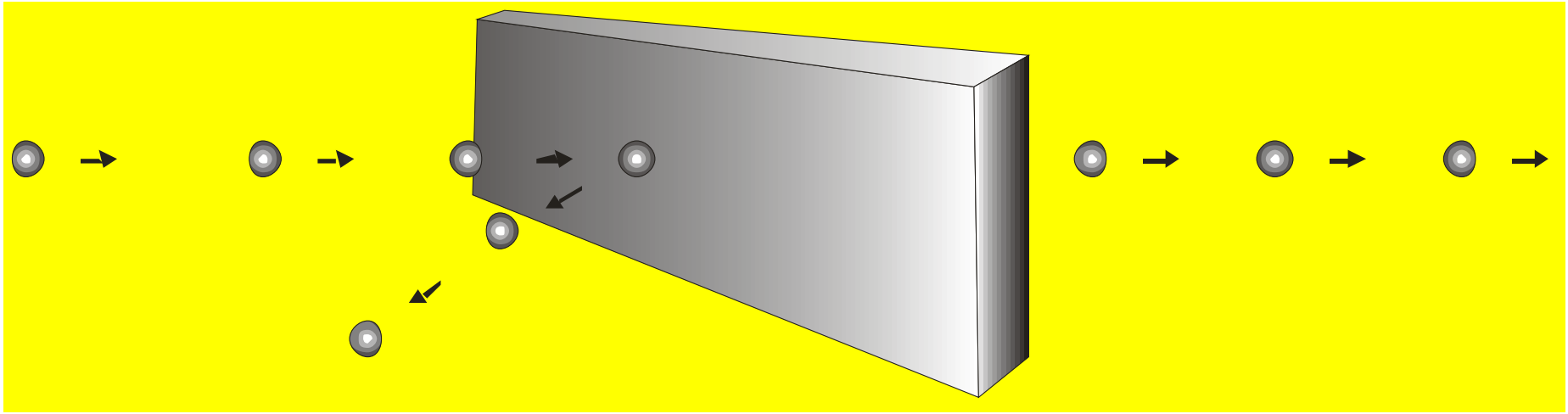
Tunnelling



The energy of the incident particle is **less** that the one of the barrier



The energy of the incident particle is **greater** that the one of the barrier



At the quantum scale

The incident particle emerges at the other side

The energy of the particle is less than the one of the barrier
Classically such happening could never occur

No particles should be observed at the other side

Tunnelling in Eurhythmic Physics

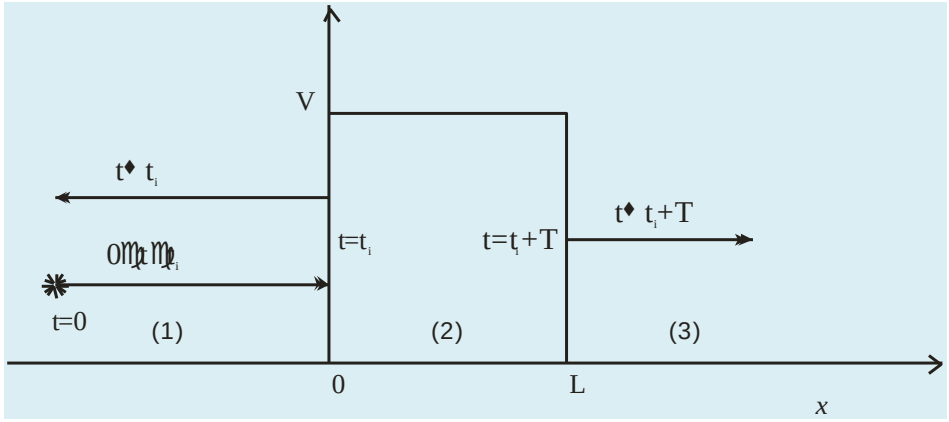
Master nonlinear equation

$$-\frac{\hbar^2}{2\eta}\theta_{xx}+\frac{\hbar^2}{2\eta}\frac{|\theta|_{xx}}{|\theta|}\theta+U\theta=i\hbar\theta_t$$

$$\begin{cases}\dfrac{1}{2\eta}\varphi_x^2+V=-\varphi_t\\[2ex]\dfrac{1}{\eta}\partial_x(a^2\varphi_x)=-\partial_t a^2\end{cases}$$

Potential Barrier

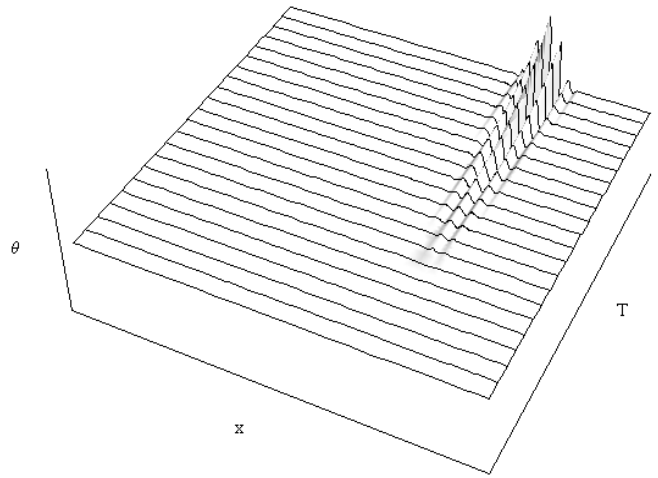
Tunnelling



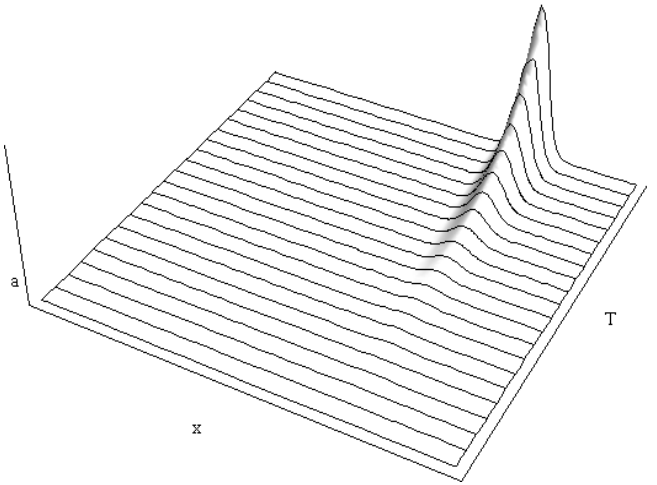
$$\theta(x,t) = Ae^{-\frac{(x-vt-\ell)^2}{2\sigma^2}+i(kx-\omega t-\delta)}$$

Solution when $E < V$

$$\theta_t(x,t) = Ce^{-\frac{(x-\ell)^2}{2\sigma_2^2} - k_2(x-\ell)} \; e^{\frac{v_2^2}{2\sigma_2^2}t^2} \; e^{i\left(\frac{x-\ell}{\sigma_2^2}v_2 - \omega_2\right)t}$$



The wave emerges



The intensity seen
by the sensing devices emerges

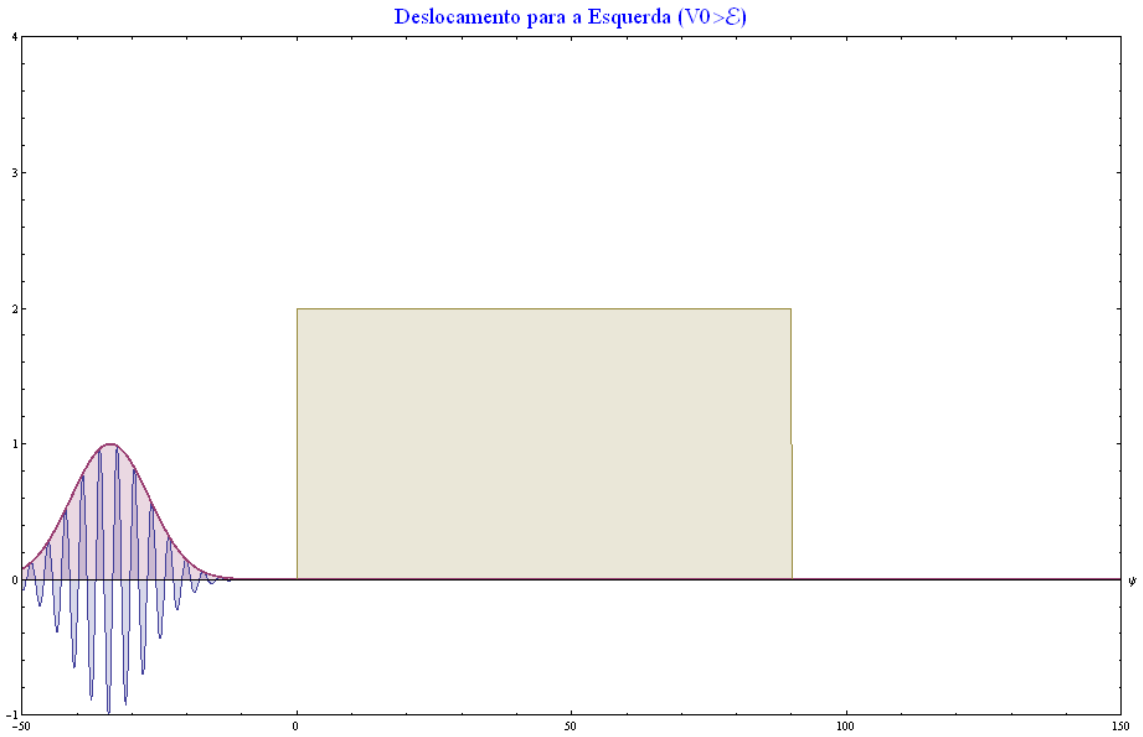
Solutions and boundary conditions

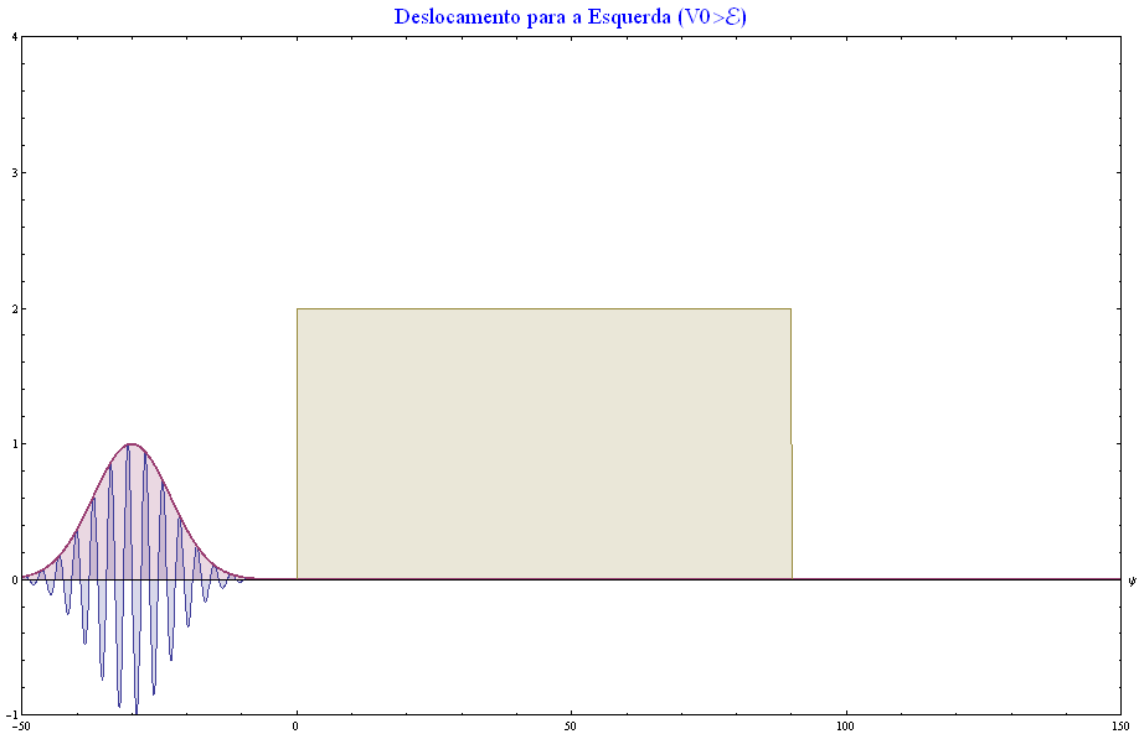
$$\begin{cases} \theta_{1i}(x,t) = Ae^{-\frac{(x-v_1(t_i-t))^2}{2\sigma_1^2}+i(k_1x-\omega_1(t_i-t))}, & x \le 0, \quad 0 \le t \le t_i \\ \theta_{1r}(x,t) = Be^{-\frac{(x+v_1(t-t_i))^2}{2\sigma_1^2}+i(-k_1x-\omega_1(t-t_i))}, & x \le 0, \quad t \ge t_i \\ \theta_t(x,t) = Ce^{-\frac{(x-\ell)^2}{2\sigma_2^2}-k_2(x-\ell)} e^{\frac{v_2^2}{2\sigma_2^2}(t-t_i)^2} e^{i\left(\frac{x-\ell}{\sigma_2^2}v_2-\omega_2\right)(t-t_i)}, & 0 \le x \le L, \quad t_i \le t \le t_i+T \\ \theta_3(x,t) = Fe^{-\frac{((x-L)-v_1(t-(t_i+T)))^2}{2\sigma_1^2}+i(k_1(x-L)-\omega_1(t-(t_i+T)))}, & x \ge L, \quad t \ge t_i+T \end{cases}$$

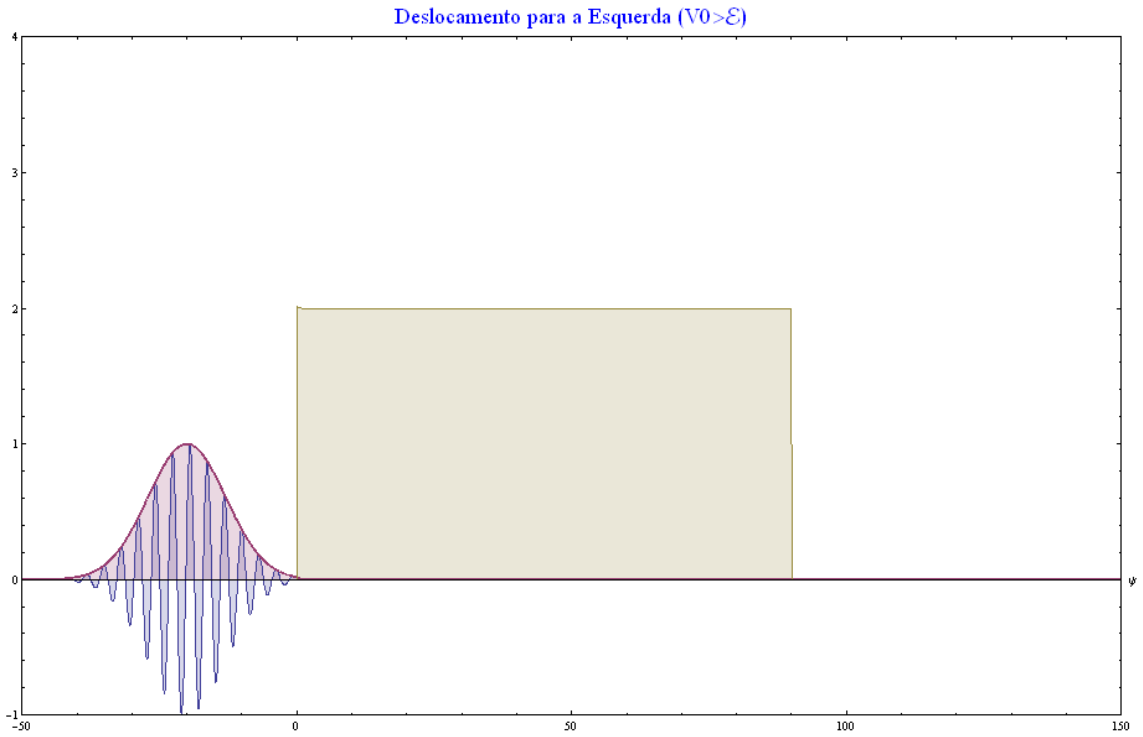
$$\begin{cases} \theta_{1i}(0,t_i)+\theta_{1r}(0,t_i) = \theta_t(0,t_i) \\ \theta'_{1i}(0,t_i)+\theta'_{1r}(0,t_i) = \theta'_t(0,t_i) \end{cases}$$

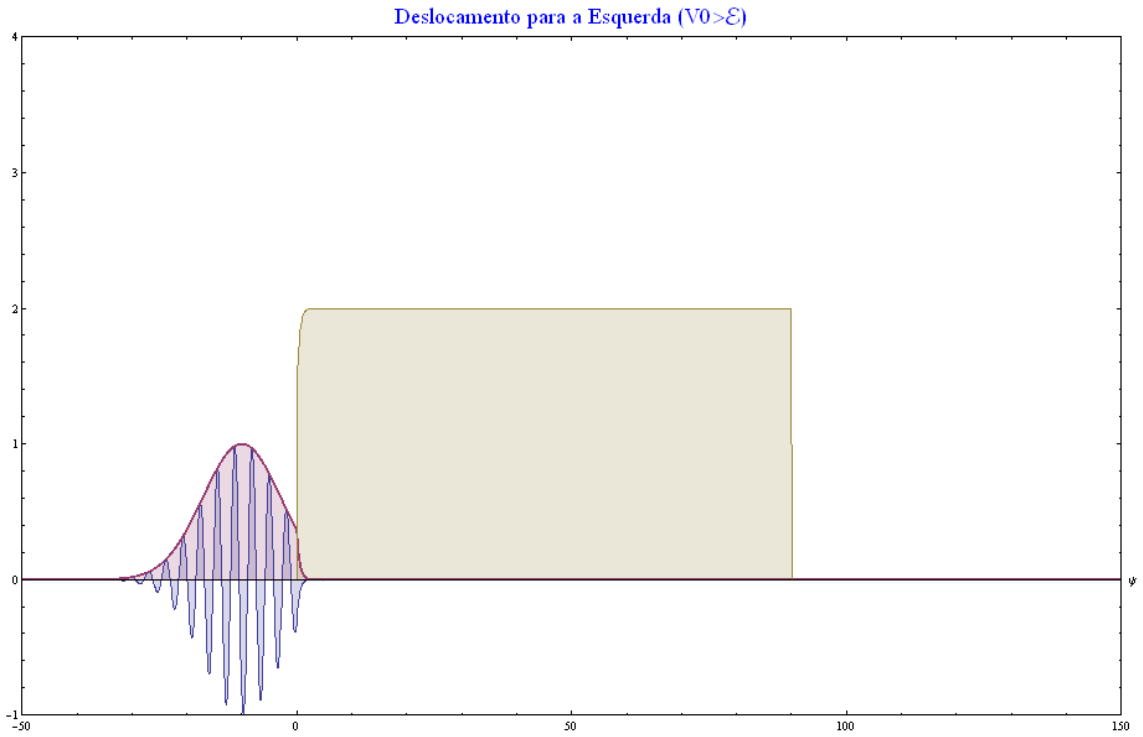
$$\begin{cases} \theta_t(L,t_i+T) = \theta_3(L,t_i+T) \\ \theta'_t(L,t_i+T) = \theta'_3(L,t_i+T) \end{cases}$$

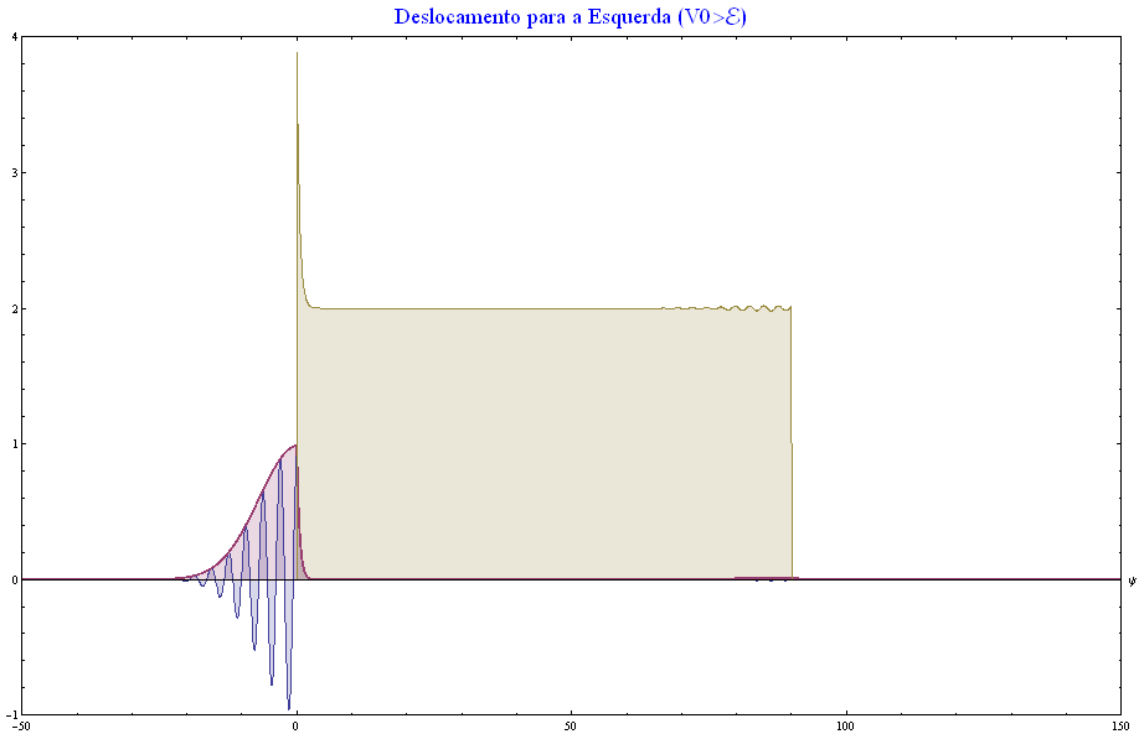
Graphics by João Araújo

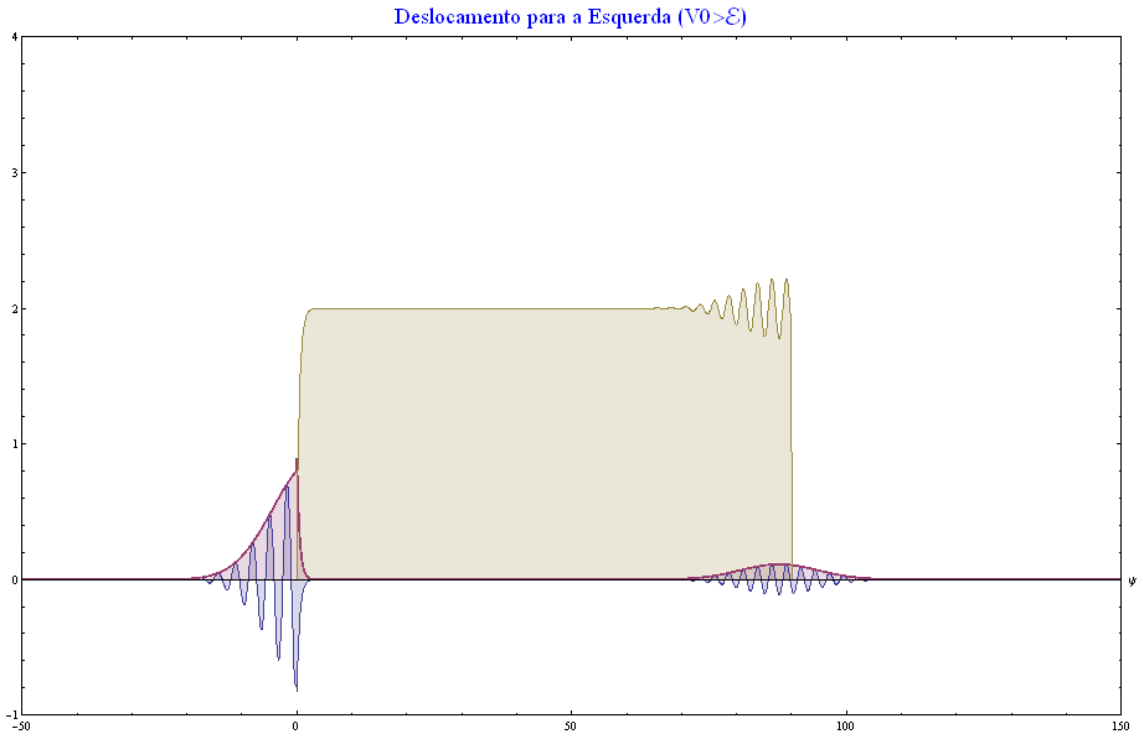


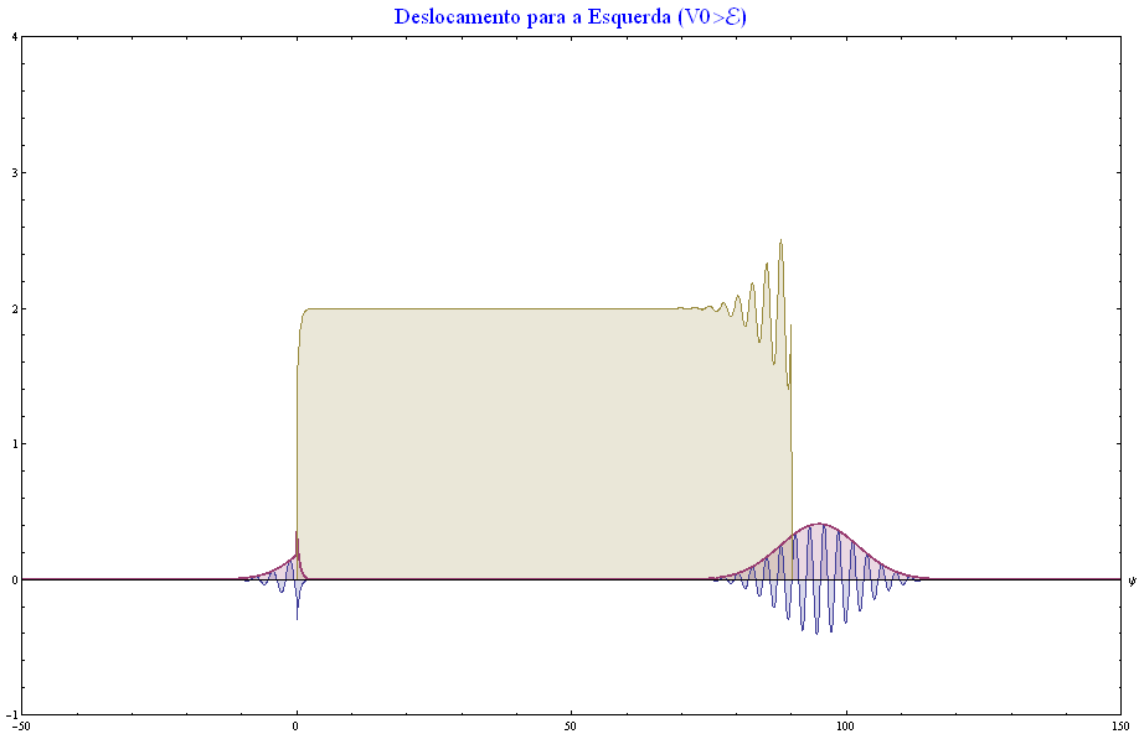

Deslocamento para a Esquerda (V0>ℰ)
4
3
2
1
0
−1
−50
0
50
100
150
ψ

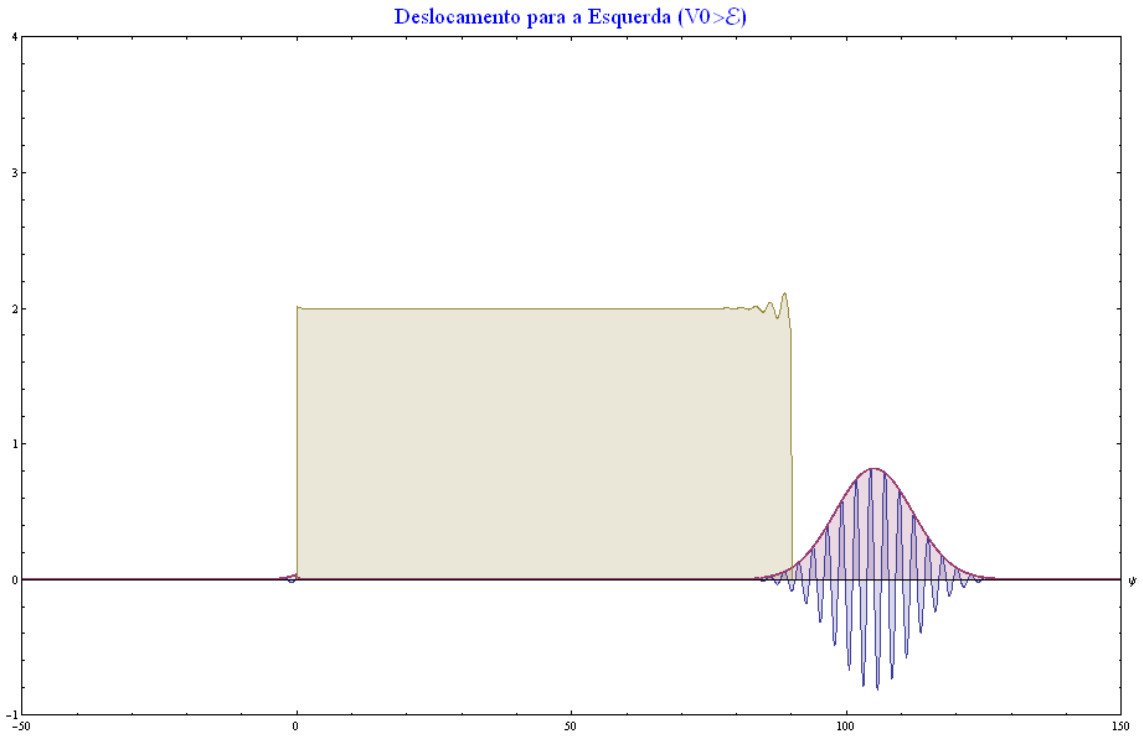

Deslocamento para a Esquerda (V0>ℰ)
4
3
2
1
0
−1
−50
0
50
100
150
ψ

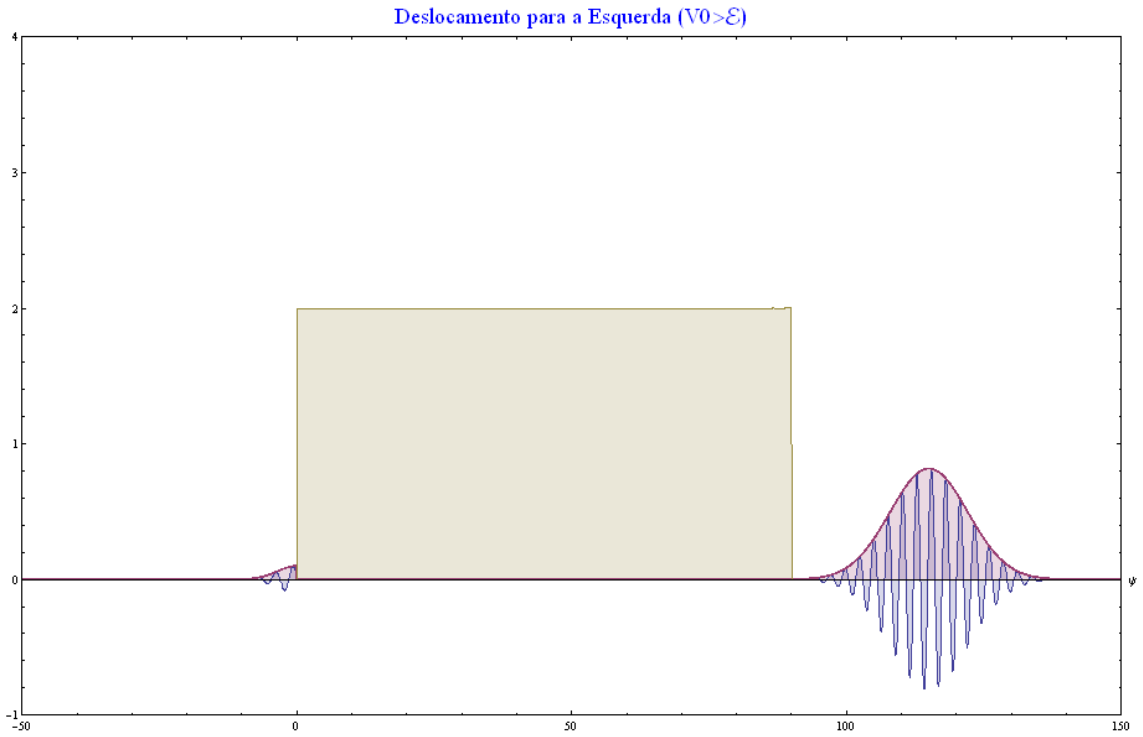

Deslocamento para a Esquerda (V0>ℰ)
4
3
2
1
0
−1
−50
0
50
100
150
ψ

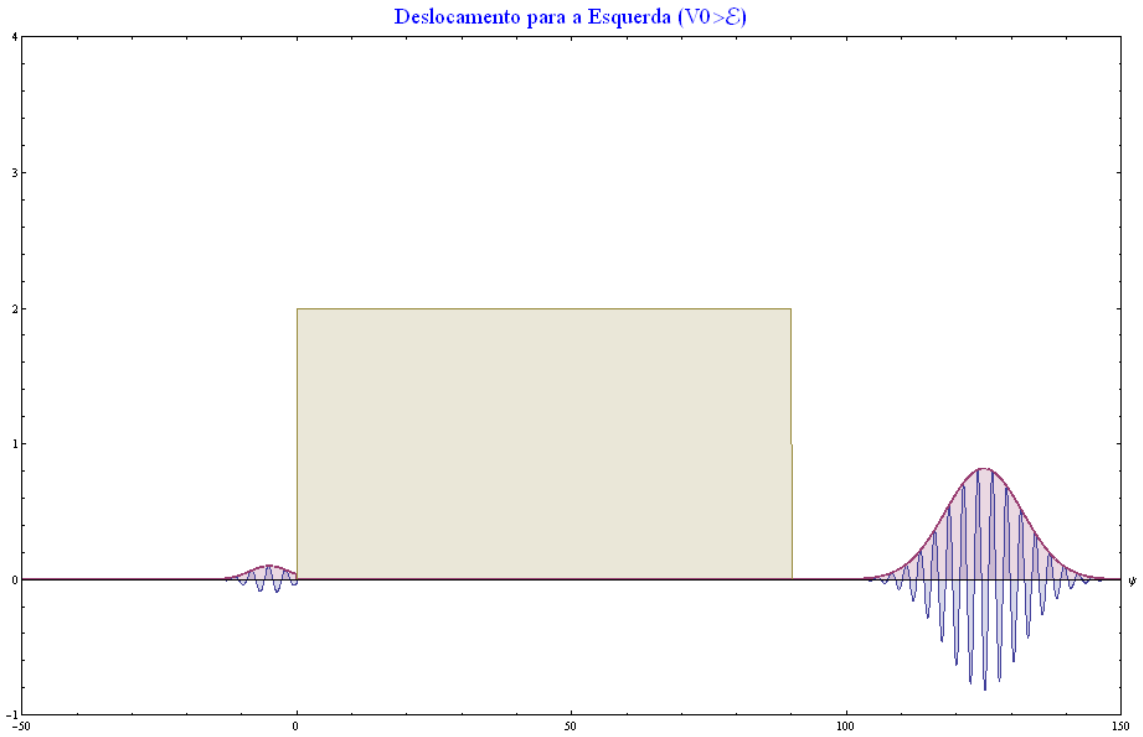

Deslocamento para a Esquerda (V0>ℰ)
4
3
2
1
0
−1
−50
0
50
100
150
ψ

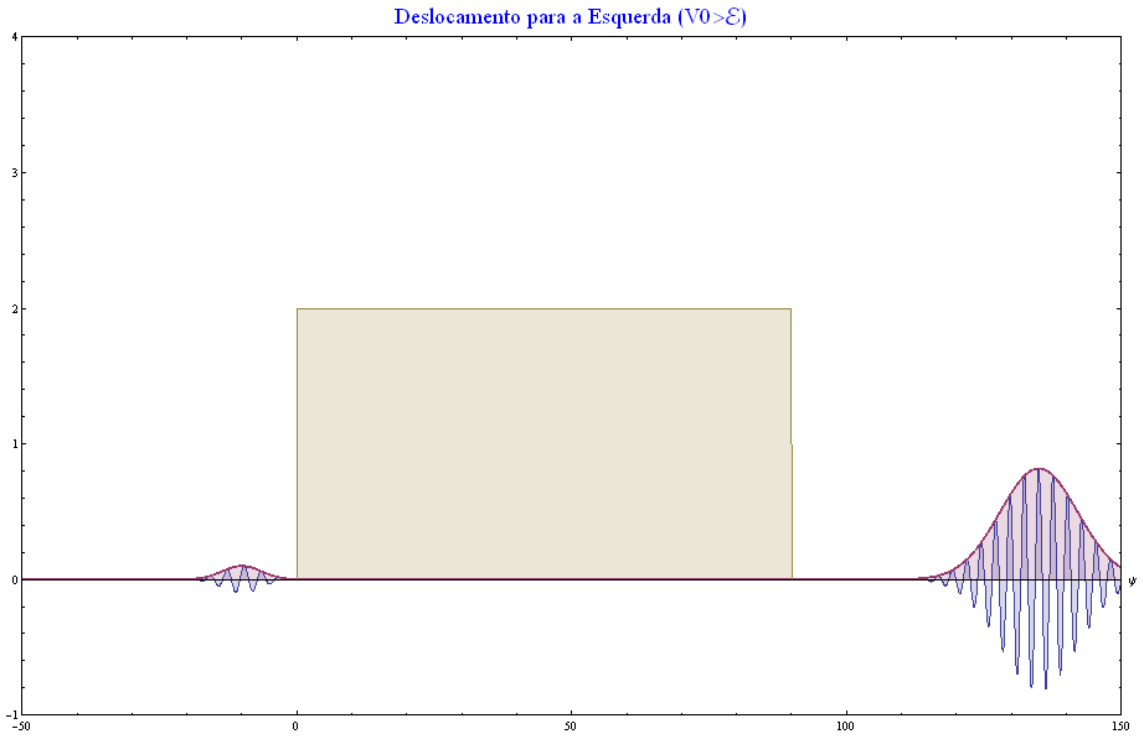

Deslocamento para a Esquerda (V0>ℰ)
4
3
2
1
0
−1
−50
0
50
100
150
ψ


Deslocamento para a Esquerda (V0>ℰ)
4
3
2
1
0
−1
−50
0
50
100
150
ψ


Deslocamento para a Esquerda (V0>ℰ)
4
3
2
1
0
−1
−50
0
50
100
150
ψ


Deslocamento para a Esquerda (V0>ℰ)
4
3
2
1
0
−1
−50
0
50
100
150
ψ


Deslocamento para a Esquerda (V0>ℰ)
4
3
2
1
0
−1
−50
0
50
100
150
ψ


Deslocamento para a Esquerda (V0>ℰ)
4
3
2
1
0
−1
−50
0
50
100
150
ψ

the emergence time

$$T = \frac{\eta}{\hbar}\sqrt{\frac{E}{V-E}}\,\sigma_2^2$$

the emergence time does not depend on the length L of the tunneling barrier

$$T \neq T(L)$$

This time may be assumed as a kind of igniting time characteristic of the nature of the quantum particle and the energy of the barrier

Experimental evidence for this formula

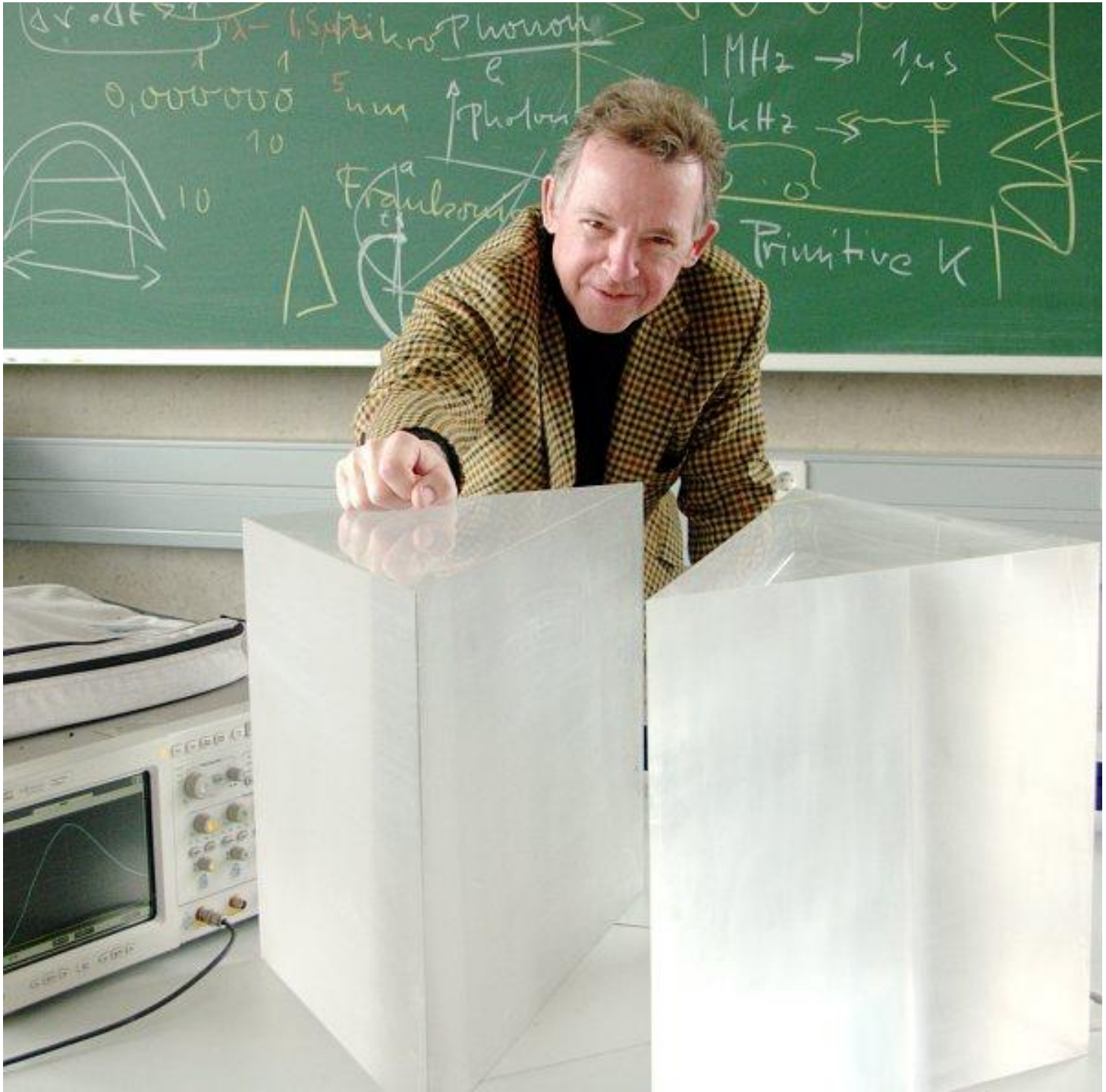
Nimtz and his group

at Koln University did many experiments showing **Zero time transition**

Even at macroscopic scale

Wavelength ~ 33 mm

L ~ 1 m


Photon
1 MHz
1 µs
kHz
Primitive K

Günter Nimtz and Astrid Haibel

WILEY-VCH

Zero Time Space

How Quantum Tunneling Broke the Light Speed Barrier

With
a Foreword by
Ulrich Walter

superluminal velocities

Besides these seemingly strange facts
another unexpected experimental discovery
related with tunnelling
has shown the possibility of attaining in
the concrete practice superluminal velocities
that is, velocities greater than c

$$v \geq c = 300\,000 km/s$$

Surprise!!!

All this happens

with the particle
never being
inside the barrier

How is that possible?

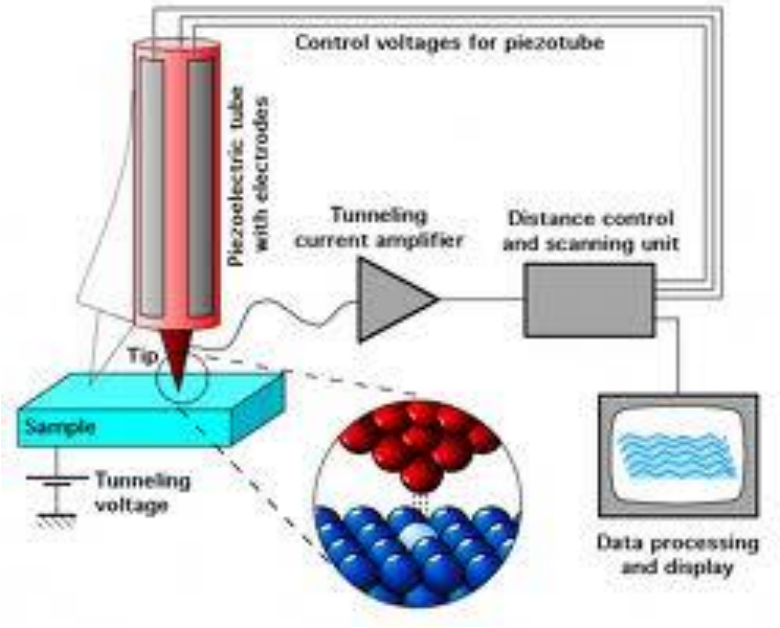
What is the explanation!

Before we see the why

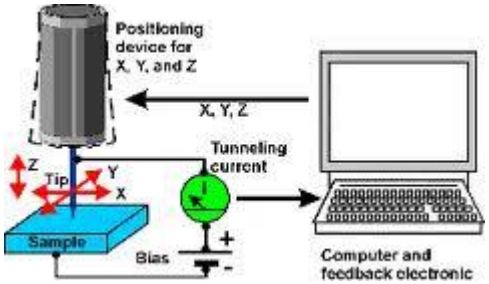
it is convenient to emphasise that

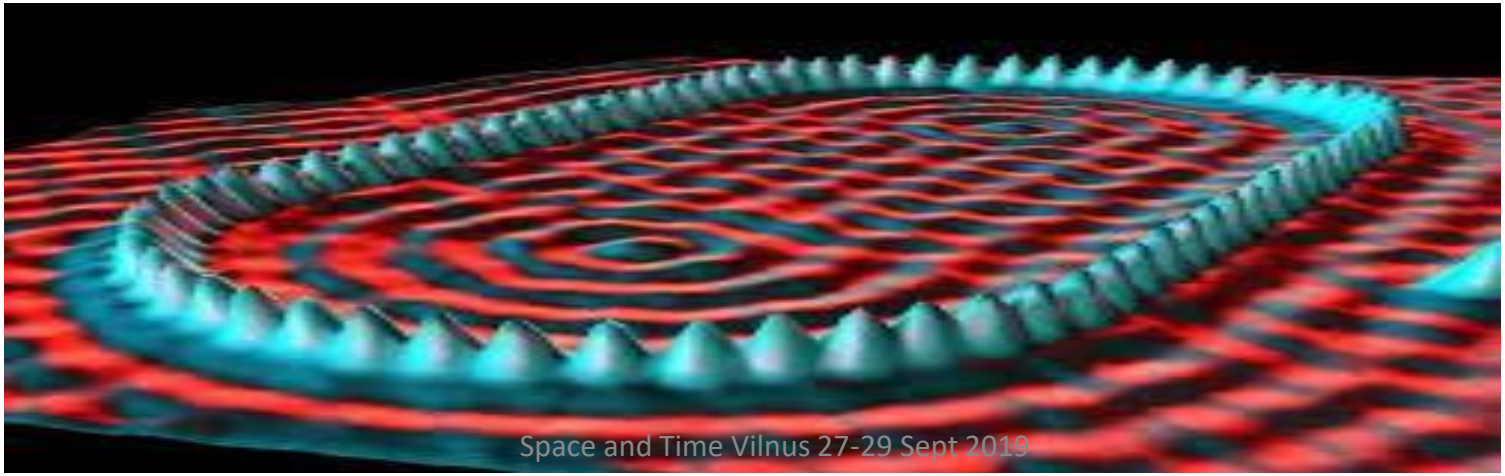
From a mere laboratorial curiosity
this seemingly strange effect
has now enormous technological applications
namely in the
super resolution microscopes

Super-resolution microscope – based in the tunnelling effect



$$\Delta x = \frac{1}{500}\,\lambda \leq \frac{1}{2}\,\lambda$$





Consequências do tempo de transição ser zero!!!!

Será que

o espaço e o tempo cronológico

Tem um estatuto ontológico

ou

são meros instrumentos

adequados apenas a uma certa escala de descrição da realidade?

BEYOND SPACE AND CRONOLOGICAL TIME the BECOMING

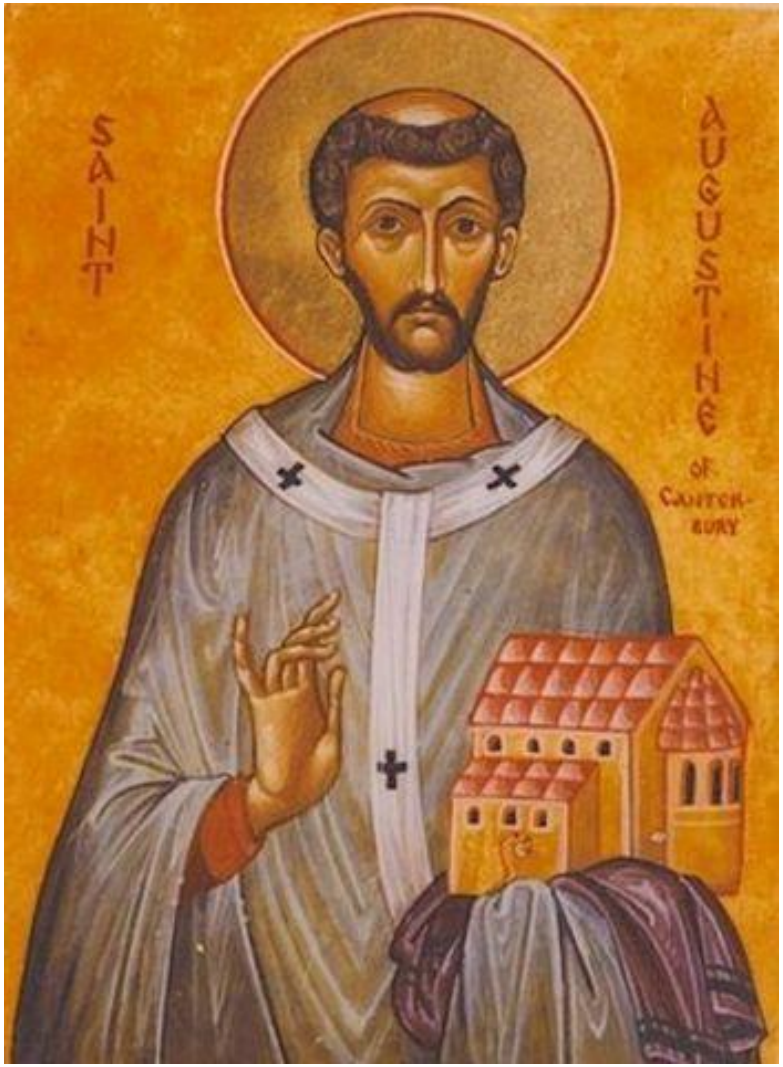
J.R. Croca

Departamento de Física Faculdade de Ciências
Centro de Filosofia das Ciências Universidade de Lisboa
Campo Grande Ed. C8
1749-016 Lisboa Portugal
email: croca@fc.ul.pt

Space and Time Vilnus 27-29 Sept 2019

Time

by J.R. Croca, 1958



St. Augustine --- Bishop Augustine of Hippo

in his Book 11
of *the Confessions*,
that deals with time,

St Augustine asks:
what exactly is time?
and says, somewhat comically,
"If no one asks me,
I know what it is."

Vejamos brevemente

a

evolução

dos conceitos de

Espaço

e

Tempo

Classical Physics

space and time

To give meaning to the to the fundamental law of his mechanics,

$$f = m_i a = m_i \frac{d^2 r}{dt^2} = f(r,t)$$

the force f is a function of space r and time t,

Absolute Space

in its own nature,

without regard to anything external, remains always similar and immovable

Absolute

True

and

mathematical time

of itself, and from its own nature

flows equably

without regard to anything external, …

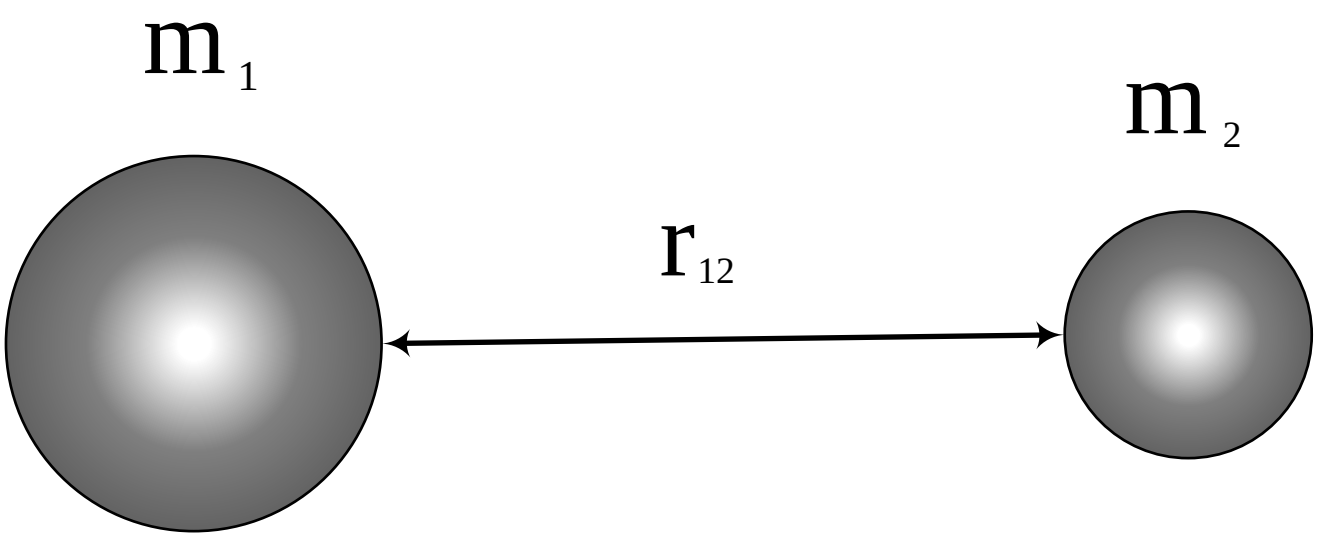
Still in this beautiful picture there was something strange

the so-called

interaction-at-a-distance

$$f_g = G\frac{m_{g1} * m_{g2}}{r_{12}}$$

The assumed universal attraction law



No Time

Instantaneous interaction

by the action of

GOD

In these circumstances the first ”law” need to be rewritten

$$\boldsymbol{f_i = m_i a = m_i \frac{d^2 r}{dt^2} = f_i(r, t)}$$

where stands f_i for the inertial force and m_i the inertial mass.

In most common cases the two masses are about equal. Nevertheless, in general the inertial mass is proportional to the gravitic mass, $m_i \propto m_g$.

Intelligere, Revista de História Intelectual
vol. 3, nº 2, out.2017

The concept of mass gravitic and inertial in eurhythmic physics

J.R. Croca, Gildo Magalhães and J. Alexandre Croca

Spacetime

Leibnitz saw significative fragilities

in Newton's seemingly beautiful theoretical construction.

Indeed, for him,

space and time

had only a

relative relational nature.

Gottfried Wilhelm Leibniz.

1646-1716

The history of his long controversy
with Newton, through Clark,
is a clear example of this deep disagreement.

For Newton the
interaction-at-a-distance,
implied in his gravitic interaction mathematical formula,

was the **work of God.**

Being omnipresent,

that is

beyond space and time

God

in

His supreme benevolence and goodness

had chosen to manifest

His permanent action on

His creation, the World.

It is well-known,
that to this argument
Leibnitz
argued
that if that
were the case, then

Newton's God

would be

a very lousy clock maker

because

He had built, Create,

a clock, the World,

that were in

permanent need

of adjustments and maintenance.

Still there were some thinkers

of the nineteen century

mainly in the awake of the Leibniz followers,

opposing the main trend,

in which

absolute space and absolute time

ruled

Among others,

I may refer for instance

Edgar Allan Poe

who explicitly wrote in his Eureka that

time (chronological time) was deeply interconnected with space.

1809-1849

The Change

The explosive development of optical technology,
in the second half of the nineteenth century,
especially in the field of interferometry,
lead to the possibility of concrete evaluation of
very short time intervals,
of the order of the femtosecond

$$\Delta t = 10^{-15}\mathrm{s}$$

These devices, allowed the realizations of very precise
optical experiments, such as the one of
Michelson and Morley.

The experimental results,
obtained by these researchers,
were one of the main points of depart
for the construction of Relativity

Relativity rejects the concepts of

absolute space and absolute time,

assumed to be perfectly independent.

postulates the primacy of

spacetime

assuming that there is a linear relationship

between space and time,

$$r \propto t$$

connected by the velocity of light, c, assumed to be a universal constant,

$$r = c\,t$$

Quantum Mechanics

In March of 1927, Heisenberg went to Copenhagen
to present Niels Bohr
a set of mathematical relations
he had derived from matrix analysis.

These mathematical expressions, later got the name of Heisenberg relations.

$$\Delta x \Delta p_x \geq h$$

$$\Delta t \, \Delta E \geq h$$

Nonlocality

in

space and time

That is
space and time
are not fundamental basic concepts
Traduced formally by Fourier ontology

The process
leading to such solution
introduced a radical change
to the traditional way of
understanding

space and time

or even with the

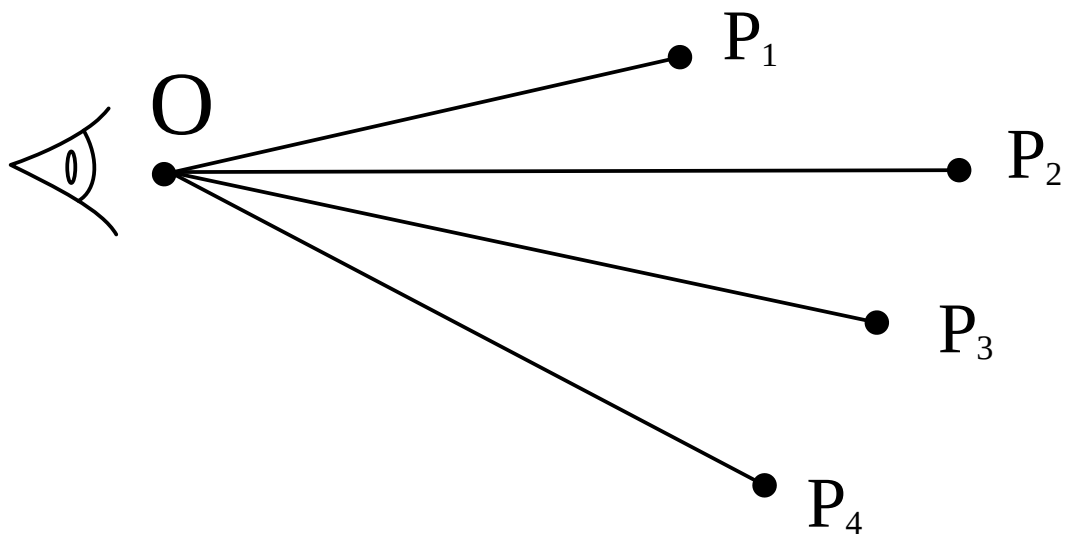
concept of spacetime

From the crucial fact,
that the tunneling transition time, T,
is independent of the size L of the barrier

$$\boldsymbol{T \neq T(L)}$$

we are encouraged to conclude that
for any two or more points connected by
a tunneling barrier
the spatial distance L has no relevance.

Suppose that we have four points:
P_1, P_2, P_3 and P_4,
and wish to determinate their distance to the observer O




A
B
C
D

Usual measurements are done

by sending a pulse of light from

the observer to the point that is reflected to the observer

the distance is diverse

$$x_1 \neq x_2 \neq x_3 \neq x_4$$

measurements are done using, a tunneling barrier process

In these very special tunneling conditions,

the measured time

to the diverse points is precisely the same

$$\Delta t'_1 = \Delta t'_2 = \Delta t'_3 = \Delta t'_4 = \Delta t'$$

measurements are done in the

traditional way,

the distance is diverse

$$x_1 \neq x_2 \neq x_3 \neq x_4$$

tunneling,

the distance is the same

$$x_1 = x_2 = x_3 = x_4$$

Now
we have a
Problem!

If all points are reached at the same time

Then

where is distance?

where is space?

A natural conclusion
would be that

space

and

chronological time

are only secondary conceptual tools

that have shown

theirs limits of adequacy

in the understanding of Nature

at a more deep level

In such circumstances

it would be necessary to develop a

New Physics

PHYSICS OF BECOMING

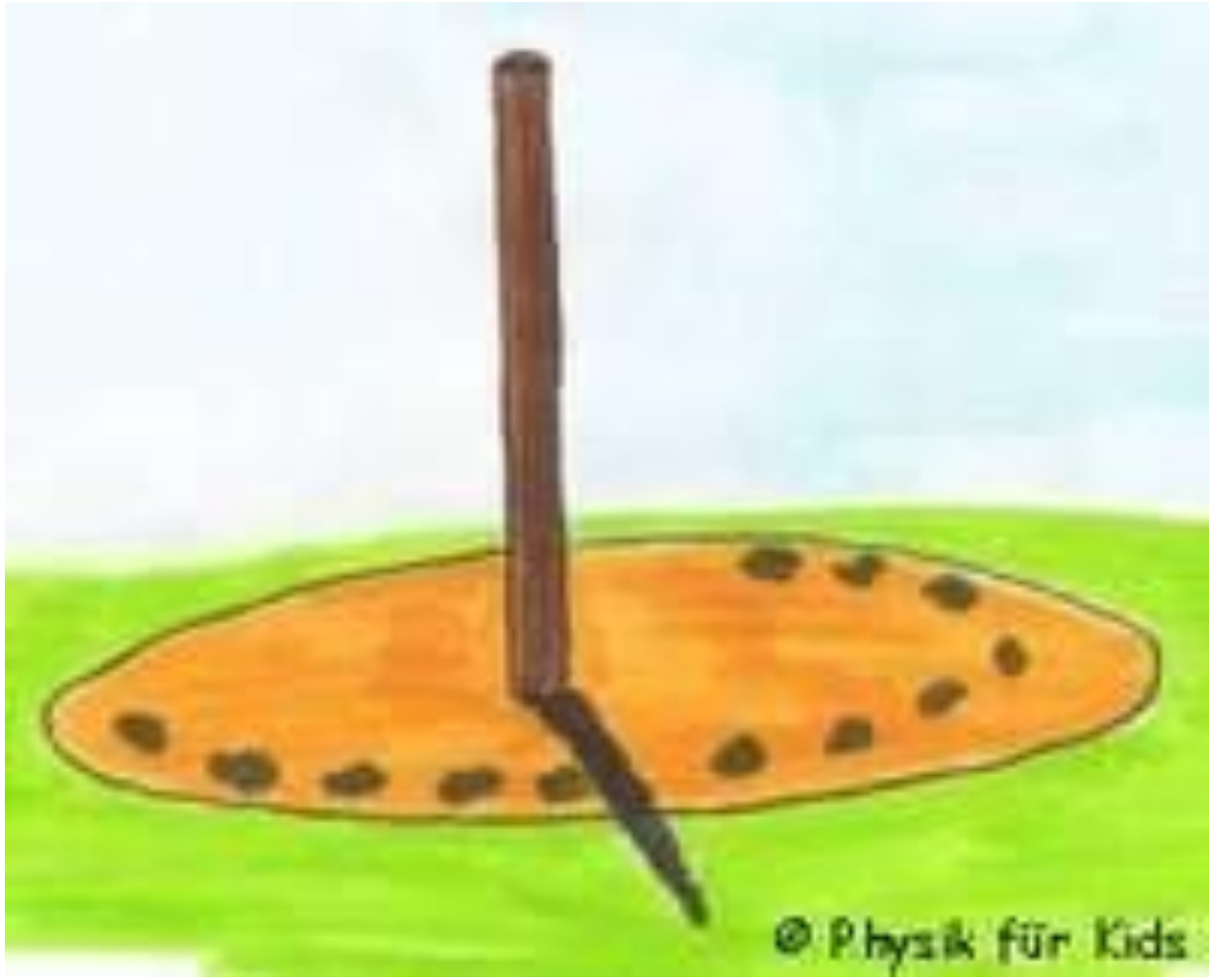
physics beyond space and chronological time

Chronological Time

is nothing more than a
relation with space

Basically is a measurement done with the help of space:

the position of the rods of a device,
the shadow of a tree branch, and so on …


© Physik für Kids


silicon
scientific
WED
SOLAR
RADIO CONTROLLED

In last instance
what really is measured is

A position – space

without space

chronological time
has no meaning

Consequently
space and chronological time
are intimately correlated

Chronological Time

is ontologically

quite different from

TIME

In the sense of

BECOMING

In the more general framework of the

Physics of Becoming

causality

has a more general sense.

Implicating a continuous becoming

in which

each emergent state

each physical phenomenon,

is the final natural result

of a complex reciprocal

web of interactions among the diverse states

In the
physics beyond
space and chronological time
the Physics of the Becoming

A most important concept is

INTERACTION

RECIPROCAL INTERACTION

the capacity of inducing and being induced change

In the Physics of Becoming,
the most basic concepts are:

1 - The Becoming - Δ

2 - The universe of Sates, the Symploke - Σ

This web of states and interactions that makes a certain inter-relational state is named by the Greek word

Συνπλοκή

ΣΥΜΠΛΟΚΗ

Symploké

As referred by
Plato in a middle portion of the *Shophist:*

Symploké eidón tón allón
(interweaving of the forms with one another)

So, there is no inside and outside.

These traditional notions are now replaced
by the much more general and meaningful concepts
of similar and diverse
that is, of particular sates of reciprocal interrelation.
We, no more have to say that a certain state
is inside the other state or even outside the other state.

This, in reality, means that
a certain state is diverse from the other
and shares with it
some particular type of different interaction.

also in the Physics of Becoming
the traditional basic concept:

I am, in the sense of
being here, of staying, in Latin *ego sto*,

is changed by the more fundamental concept

I am, with the meaning of,

I exist, in Latin *ego sum*,

but now without any reference regarding space.

we have to say:

I do not stay,

I exist. I exist, that’s all!

The very existence by itself implies

the becoming
which results from very complex
reciprocal web of interactions with the other beings.

Persistence, endurance, survival
are the most basic natural processes.

Still the concept of physical space,
was exported to practically
all human domains.
So, it is no surprise to verify that
our language and ways
are completely intertwined
with ideas and wordings related
directly or indirectly with space.

let us see,

out of many,

a case,

in which

the word and concept of space

was exported

to other domains

that in reality have nothing to do with physical space:

for example,

the degree in the hierarchy in a given society,

or the degree of importance

of a person in a specific social realm.

Suppose, that in a given situation,

one person is considered to be very important, eventually attaining the maximum degree in the social hierarchy,

while other is supposed to be of practical no importance.

In the traditional language,
in which the space wording is in fashion,
this situation is commonly translated, saying
that there is a big distance between the two persons.
There is much *space* between them,
instead of saying that they have a
very significant difference in the social hierarchy.
Here the word *space*, social space
is used instead of, the more adequate word
hierarchy, social hierarchy.

Let us see some examples
in which
the concept of space
is commonly used
to translate
the degree
of inter-relationship
among different states:

- Symploke ↔ Space

- Degree in the hierarchy
  of reciprocal interaction ↔ Distance

- Significant or important
  degree of reciprocal interaction ↔ Near

- Non-significant or non-important
  degree of reciprocal interaction ↔ Far

- Significant, Important ↔ High, Big, Enormous, Tall, etc.

- Unimportant, Insignificant ↔ Small, Minor, etc.

- A state may have a:

1 - Very significant degree of interaction with some other particular states in the symploke and low or practically null with the great majority ↔ Inside.

2 - Low or practically null interaction with some particular states ↔ Outside.

Human beings

are immersed in a multiplicity of interactions

with other physical entities,

which constitutes the interacting realm.

In order to persist,

we need to make

as intelligible as possible

these diverse interactions.

We need to

hierarchize the Interactions

this very

complex hierarchization process
establishes degrees

of difference and even equalities

among the diverse states.

Still, this process

is never absolute but only relative.

in a certain interactive context,
two states, A and B
may be assumed to be equal,

$$A = B$$

while in other interactive situation,
the same states need to be considered as different,

$$A \neq B$$

To make the things even worse,
it is necessary to acknowledge that
when two given states
are assumed to be equal,

$$A = B$$

we are not sure if they are truly equal.

Due to the natural errors that
occur in any measurements process,

the way for establishing
the degree in a given hierarchy
is never absolute.

So, the best we are able to do
is to say is, that

under a certain interacting conditions

the two states may be assumed to be equal.

the evaluation of importance
of these interactions
is basically given by
their capacity
of inducing
a major or minor
degree of modification
in a reference state.

the degree of modification
experienced by
the physical beings
due to the reciprocal interaction
is what is really important.
Our capacity of predicting,
in order to persist,
in the becoming,
depends significantly on it.

The traditional notion of

space

that is,

of distance

is deeply interconnected

with the degree

of interaction

that a certain state,

experiences with the surrounding medium.

saying that a physical system

is at one place

is,

in last instance,

no more than

a simplified way

of describing the type and grade

of possible reciprocal interaction

it underwent with medium.

To better understand the statement

let us consider

a hypothetical conceptual situation

Suppose the we want to go from

Lisbon to Paris

Now we are in Lisbon

we want to Paris

If we were at an epoch before the development of the transportation devices,

the only process to reach Paris, starting from Lisbon, would be by walking.

The trip, would certainly take more than a month’s walk.

In the process we would have the opportunity of strongly interacting with the medium

the landscape, mountains, plains, rivers, cities, people and so.

In the whole interacting process, we would securely experience a very significant degree of change.

Suppose that at our present time we decide to travel by car.

With this traveling process we would take say, about sixteen hours to reach Paris, less than a day.

In this situation our capacity of interacting, with the medium,

mountains, people and so

would be not much significative.

In such conditions, our degree of global changing would be, securely much less than by walking.

Now, suppose that we went
by plane,
taking about three hours.

In this situation,
the degree of interaction
experienced with the medium
would be much less significative
and consequently our degree of change

would also be not much significative.

Finally, we went from Lisbon to Paris by

a yet to be developed

tunneling process.

In this hypothetical case,

the time of the trip would be about zero.

Meaning that we underwent practically no chance due to the fact that

there was no meaningful interaction

with the medium, which in this case and for all practical purposes behaves as if non-existent.

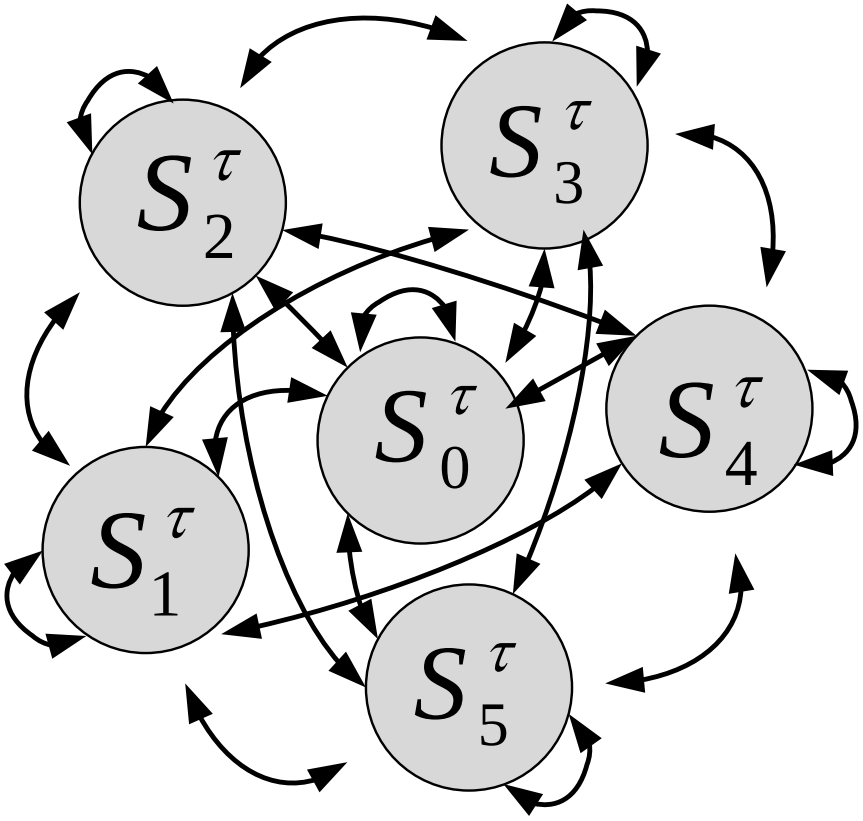
In last instance, what really matters
is not the chronological time interval,
but the degree of interaction
and consequently
the degree of change we experience with the multiplicity
of real existing interacting physical states.
In the first case of walking,
before we interact with Paris
we need first to experience
a very large amount of potentially modifying situations.

Totally opposed is

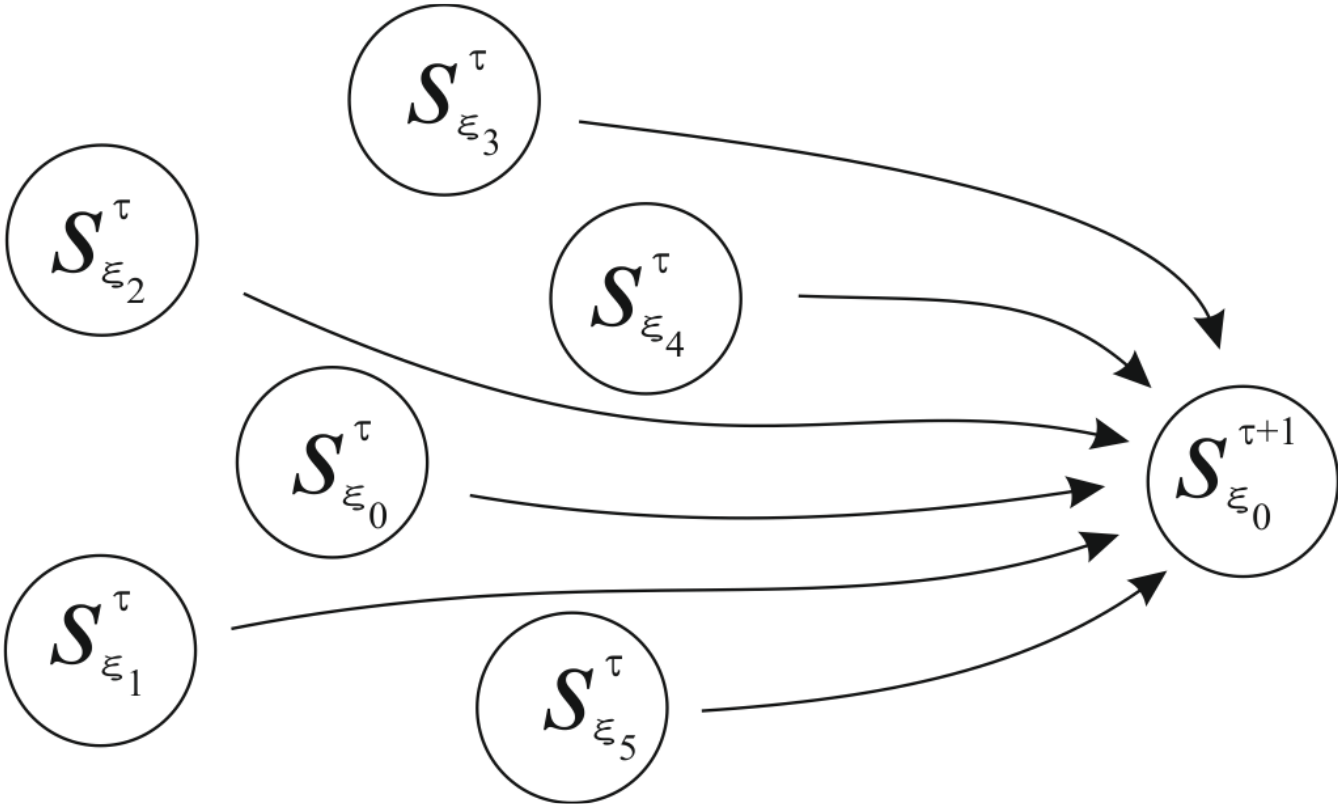
the hypothetical tunneling case.

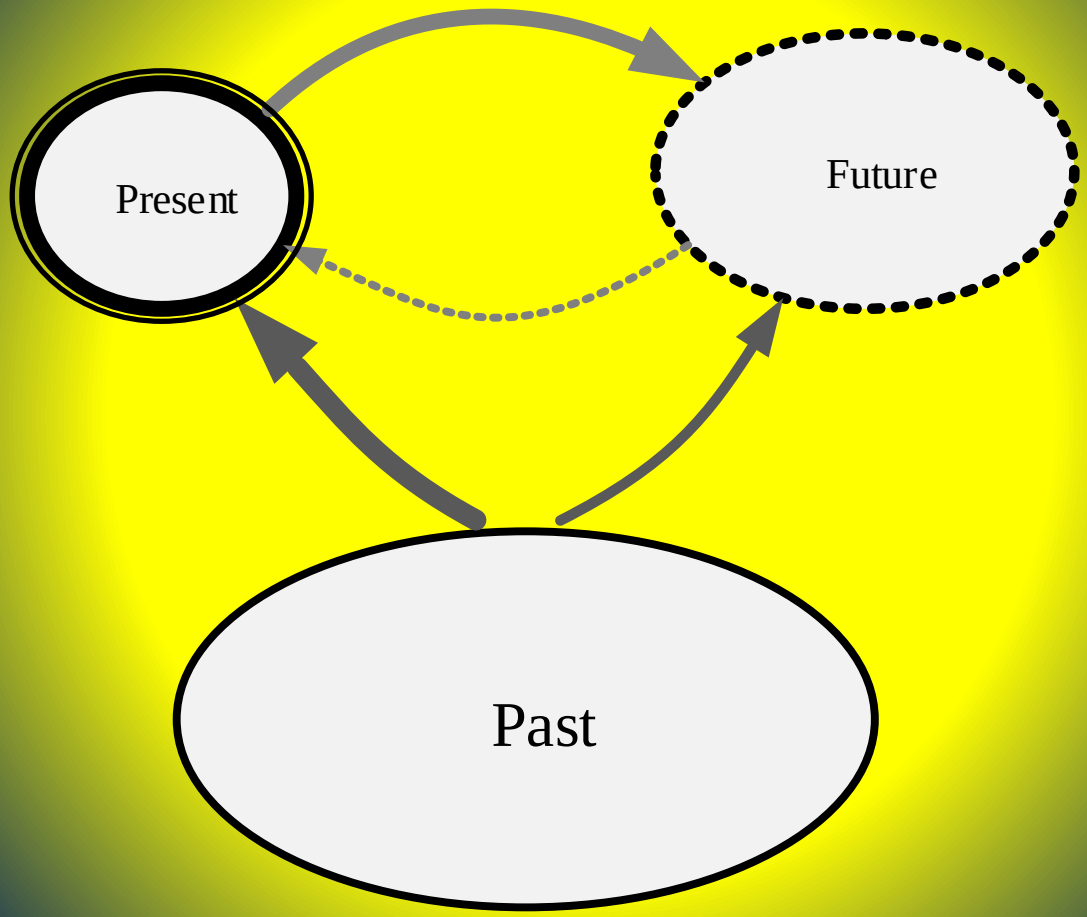
In this situation
practically,
no delays,
no sufficient experienced modifications
are to be found
between interacting with the medium
we call Lisbon or Paris.

sketch for the web of interacting states



The next transition the final state results from the interacting contribution of each anterior state




Present
Future
Past

Yet, in reality,
things are a little bit more complex.
In a **relational universe**,
all states are
reciprocally interconnected
in a more or less significant degree.
In such conditions,
the past,
is not wholly independent by itself

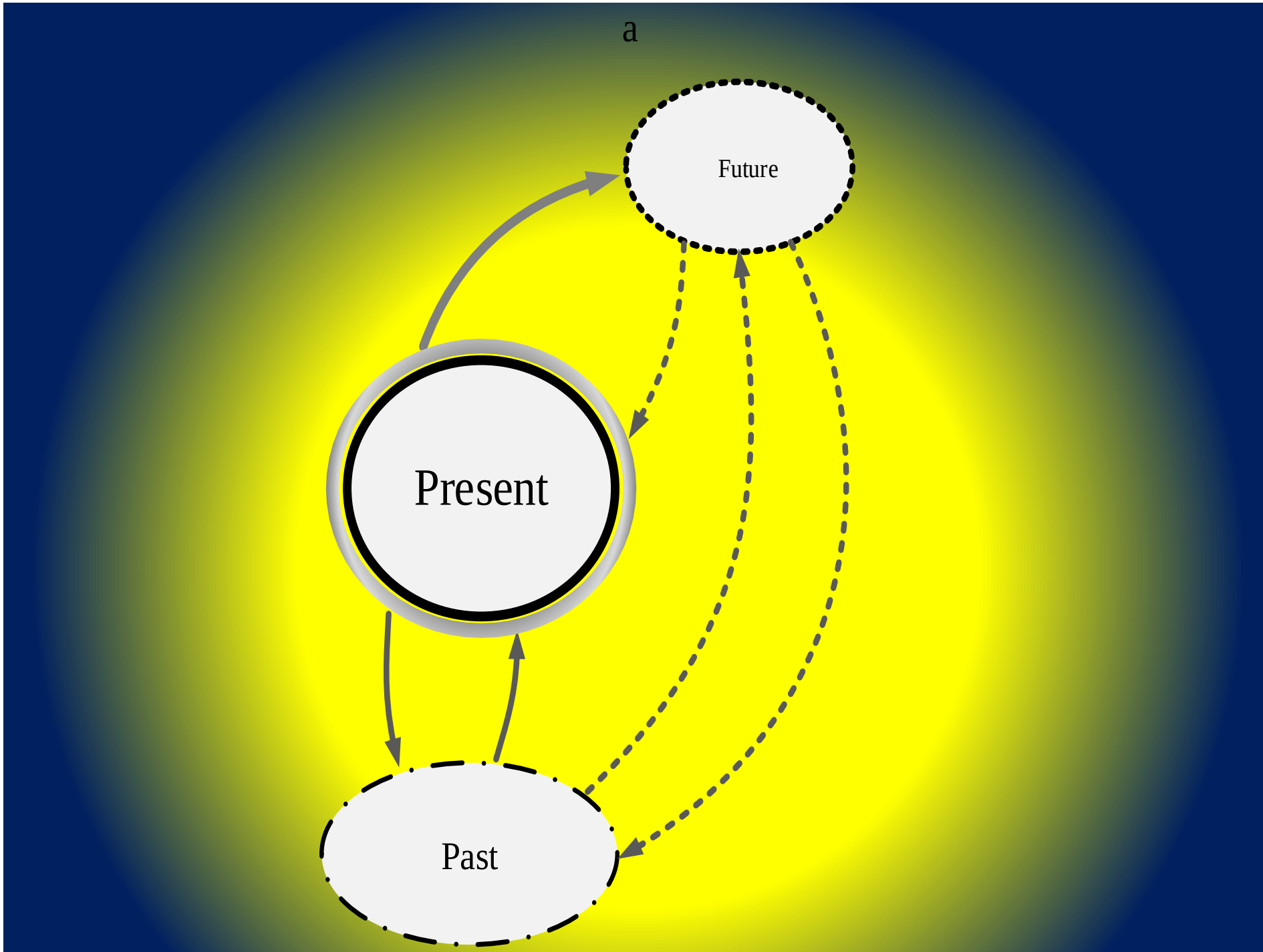
the past,
“seen”
by the reference state,
the past
we deal with,
the past that mostly matters,
the relational past,
is indeed
a construct of the present.

This relational construct,
this past,
depends on
the interacting realm
of the reference state
with
the present universe of states.

If
the interacting relations
and
the hierarchy among them
change,
then the reference state **“sees”**
a different past.

This means that
by attributing
different interacting degrees
in the evaluation
hierarchization process,
the final result may
give origin to
another past.

In this sense,
present, past and future
are all
deeply interconnected
in a
single relational unity,
present-past-future
always changing
in the becoming


a
Future
Present
Past

Summarizing

From the presented evidence,
related mainly with a very especial interaction type,
the tunneling interaction,
it is reasonable to infer that there is a fair,
experimental and conceptual,
support indicating that the
concepts of space and chronological time
are indeed not basic ontic concepts.

Undeniably, they are no more than mere useful tools,
more or less adequate,
relative to a given scale of
interaction and description of **Reality**.

Still, it is convenient to clarify,
that even if
space and chronological time
are not ontic basic concepts
they still, keep being quite useful
in the
description and prediction
of most classic current phenomena.

Futuro?

Comunicações com ondas theta

ondas subquânticas

Controle da gravidade

Energia do meio subquântico

Velocidades superluminais

?????????