

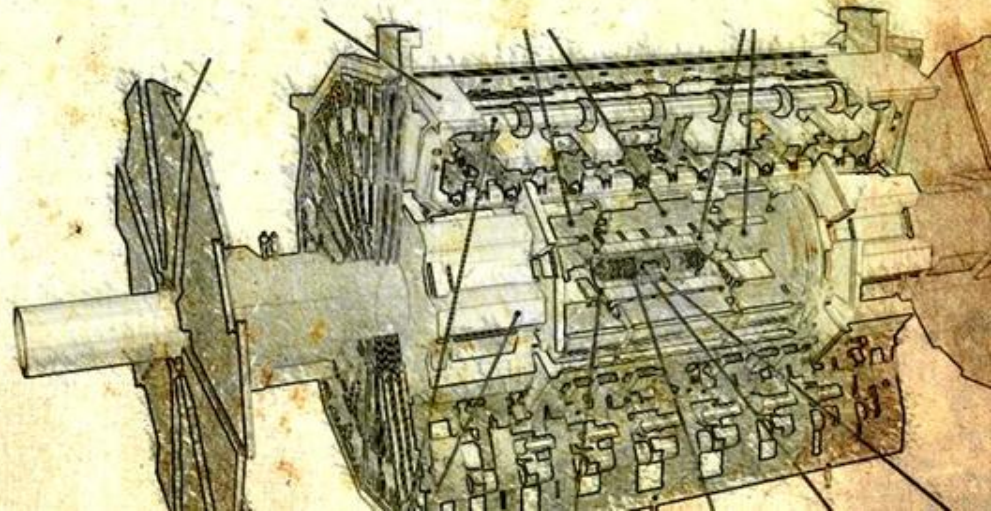
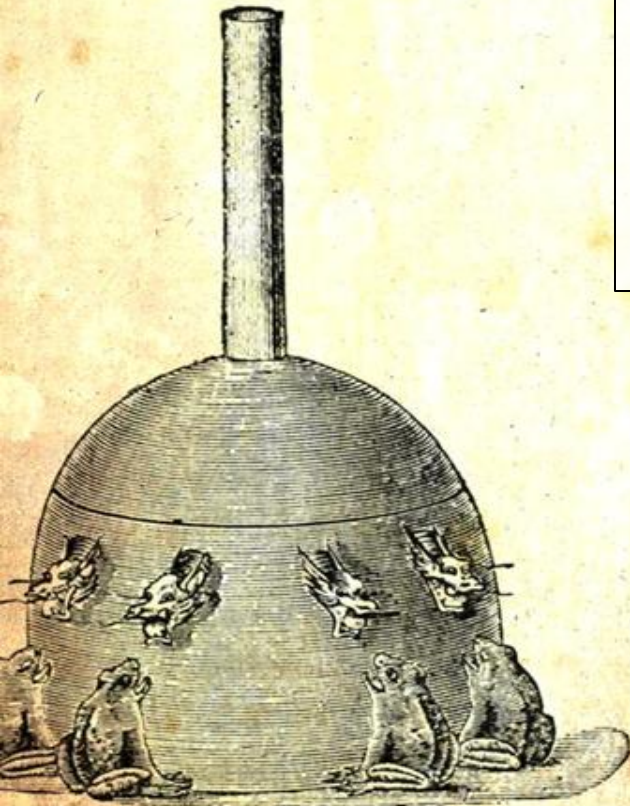


Seminar

The most important Mistakes in Physics's History

The Structure  
\_\_\_\_\_ of

Scientific Revolutions





Geocentric model  **ANTIQUE**

4-Elements Model

Kinetics of Inertia

Χρόνος



Geocentric model  **ANTIQUE**

4-Elements Model

Kinetics of Inertia

**PRE-PHYSICS ERA**

Phlogiston  
The Infinite

Alchemy

Χρόνος



Geocentric model  **ANTIQUE**

4-Elements Model

Kinetics of Inertia

**PRE-PHYSICS ERA**

Phlogiston

Alchemy

The Infinite

**CLASSICAL PHYSICS**

Aether Theory

N-Rays Bohr: Atomic Model

Einstein's Lambda



Geocentric model  **ANTIQUÉ**

4-Elements Model

Kinetics of Inertia

**PRE-PHYSICS ERA**

Phlogiston

Alchemy

The Infinite

**MODERN PHYSICS**

Transuranium Elements

Cold Fusion

Heisenberg's Theory of Everything

Magnetic Monopoles

Polywater

**CLASSICAL PHYSICS**

Aether Theory

N-Rays Bohr: Atomic Model

Einstein's Lambda





Geocentric model  **ANTIQUE**

4-Elements Model

Kinetics of Inertia

**PRE-PHYSICS ERA**

Phlogiston

Alchemy

The Infinite

**MODERN PHYSICS**

Transuranium Elements

Cold Fusion

Heisenberg's Theory of Everything

Magnetic Monopoles

Polywater

**CLASSICAL PHYSICS**

Aether Theory

N-Rays Bohr: Atomic Model

Einstein's Lambda

**PARTICLE PHYSICS**

Gravitational Waves Double-Beta Decay

GSI Neutral Particles

HERA-B

Super Symmetry

Superspeed Neutrinos

Pentaquarks



# The Beginning of Science



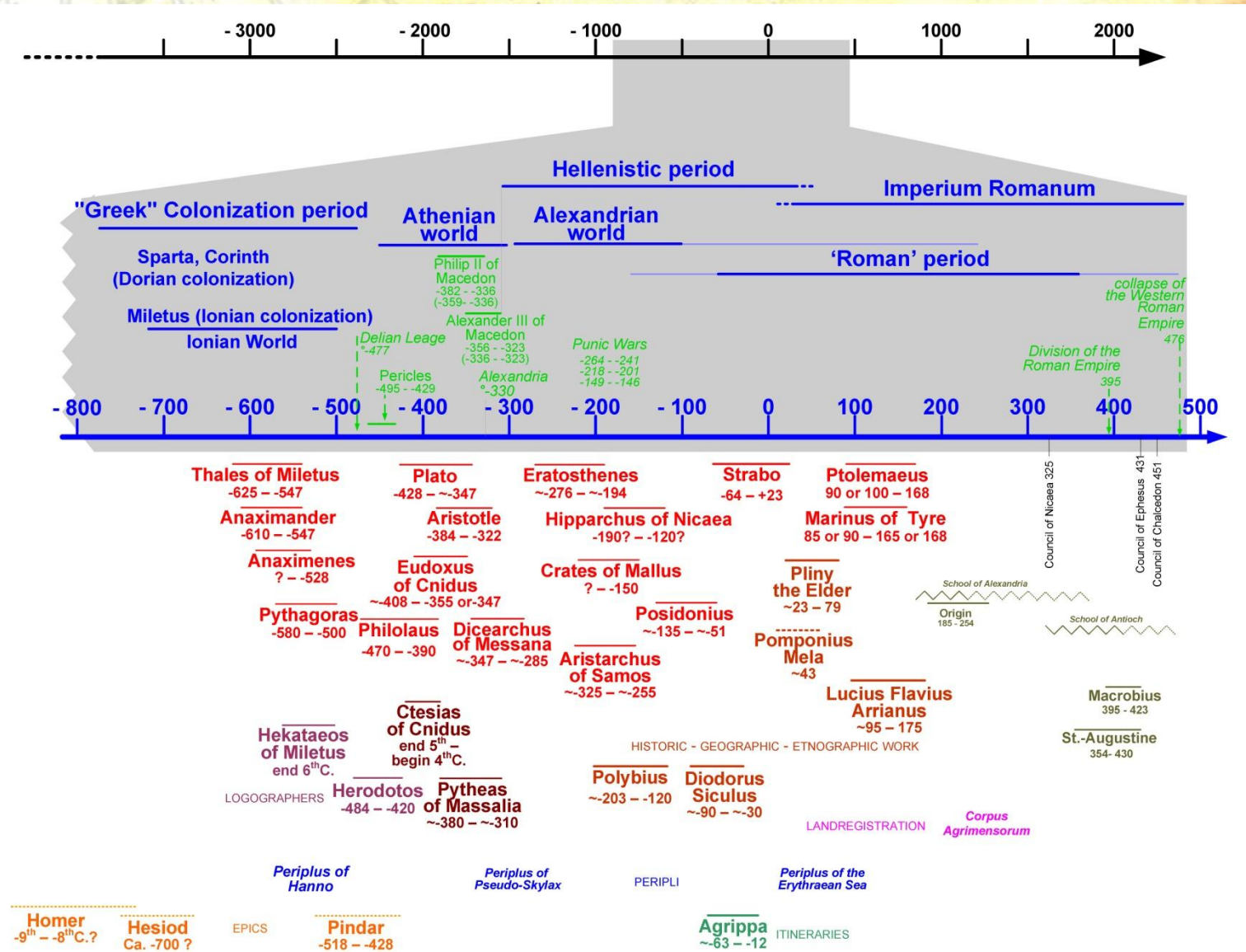


# The Beginning of Science





# The Beginning of Science





# The Structure of Science

**Irrationalism**

Dogmata



Metaphysics

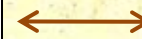


# The Structure of Science

## **Irrationalism**

Since 1386.

Dogmata



Metaphysics

Hypothesis



pure logic of mind



# The Structure of Science

## **Irrationalism**

Since 1386.

## **Rationalism**

John Locke

René Descartes

Dogmata



Metaphysics

Hypothesis



pure logic of mind



# The Structure of Science

## Irrationalism

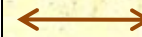
Since 1386.

## Rationalism

John Locke

René Descartes

Dogmata



Metaphysics

Hypothesis



pure logic of mind

Theory

Deduction



Induction

Empirical Research



# The Structure of Science

## Irrationalism

Since 1386.

## Rationalism

John Locke

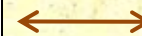
René Descartes

## Empirism

Francis Bacon

David Hume

Dogmata



Metaphysics

Hypothesis



pure logic of mind

Theory

Deduction



Induction

Empirical Research



# The Structure of Science

## Irrationalism

Since 1386.

## Rationalism

John Locke

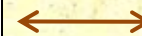
René Descartes

## Empirism

Francis Bacon

David Hume

Dogmata



Metaphysics

Hypothesis



pure logic of mind

Theory

Deduction



~~Induction~~

Empirical Research



# The Structure of Science

## Irrationalism

Since 1386.

## Rationalism

John Locke

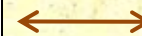
René Descartes

## Empirism

Francis Bacon

David Hume

Dogmata



Metaphysics

Hypothesis



pure logic of mind

Theory

Falsifiability

Deduction



Empirical Research



# The Structure of Science

## Irrationalism

Since 1386.

## Rationalism

John Locke

René Descartes

## Empirism

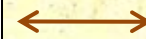
Francis Bacon

David Hume

## Empirism

Karl Popper

Dogmata



Metaphysics

Hypothesis



pure logic of mind

Theory

Falsifiability

Deduction



Empirical Research



# The Structure of Science

## Irrationalism

Since 1386.

## Rationalism

John Locke

René Descartes

## Empirism

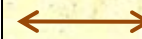
Francis Bacon

David Hume

## Empirism

Karl Popper

Dogmata



Metaphysics

Hypothesis



pure logic of mind

Theory

Falsifiability

Deduction



Empirical Research

**„If any and every failure to fit  
were ground for theory rejection,  
all theories ought to be rejected at all times.“**



# The Structure of Science

## Irrationalism

Since 1386.

## Rationalism

John Locke

René Descartes

## Empirism

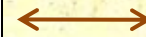
Francis Bacon

David Hume

## Empirism

Karl Popper

Dogmata



Metaphysics

Hypothesis



pure logic of mind

Theory

Falsifiability

Deduction



Empirical Research

**Thomas Kuhn: „If any and every failure to fit were ground for theory rejection, all theories ought to be rejected at all times.“**



# The Structure of Science

Science as a **social** business



# The Structure of Science

Science as a **social** business

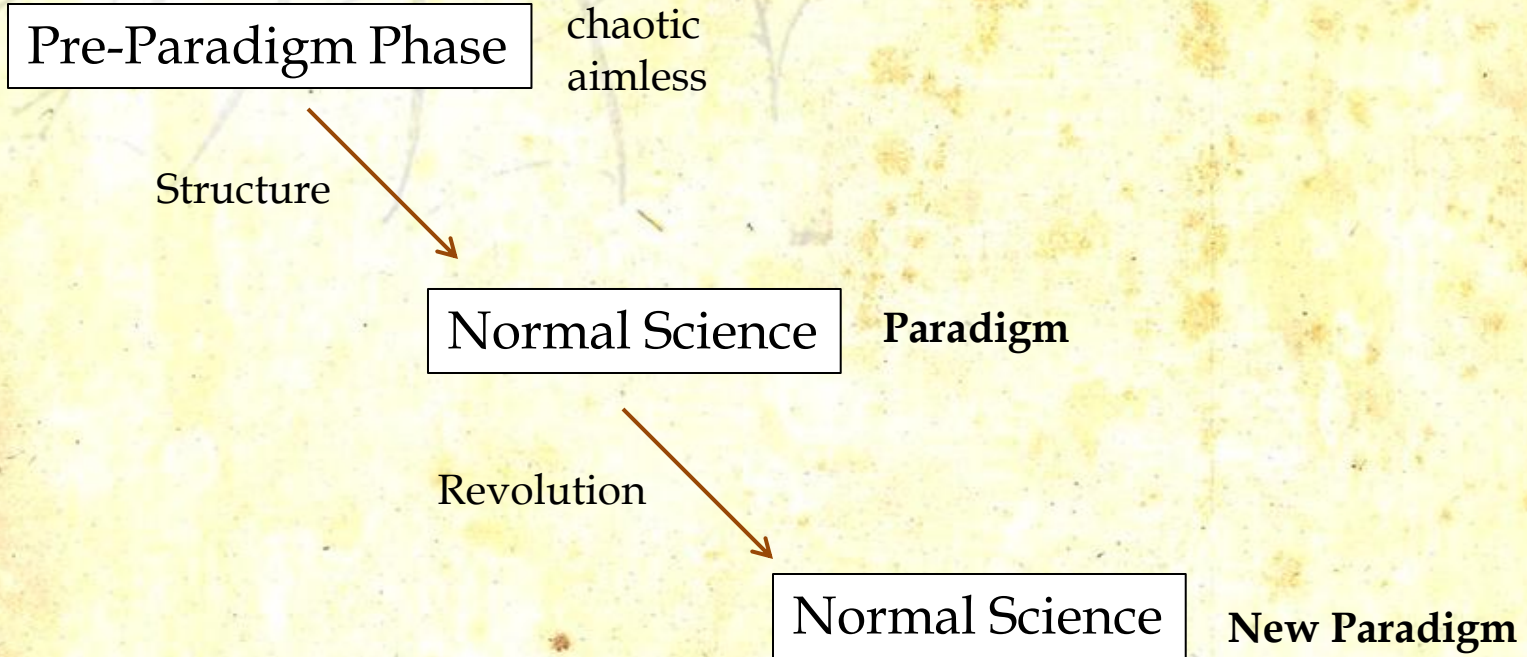
## **Paradigm**

“A paradigm (...) is a whole way of doing science in a particular field that includes an entire package of ideas and claims about the world, as well as of methods for gathering and analyzing data, of pursue the theoretical elaboration of the field.”

**Thomas Kuhn**

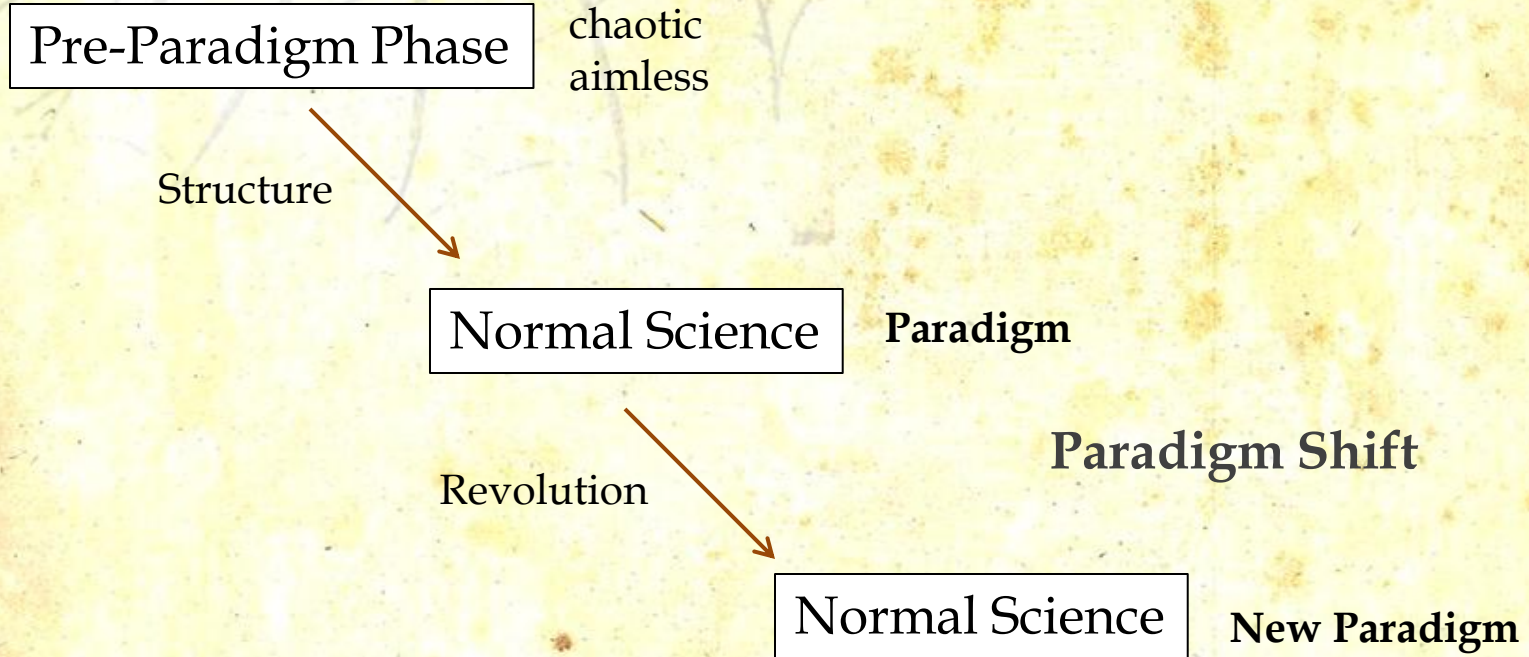


# The Route of Science





# The Route of Science

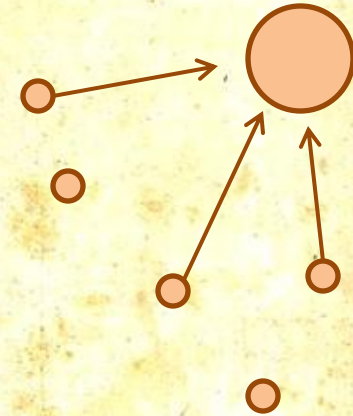




# The Three Phases of Science

## Pre-Paradigm Phase

- manifold of theories exist
- incomplete and inconsistent theories
- no particular consensus on any theory
- ineffective

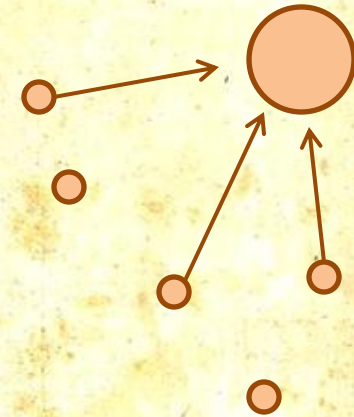




# The Three Phases of Science

## Pre-Paradigm Phase

- manifold of theories exist
- incomplete and inconsistent theories
- no particular consensus on any theory
- ineffective



**Eventually:** Opinions gather around one

## Examples

ARISTOTELES: Physica (4th c. BC)

PTOLEMÄUS: Almagest (2nd c.)

NEWTON: Principia (1686), Opticks (1704)

FRANKLIN: Experiments and Observations on Electricity (1750)

LAVOISIER: Elementary Treatise on Chemistry (1789)



# The Three Phases of Science

Normal Science = established Paradigm

**Paradigm**

- puzzle solving
- advance in details, refinement
- „scientific engineering“
- no revision process
- theoretical background stays constant
- no debate about fundamental principles



# The Three Phases of Science

Normal Science

**Paradigm**

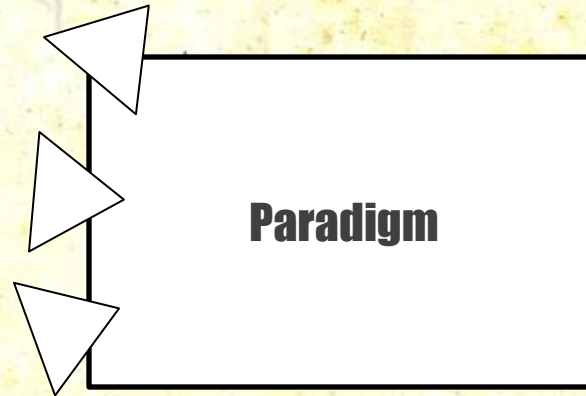
## Three Foci:

- solving of ,new' problems, revelations
- testing what is already predicted by theory
- Articulate a theory, e.g. determine parameters and constants



# The Three Phases of Science

Anomaly and Crisis



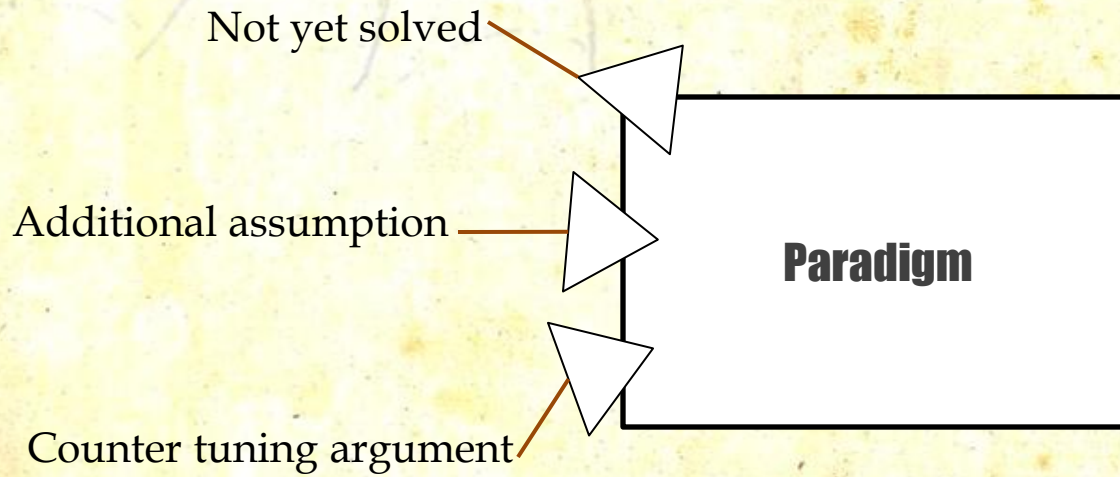
Incommensurable

**Other Theory**



# The Three Phases of Science

## Anomaly and Crisis

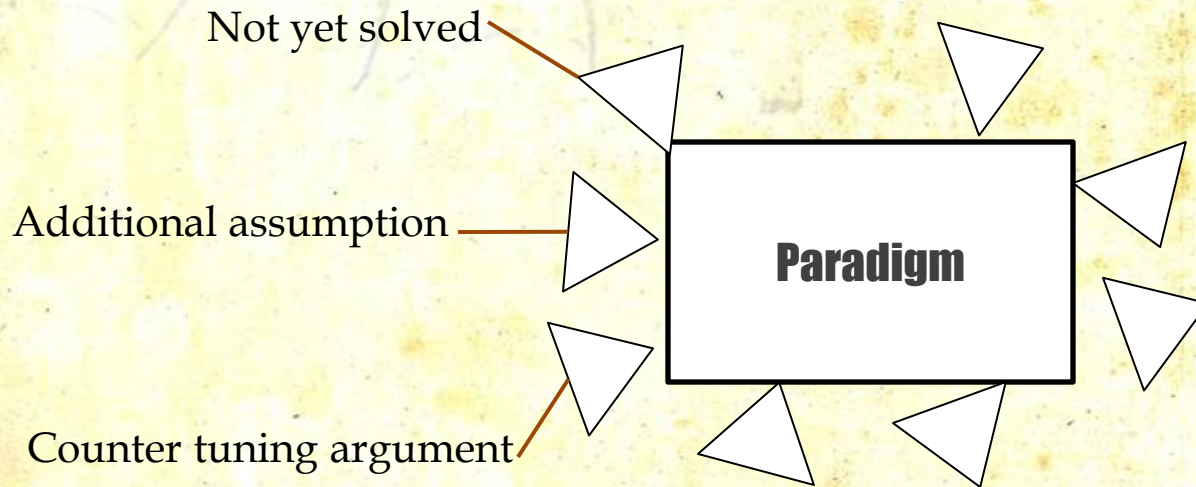


**Other Theory**



# The Three Phases of Science

## Anomaly and Crisis





# The Three Phases of Science

Anomaly and Crisis

**Paradigm**



anomalies of old theory  
=  
background of new theory

**New Paradigm**



# The Three Phases of Science

## Anomaly and Crisis

- Anomalies: data incompatible with theory
- Anomalies: predictions not met

**Revolution** happens if:

- critical mass of anomalies reached
- a new paradigm has emerged



# The Three Phases of Science

## Anomaly and Crisis

- Anomalies: data incompatible with theory
- Anomalies: predictions not met

**Revolution** happens if:

- critical mass of anomalies reached
- a new paradigm has emerged

any alone won't lead to  
paradigm shift

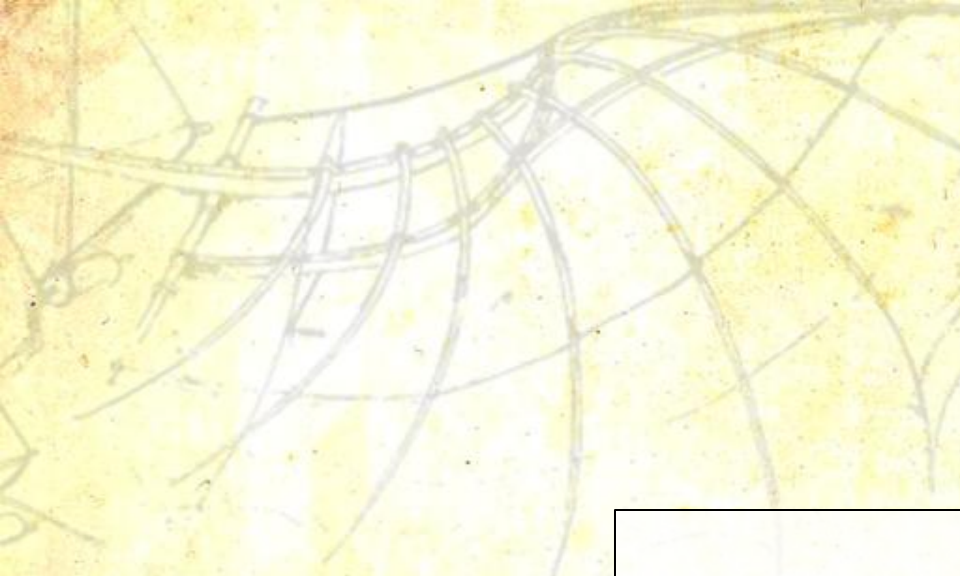


# The Three Phases of Science

Normal Science again

**New Paradigm**





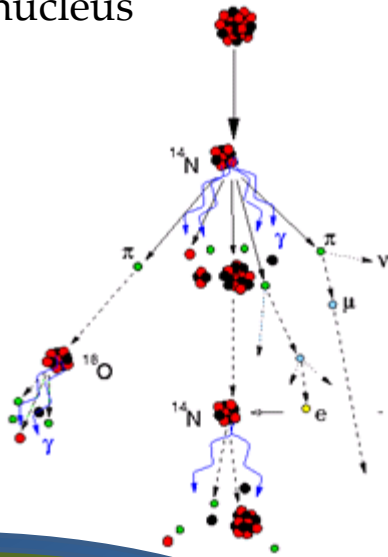
Actual Example  
of  
Crisis & Paradigm



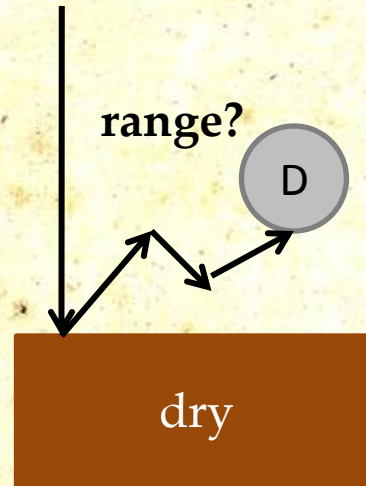
# Example: Footprint of Cosmic Neutrons

Can cosmic neutrons  
...be used to probe the moisture content of the soil ?

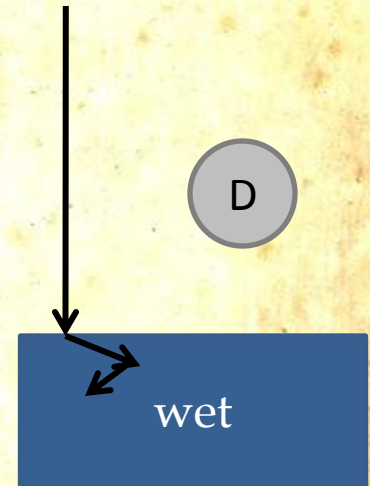
primary (high energetic)  
nucleus



Neutrons



Neutrons





# Example: Footprint of Cosmic Neutrons

## The COsmic-ray Soil Moisture Observing System (COSMOS)

M. Zreda, J. Shuttleworth, X. Zeng and C. Zweck - University of Arizona

### *Intellectual merit*

**Rationale:** Soil water exerts a critical control on weather, climate, ecosystem, and water cycle, and hence is crucial for many fields within atmospheric sciences and related disciplines. A serious handicap in soil moisture measurements is the mismatch between limited point measurements using contact methods and remote sensing estimates over large areas ( $100 \text{ km}^2$  -  $2500 \text{ km}^2$ ) without thick vegetation cover. The purpose of this project is to fill this gap by using a novel, non-contact technique capable of measuring average soil water content over a footprint of 34 hectares (a circle with a radius of 330 m) and depths up to 50 cm.

## Objectives

COSMOS is a young and promising technology for non-contact moisture measurements with a footprint of about 600 m in diameter and 10-50 cm in depth. The fourth COSMOS workshop will focus on

## Footprint diameter for a cosmic-ray soil moisture probe: Theory and Monte Carlo simulations

Darin Desilets<sup>1</sup> and Marek Zreda<sup>2</sup>

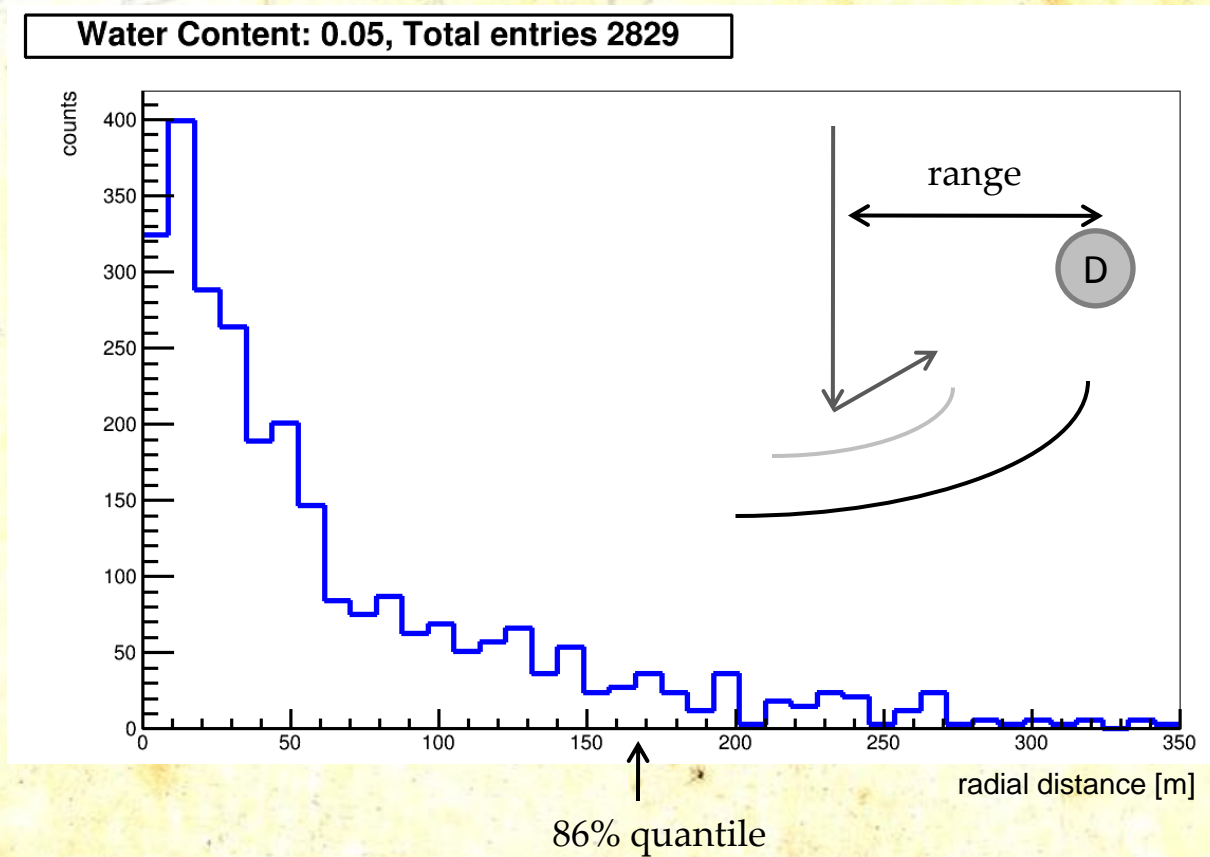
Received 2 October 2012; revised 26 February 2013; accepted 7 March 2013; published 20 June 2013.

eV. If we define the lateral footprint as the area encompassing two  $e$ -fold distances, i.e., the area from which 86% of the recorded neutrons originate, then the footprint diameter is nearly 600 m in dry air. Both theory and simulations indicate that the footprint is inversely proportional to air density and linearly proportional to the height of the sensor above the



# Example: Footprint of Cosmic Neutrons

## Simulated Detector Response





Geocentric model  **ANTIQUE**

4-Elements Model

Kinetics of Inertia

**PRE-PHYSICS ERA**

Phlogiston

Alchemy

The Infinite

**MODERN PHYSICS**

Transuranium Elements

Cold Fusion

Heisenberg's Theory of Everything

Magnetic Monopoles

Polywater

**CLASSICAL PHYSICS**

Aether Theory

N-Rays Bohr: Atomic Model

Einstein's Lambda

**PARTICLE PHYSICS**

Gravitational Waves Double-Beta Decay

GSI Neutral Particles

HERA-B

Super Symmetry

Superspeed Neutrinos

Pentaquarks