

Does Free Will require New Physics?

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Center for Quantum Philosophy
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Is science compatible with our desire for freedom?
Social Trends Institute
Barcelona, 28-30 October 2010

Introduction

Freedom is an axiom: it can neither be proved nor rejected by any scientific experiment.

But...

I wonder why a deterministic universe produces a guy like me, who wishes to be free.

Introduction

Is it possible to define “observation”
(i.e. the very basis of science)
without somewhat assuming
the capabilities of the human observer?

Whether one can make science
without assuming
freedom and consciousness,
is a controversial issue.

As a matter of fact,
standard quantum physics assumes
the “freedom of the experimenter”
as an axiom,
and is quite successful as a science.

Anyway,
if I choose the option 'freedom'
I have to reject the determinism of
the classical physics
(the physics as it was in Kant's time,
Laplace's, Einstein's physics)

So, “true quantum randomness”
is in principle
good news for free will.

But...

Objection:

Indeterminism excludes any order or plan, and therefore also quantum physics is incompatible with free will.

Answer:

This is a misconception
about the principles of quantum.

Answer (continued):

Quantum physics establishes that the detection outcomes in an experiment have to fulfill a determined statistical distribution, and each outcome is unpredictable in principle for an external observer.

Quantum physics does not establish that the outcomes must happen without any order and be meaningless.

Answer (finished):

Actually, regarding free will and consciousness the result that quantum effects come from outside spacetime and therefore involve non-material agency, is even more important than quantum indeterminism.

Does free will require new physics?

In the follow I try to give a plausible answer to this question by:

1. Showing how the quantum principle of “**Nonlocality at detection**” may be basic to free will.
2. Speculating about how “**Non-material control of neuronal networks**” may happen.
3. Stressing that “sleep” is part of the quantum axiom of “freedom”, and likely the reason for quantum randomness.

And thereafter drawing some conclusions.

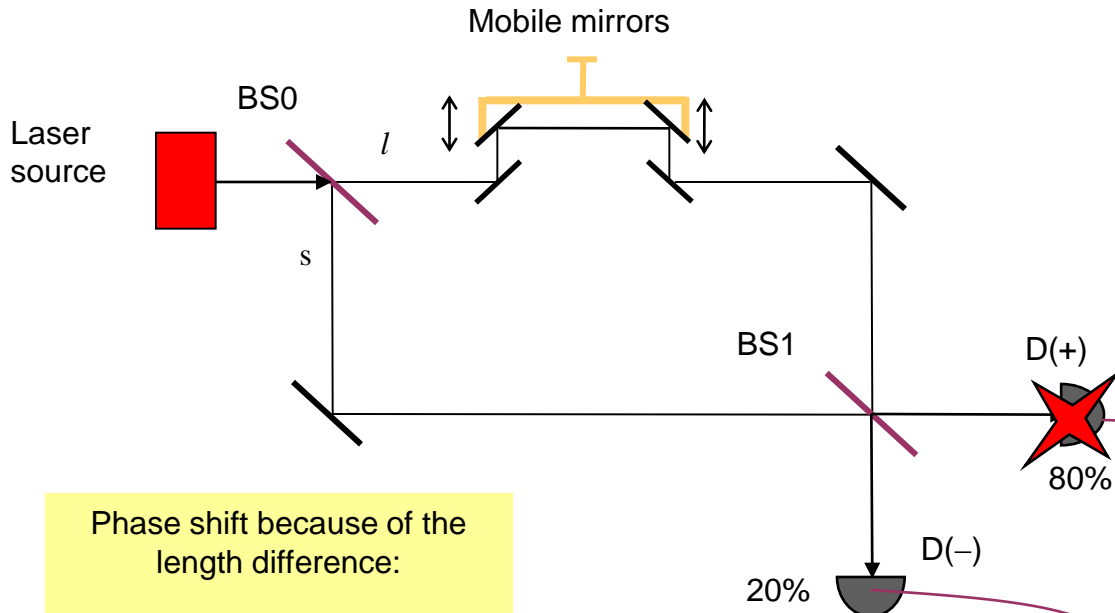
Nonlocality at detection

Entry to the Quantum World

Photoelectric effect:
The detections happen as counts of single photons.

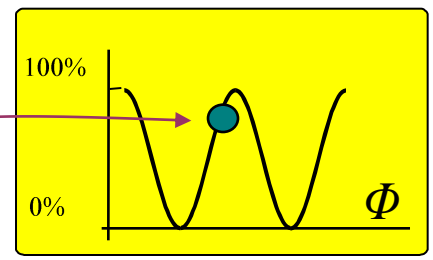


Interferences:
The counting rate depends on the path-length-difference



Counting rate D(+):

$$P(+1) = \frac{1}{2} \langle + \cos \Phi \rangle$$

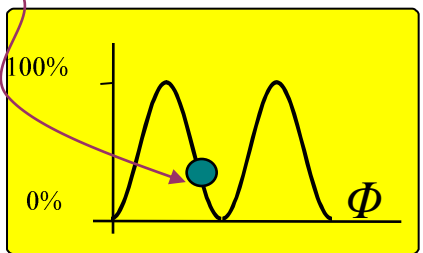


Phase shift because of the length difference:

$$\Phi = \omega \frac{l - s}{c}$$

Counting rate in D(-):

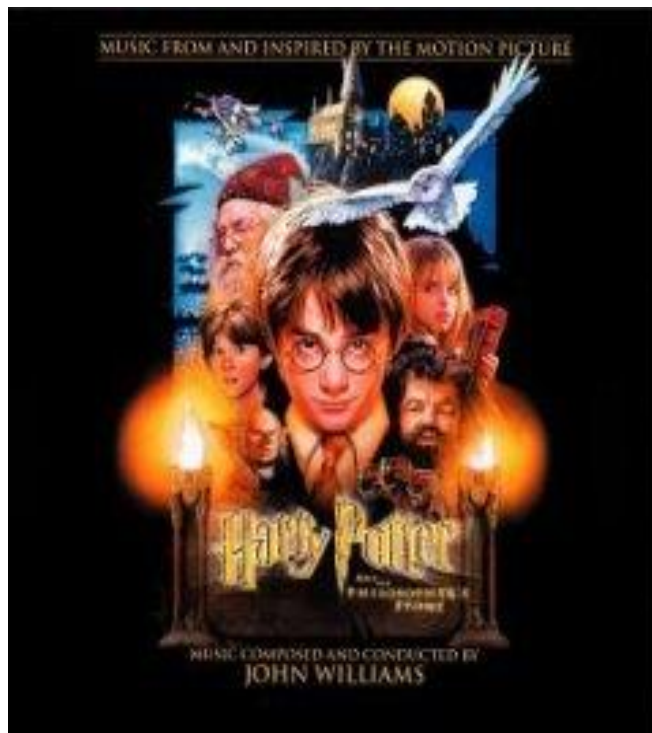
$$P(-1) = \frac{1}{2} \langle - \cos \Phi \rangle$$



Nonlocality at detection

Platform 9 $\frac{3}{4}$ to the Quantum World

Photoelectric effect + Interferences

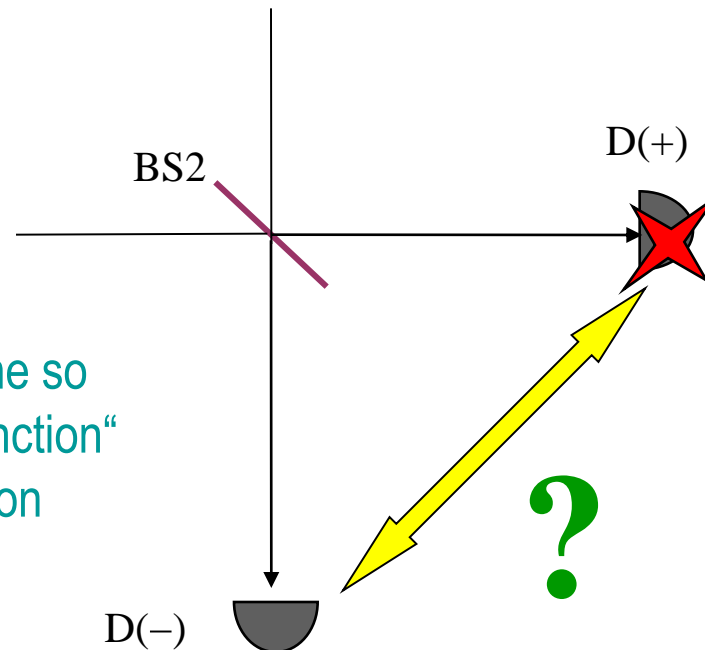


Nonlocality at detection

Nonlocal decision of the outcome at detection

Nonlocal decision between $D(+)$ and $D(-)$.

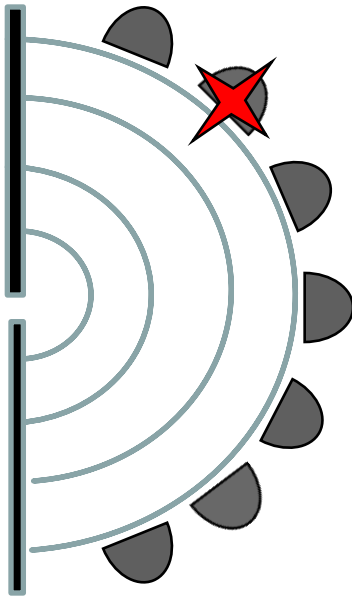
Which detector clicks, is decided by a free, non-material choice (coming from outside space-time).



This assumption is implicit in the so called „Collapse of the wavefunction“ of the Copenhagen interpretation of quantum physics.

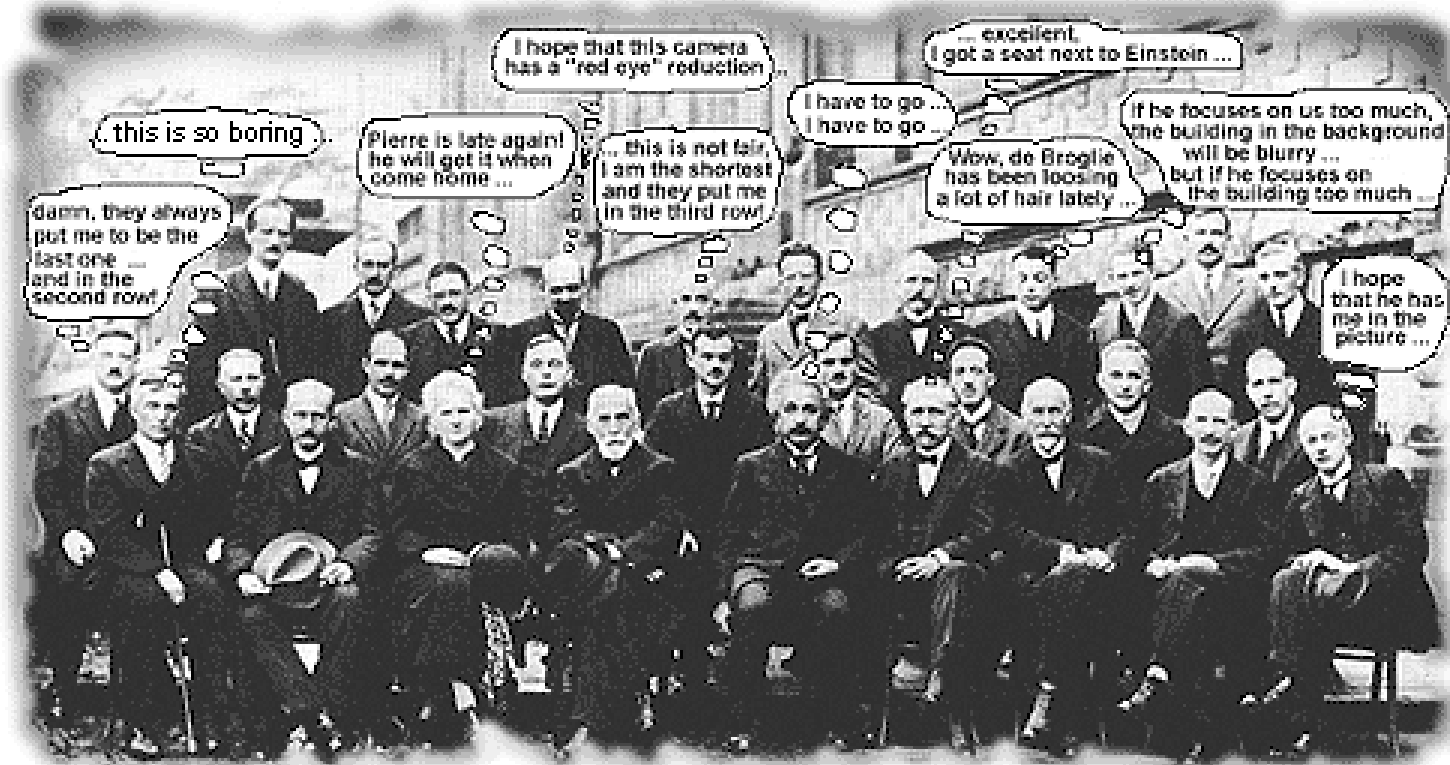
Nonlocality at detection

Nonlocality at detection provoked Einstein in the Solvay Congress 1927, and led thereafter to the EPR controversy 1935.



Light going through a slit reaches a screen. Deciding at which point the detection happens requires nonlocal coordination between all the detection units.

The Solvay Congress: Brussels 23-27.10.1927



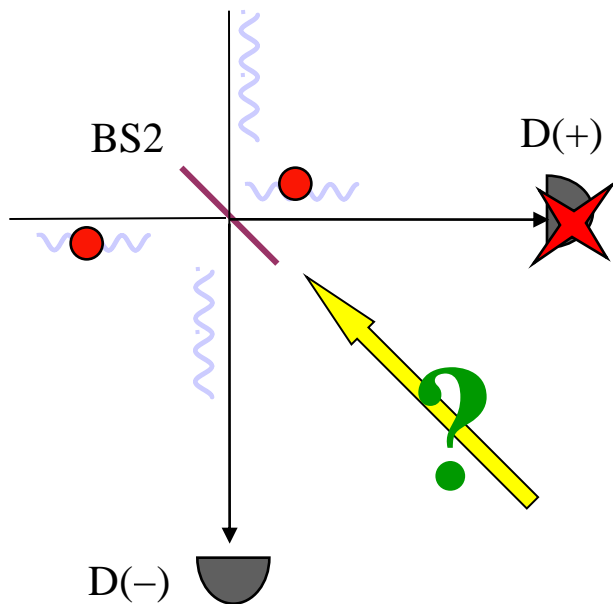
[first row] (1) I. Langmuir, (2) M. Planck, (3) M. Curie, (4) H.A. Lorentz, (5) A. Einstein, (6) P. Langevin, (7) C.E. Guye, (8) C.T.R. Wilson, (9) O.W. Richardson

[second row] (1) P. Debye, (2) M. Knudsen, (3) W.L. Bragg, (4) H.A. Kramers, (5) P.A.M. Dirac, (6) A.H. Compton, (7) L.V. de Broglie, (8) M. Born, (9) N. Bohr

[third row] (1) A. Piccard, (2) E. Henriot, (3) P. Ehrenfest, (4) E. Herzen, (5) Th. de Donder, (6) E. Schroedinger, (7) E. Verschaffelt, (8) W. Pauli, (9) W. Heisenberg, (10) R.H. Fowler, (11) L. Brillouin.

Nonlocality at detection

Louis de Broglie tries to explain things without nonlocality (using the of “empty pilot wave”)



According to de Broglie the particle travels always a well defined trajectory whereas an unobservable “empty wave” travels the alternative path, and pilots the particle when they meet at the beam-splitter according to the information it gathers in its journey.

Nonlocality at detection

The idea of an “empty pilot wave” propagating in spacetime is “weird”

The reason to escape nonlocality cannot be the wish for avoiding signaling faster than light, for it is well known that quantum mechanics does not lead to such signaling.

Thus the only plausible reason seems to be avoiding non-material agency, i.e., influences which are not directly accessible to any apparatus.

But ironically, de Broglie’s “empty wave” is an entity that although fully content and propagating in spacetime (in the lightcone), it is supposed to be inaccessible to observation or detection in principle, i.e., it is non-material. Thus the model finishes by accepting what it wishes to escape: non-material agency, and it accepts it within spacetime.

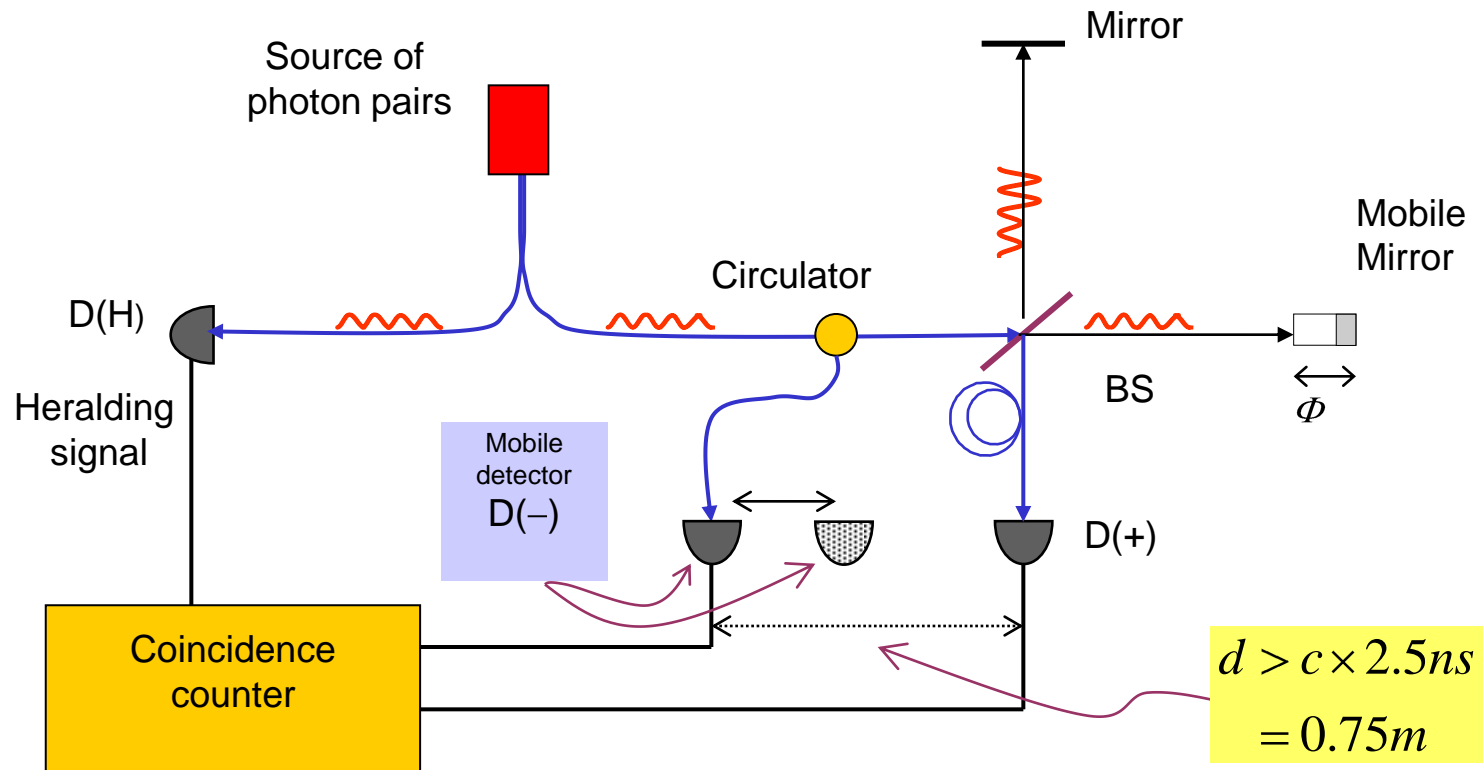
Nonlocality at detection

If one accepts that
agency happening within spacetime
necessarily comes from
an accessible material cause
as a principle of physics ,

then the only coherent explanation of
single-particle interference is
nonlocality at detection.

Nonlocality at detection

Experiment demonstrating nonlocality at detection



Nonlocality at detection

The freedom of the experimenter is
a main principle or axiom
of today's physics

Without this principle one can dispose
of quantum nonlocality
and relativity as well

Nonlocality at detection

An important property of nonlocality at detection

Nonlocality at detection is necessary to have conservation of the energy in **each individual** quantum process (and not only on the average).

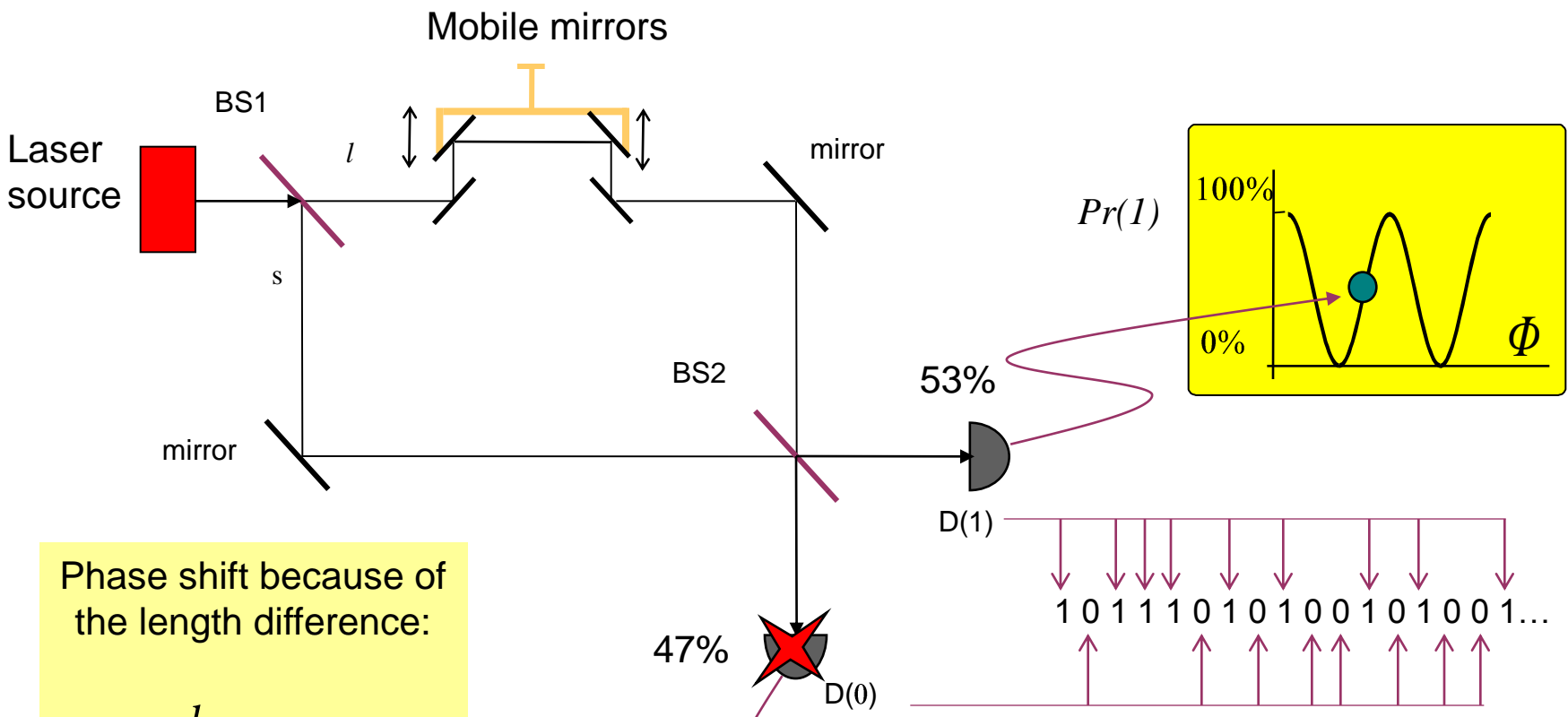
Open questions

1. Are nonlocality at detection and Bell's nonlocality two different types of nonlocality?
2. Can one nonlocality be derived from the other?

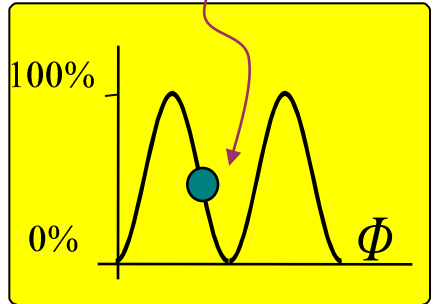
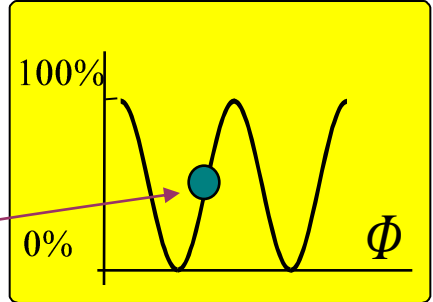
**Nonlocality at detection
in single-particle experiments
assumes that “God does not cheat”.**

If one wishes implement nonlocality for **commercial purposes** (like cryptography), one has to assume the possibility of cheating, and then one has to use 2-particle tools and Bell inequalities.

Nonlocality at detection



Phase shift because of the length difference:

$$\Phi = \omega \frac{l - s}{c}$$


Quantum physics says nothing about the order of the outcomes. They build a string of bits, which could very well contain the information of a master work of literature or music.

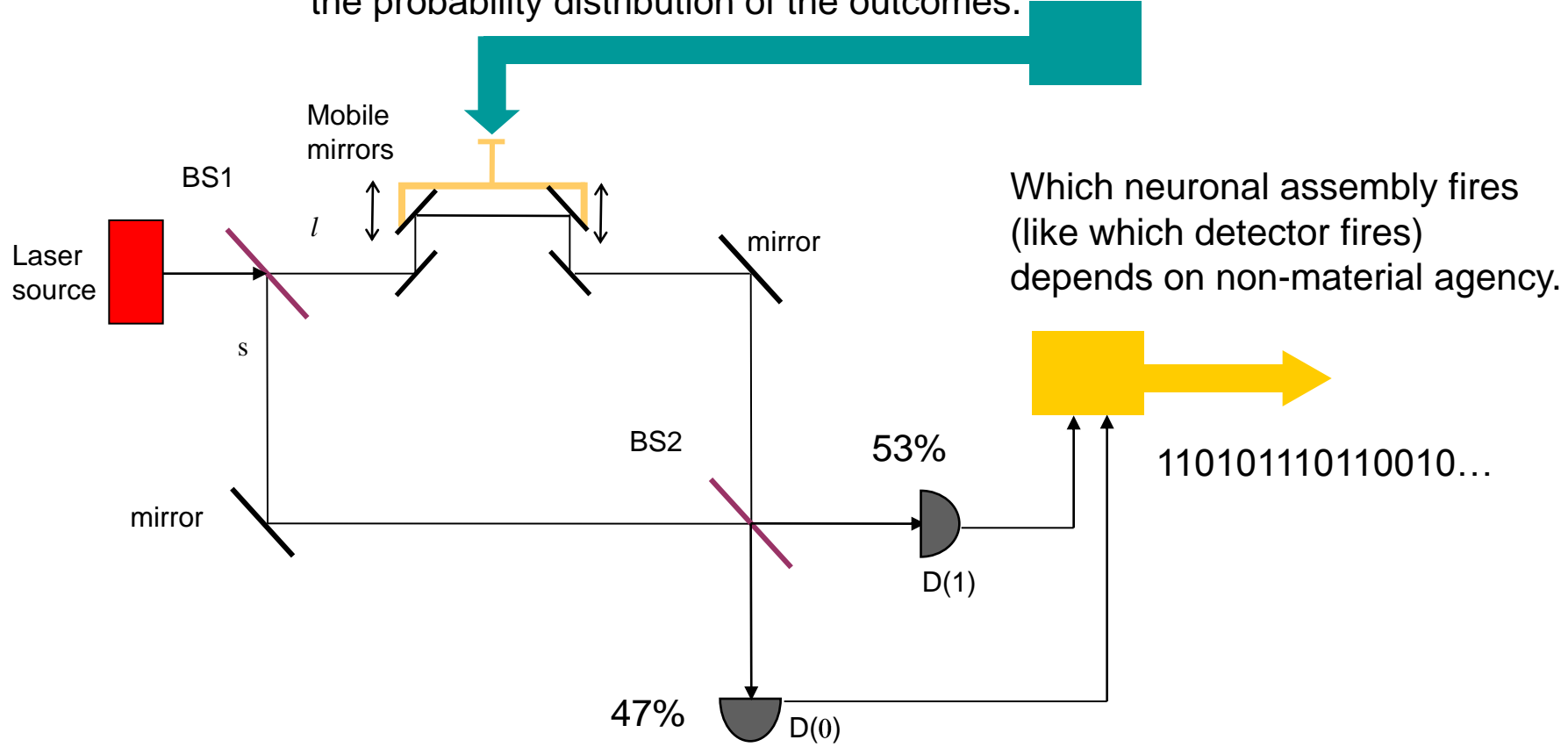
No human being can
through **material** agency
manipulate a quantum interferometer
and oblige it to print out
a determined piece of information

However, a human being can steer the order of the outcomes in his brain through **non-material** agency, and produce a meaningful piece of information: a talk, a paper, a master work of literature or music.

Non-material control of neuronal networks

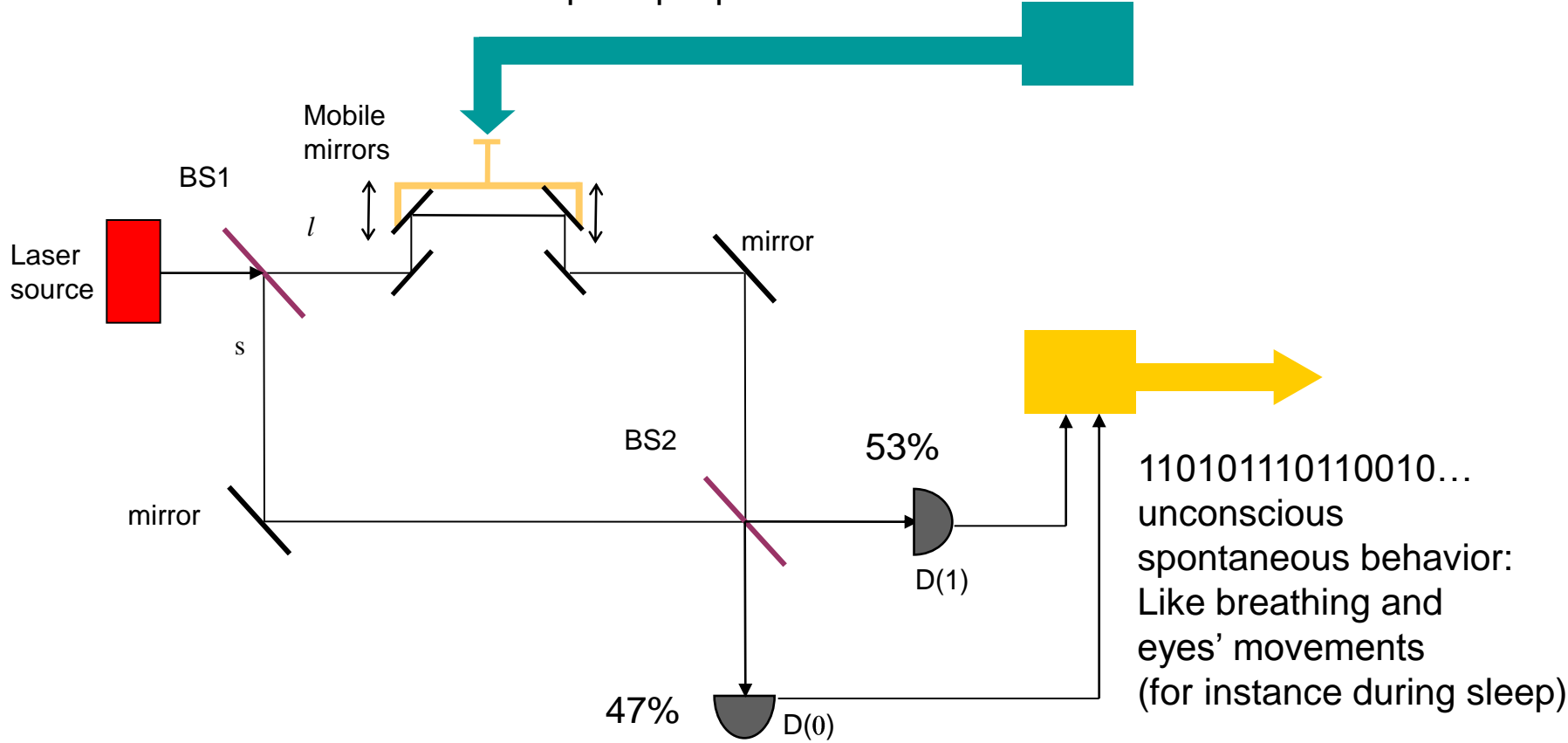
The brain functioning may follow basic principles of quantum physics

Purposeful control of the physiological parameters in the cortex may determine the probability distribution of the outcomes.



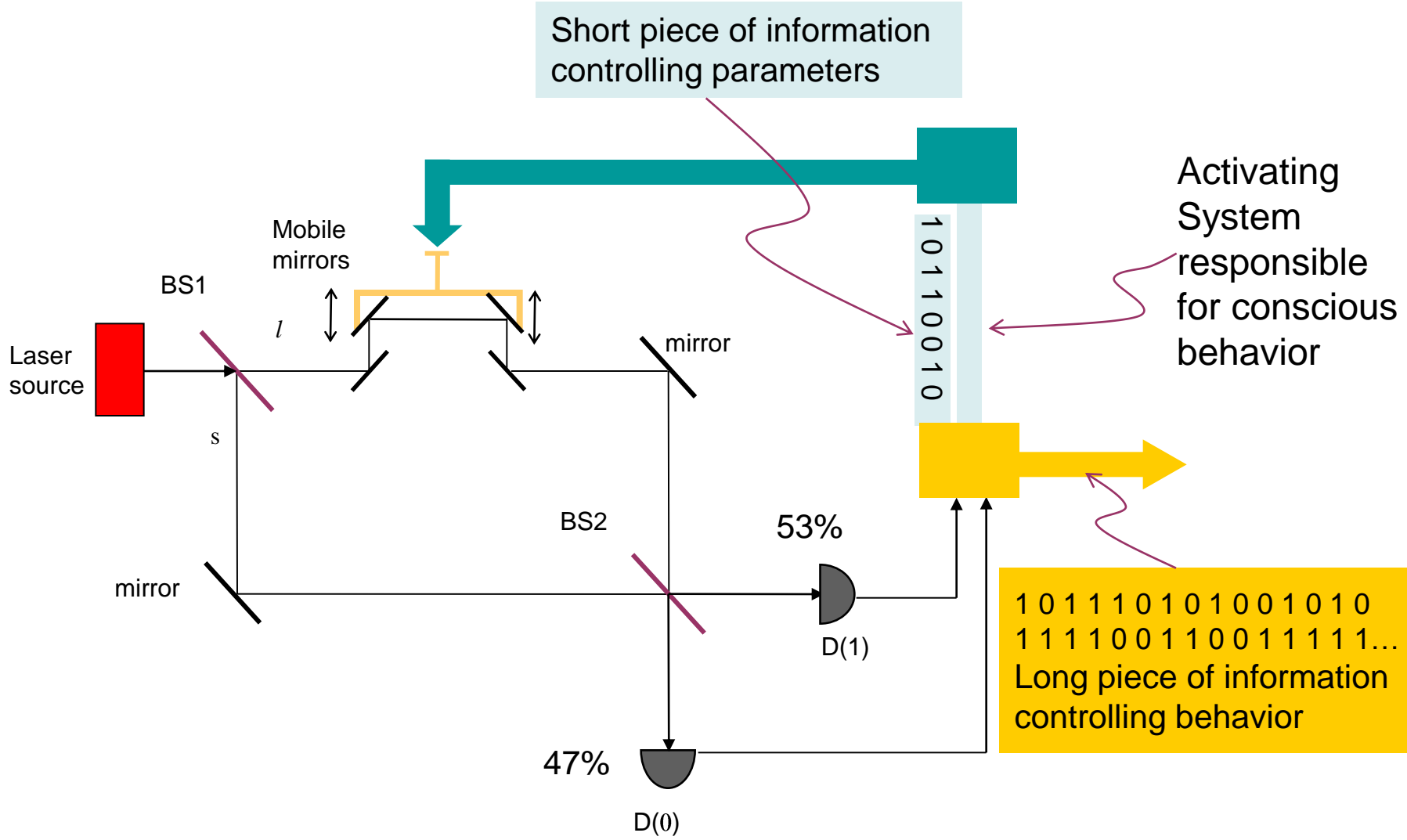
Non-material control of neuronal networks

purposeful control of the parameters determining the probability distribution is in principle possible.



Without purposeful control of the parameters determining the probability distribution, the brain produces mainly meaningless spontaneous behavior. During REM sleep muscle atonia hinders that the intense neural activity produces hazardous uncontrolled motor behaviors.

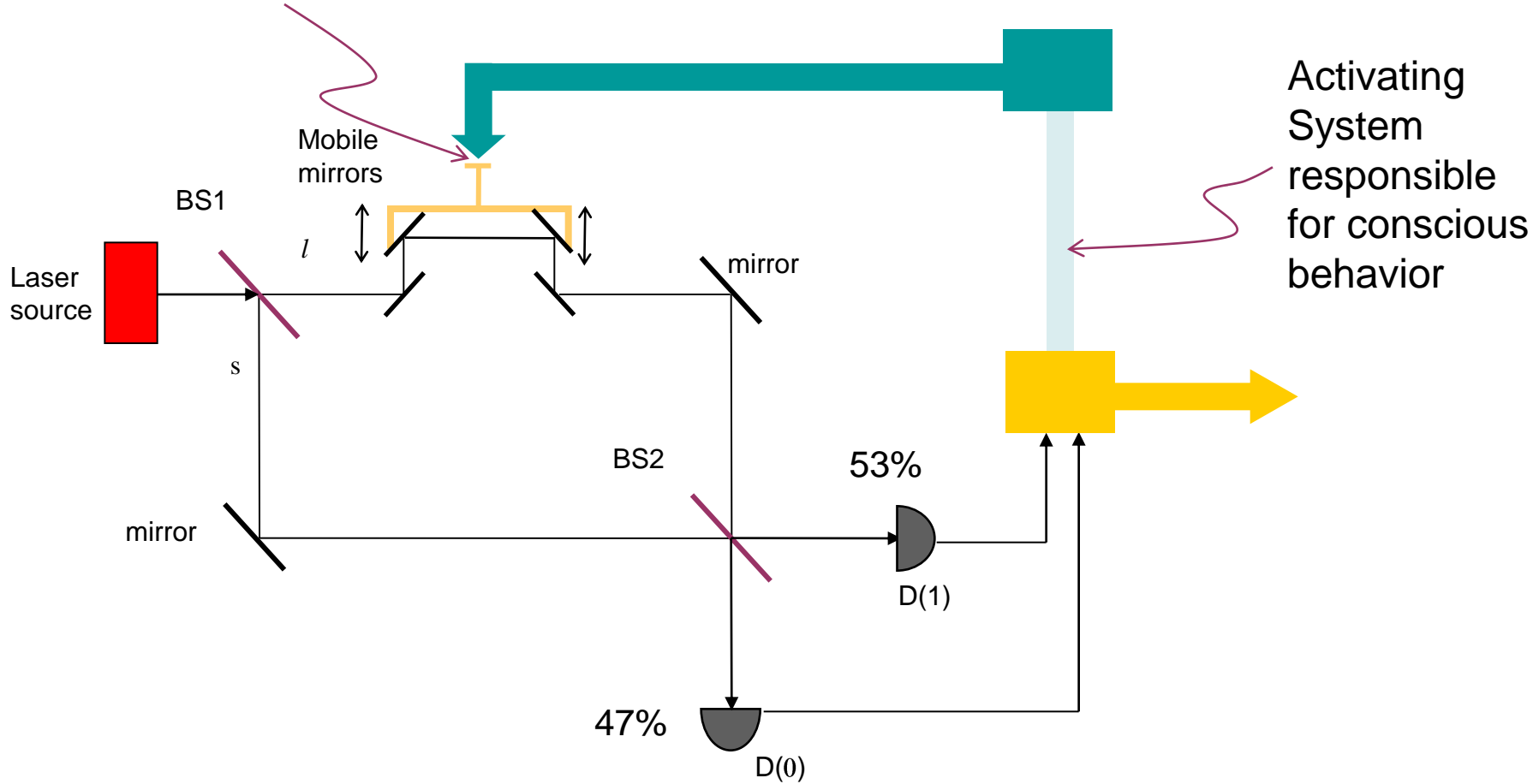
Non-material control of neuronal networks



Expander of non-material control: a small seed of meaning is expanded into a much longer meaningful string.

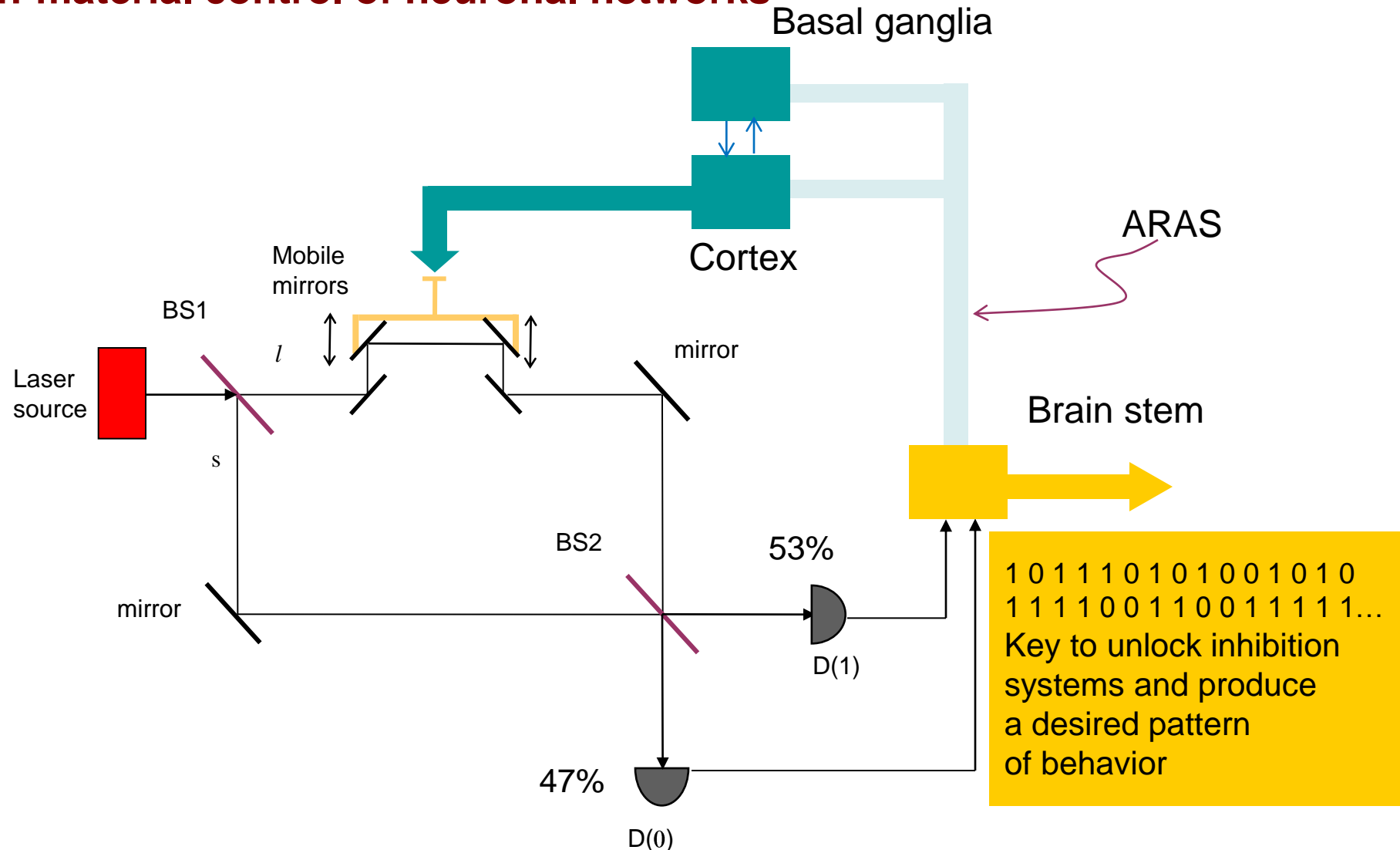
Non-material control of neuronal networks

Sensorial impressions



Sensorial impressions may act upon the parameters determining the probability distributions: When I perceive another subject performing a movement my brain parameters correspond to those I use for performing the same movement (*mirror neurons*). Childs often perform actually the movement they perceive (learning by imitation), while adults inhibit it.

Non-material control of neuronal networks



„In men there are movements of **endogenous origin**, centrally coordinated, who would be continuous if not *braked* by a central inhibition when they are not needed“

K. Lorenz, 1973

Central Pattern Generators (CPG)

„Movements are generated by dedicated network of nerve cells that contain the information that is necessary to activate different motor neurons in the appropriate sequence and intensity to generate motor patterns.

Such networks are referred to as Central Pattern Generators.“

Sten Grillner

FROM ION CHANNELS TO NEURONAL NETWORKS

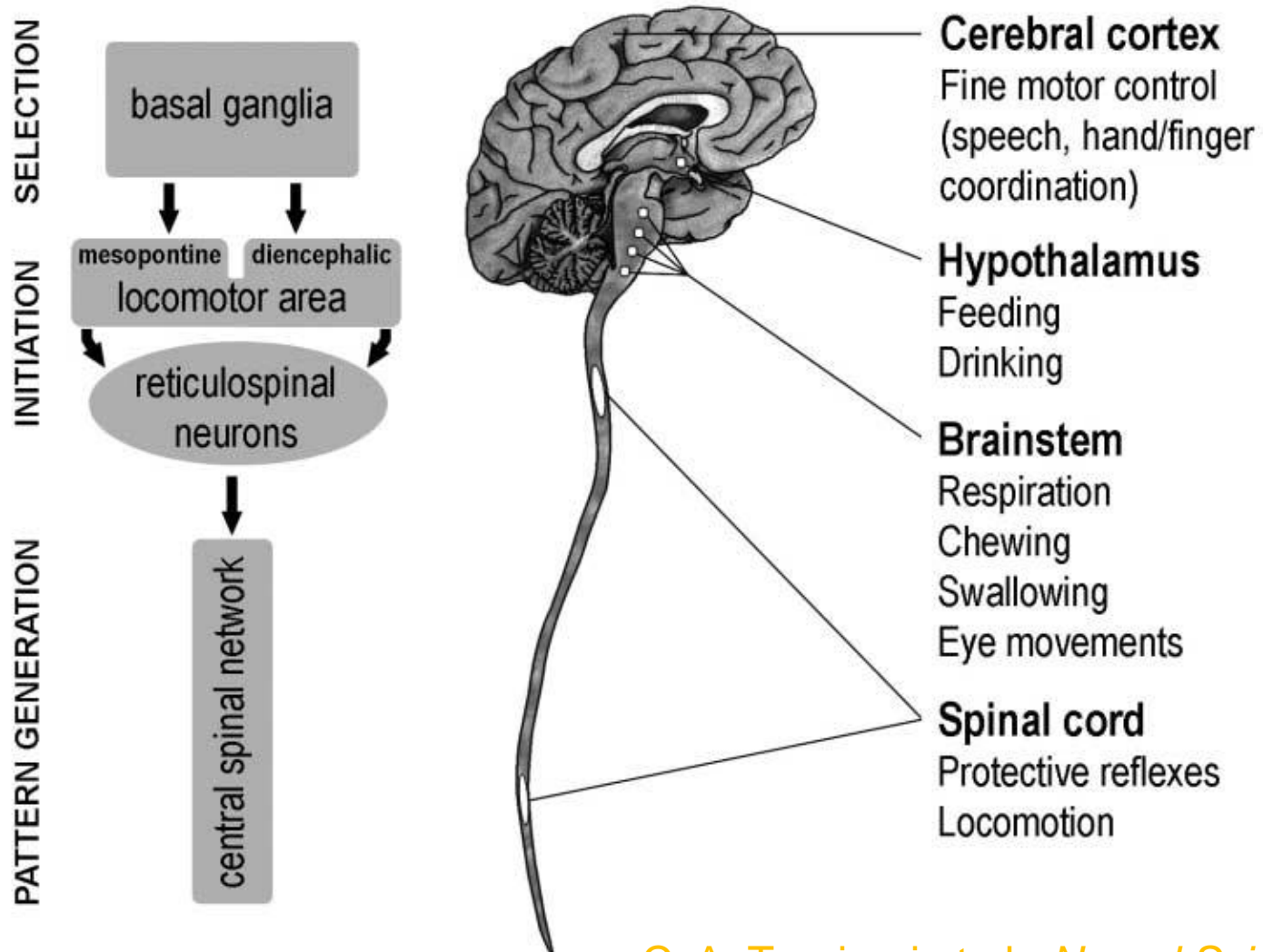
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Epilepsy, parasomnias and Central Pattern Generators (CPG)

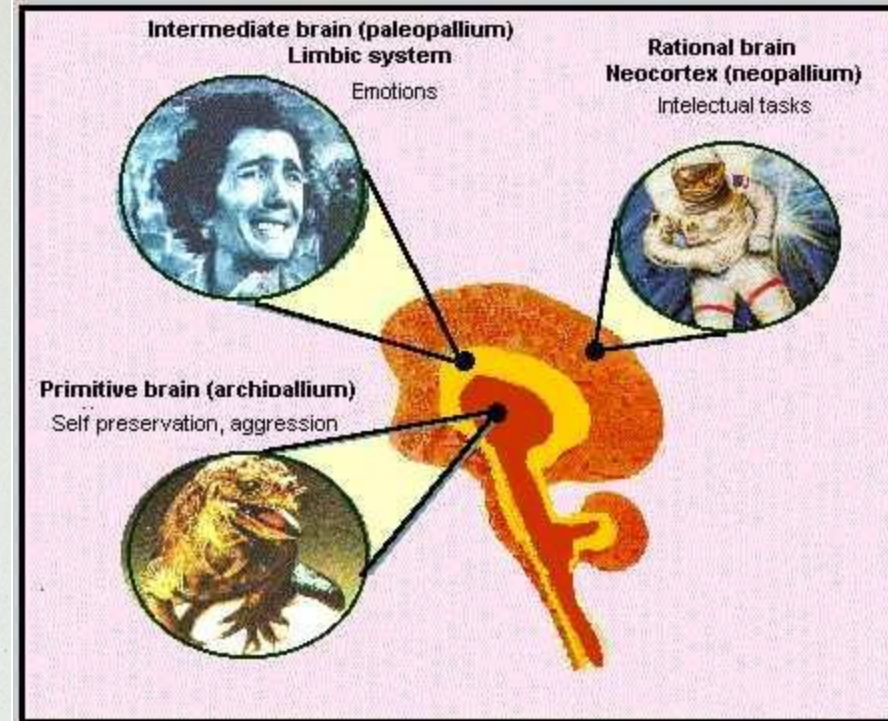
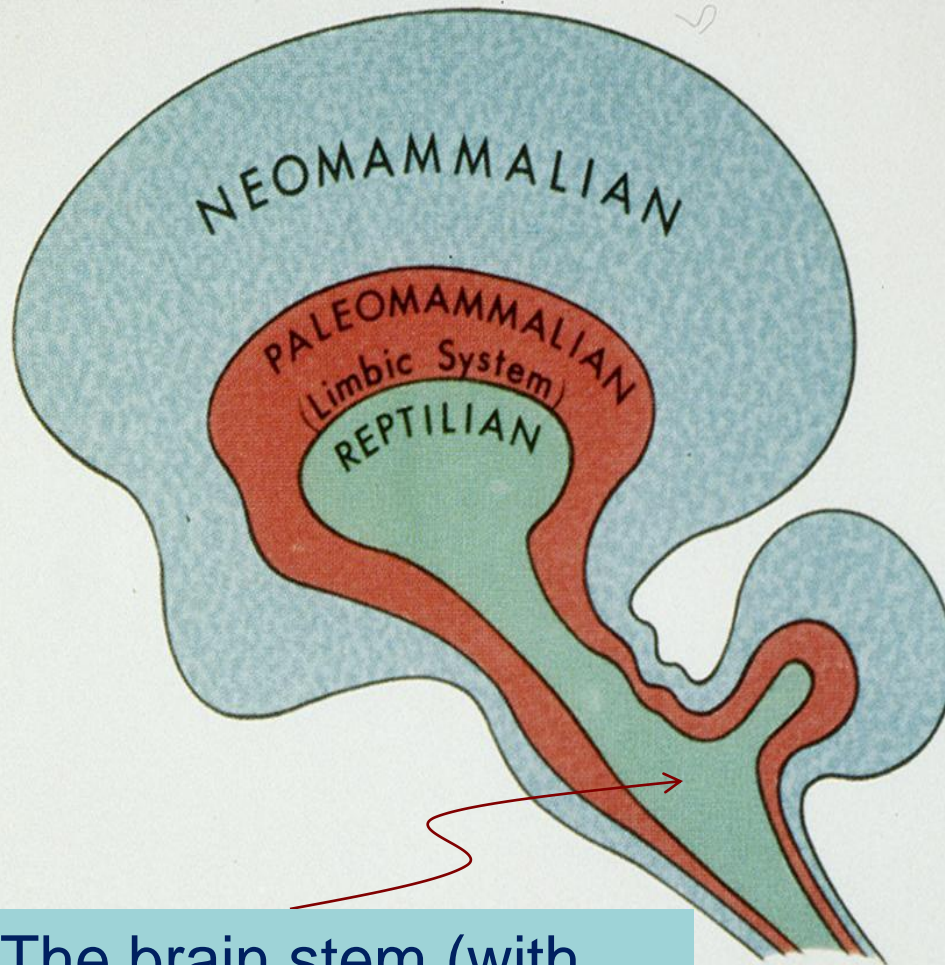
“The epileptic discharge acts as a trigger for the appearance of behaviors which are the expression of inborn motor patterns, related to CPG, mainly located outside the cerebral cortex, i.e. the meso-diencephalic-pontine regions and the spinal cord.”

C. A. Tassinari et al., Central pattern generators for a common semiology in fronto-limbic seizures and in parasomnias. A neuroethologic approach. *Neurol Sci* (2005) 26:s225–s232 DOI 10.1007/s10072-005-0492-8

Central Pattern Generators (CPG)



Paul D. MacLean 1952



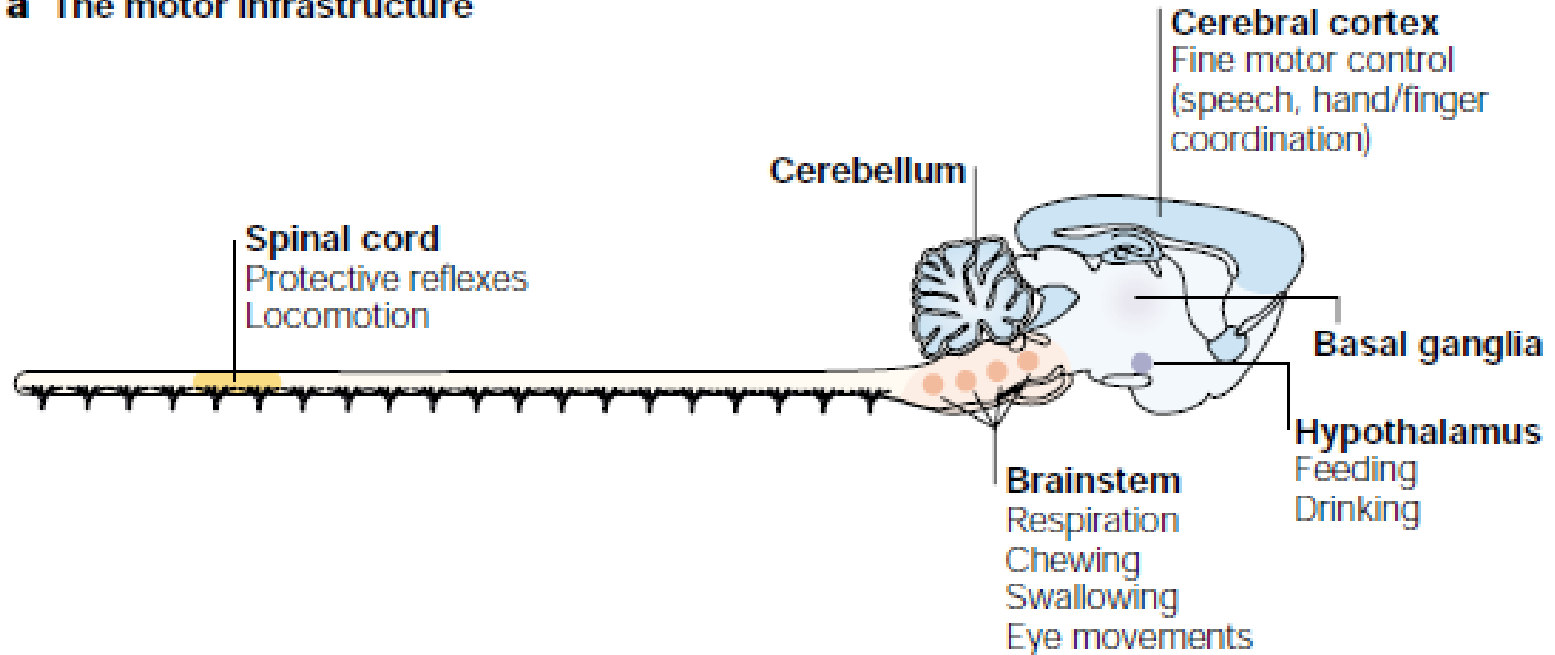
The brain stem (with the CPGs therein) is the oldest form of brain.

“Both epilepsy and sleep can lead to a temporary loss of control of neomammalian cortex that facilitates through a common platform (arousal) the emergences of stereotyped inborn fixed action patterns.”

C. A. Tassinari et al., 2005

Central Pattern Generators CPG and ion channels

a The motor infrastructure



Ion channels control the functioning of the Central Pattern Generators

Sten Grillner

Central Pattern Generators CPG, ion channels and quantum effects

Ion channels control the functioning of the Central Pattern Generators

Sten Grillner

The motor infrastructure, : From ion channels to neuronal networks.
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Work on quantum effects in ion channels is progressing fast.

A. Vaziri, M.B. Plenio

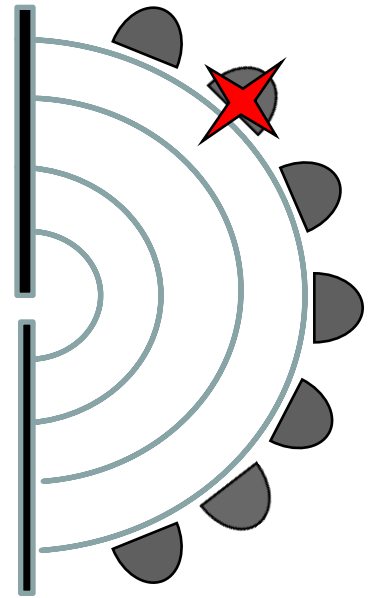
Quantum coherence in ion channels: Resonances, Transport and Verification,
New Journal of Physics 12, 085001 (2010), and references therein.

Non-material control of neuronal networks

Actually, nonlocal decision of outcome happens in daily life at “room temperature”.

Similarly, nonlocal choices happen incessantly in the brain environment.

The brain does not function like a quantum computer requiring extreme conditions of isolation.



Non-material control of neuronal networks

One can safely state that deciding which particular neuronal assembly fires involves non-material agency coming from outside spacetime.

Is sleep the reason for “quantum randomness”?

The human capacity of purposeful conscious behaviour is limited, mainly because of the necessity to sleep (the Wake-Sleep cycle)

The complete
first axiom of quantum physics
is the unity

Free Will & Sleep

Is sleep the reason for “quantum randomness”?

The constants of nature
ruling the wake-sleep cycle
are unknown to date:

Is there a relationship between
Wake-Sleep cycle
and the
Second Law of Thermodynamics?

Is sleep the reason for “quantum randomness”?

Acting unconsciously means acting “arbitrarily” rather than “involuntarily”, i.e., in a **voluntary though meaningless** way.

Quantum cryptography illustrates very well, that “randomness” can be considered a particular case of free will.

Is sleep the reason for “quantum randomness”?

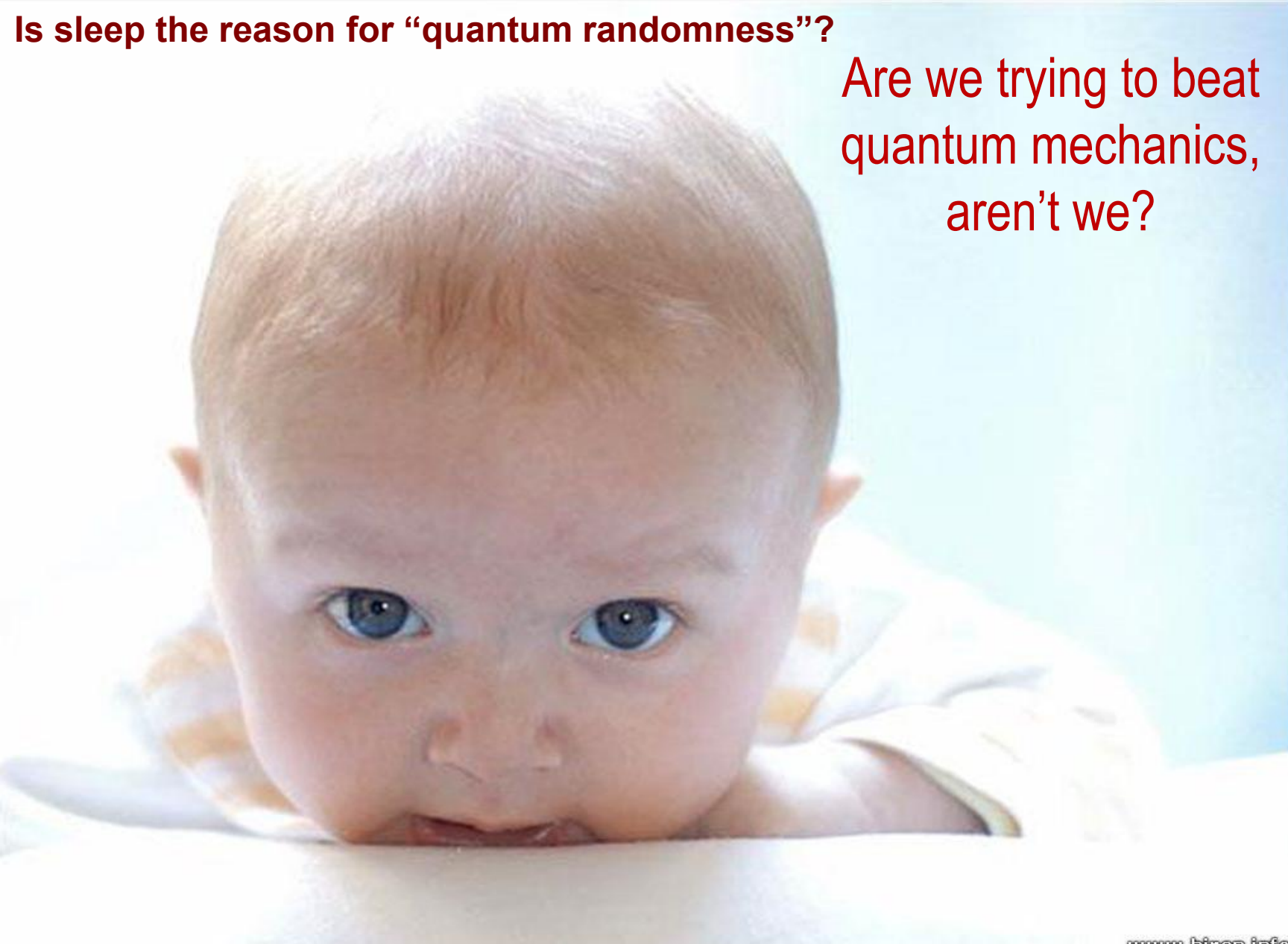
Suppose the outcomes of an interferometer are steered through **non-material** agency during a time, and thereafter follows a long period of uncontrolled (“random”) behavior: At the end the outcomes distribution tend to be that quantum physics predicts for the particular path lengths.

Is sleep the reason for “quantum randomness”?

Similarly, after a period of purposeful conscious work, spontaneous neural dynamics during sleep will tend to the “random” outcome distribution defined by the particular physiological parameters.

Is sleep the reason for “quantum randomness”?

The so called “quantum randomness”
appearing in the lab is nothing other
than the probabilities one gets
in a apparatus exhibiting
a very low level of purposeful control
through non-material agency.



Is sleep the reason for “quantum randomness”?

**Are we trying to beat
quantum mechanics,
aren't we?**

www.hiren.info

I dont want to sleep !

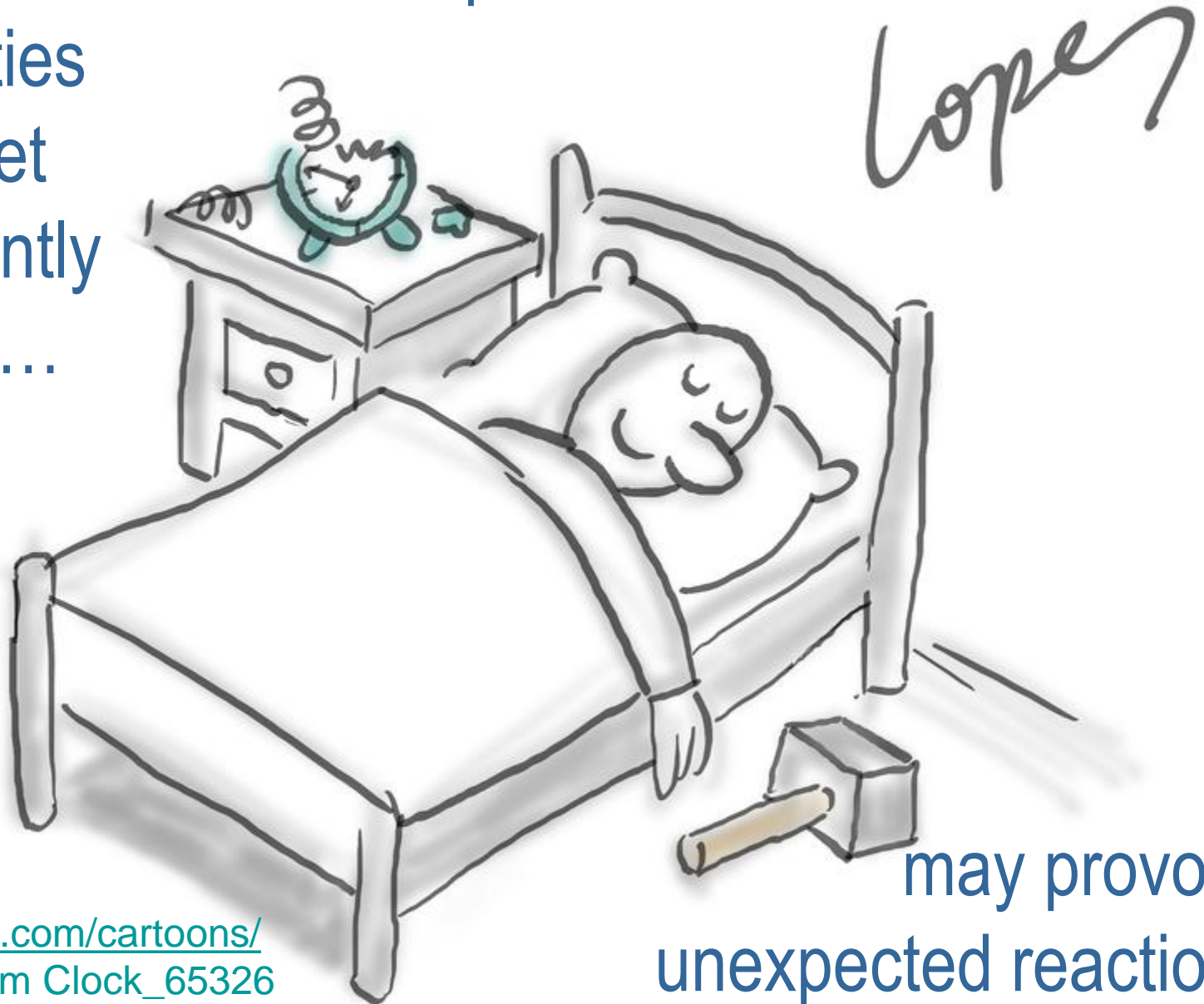
Is sleep the reason for “quantum randomness”?

Quantum mechanics prevails!



Is sleep the reason for “quantum randomness”?

Being awaked while the quantum probabilities are not yet conveniently restored ...



may provoke unexpected reactions

Does free will require new physics?

1.

Nonlocality at detection means that the outcomes of a quantum device can be in principle controlled by non-material principles.

Today's physics is compatible with free will.

Does free will require new physics?

2.

Nonlocality at detection may be key to understand how free-will steers neuronal networks.

When detection happens is an open question in quantum physics.

Conclusions

Does free will require new physics?

3.

Where does the non-material agency in the Universe outside our brains come from?

A big philosophical challenge for the coming years.

Free will requires likely more “new philosophy” than new physics.

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The End

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