

Paraconsistent Reasoning in Science and Mathematics  
Munich, June 11-13, 2014

# Functional & Inconsistent Scientific Theories

The Standard Solar Model and the Solar Neutrinos' Problem

Maria del Rosario Martinez Ordaz  
UNAM-Mexico

La investigación y preparación para la realización de esta ponencia/conferencia fue apoyada financieramente por el proyecto "Lógicas del descubrimiento, heurística y creatividad en las ciencias" (PAPIIT, IN400514-3) otorgado por la *Dirección General de Asuntos del Personal Académico* de la Universidad Nacional Autónoma de México (UNAM).

Three types of examples are typically given

“Not always, logically inconsistent theories must be rejected”

Logically inconsistency is a fact of life in science

[2014] Kevin Davoy

“Whenever we find a logical contradiction in a body of scientific beliefs we also come to realize that one or another of these beliefs (...) is unjustified”

Davey <sup>[2014]</sup>Kevin

“*Faced with a theory that is known to be inconsistent, the scientist will still be able to trust consequences of the theory that are based on especially well confirmed parts of the theory*”

Davey [2014] Kevin

- 1) Classification.
- 2) FITs
- 3) Standard Solar Model & Solar Neutrinos's problem.
- 4) Conclusions.

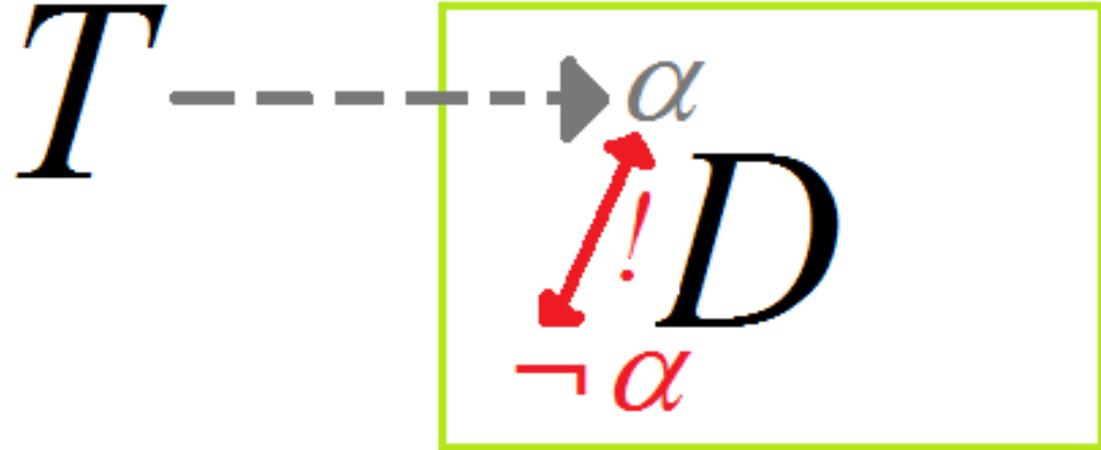
# A classification

Laudan<sup>[1978]</sup>  
da Costa<sup>[1997]</sup>  
Priest<sup>[2002]</sup>

A theory could be  
inconsistent with:  
**Observation**  
**Other Theories**  
**Itself**

# A classification

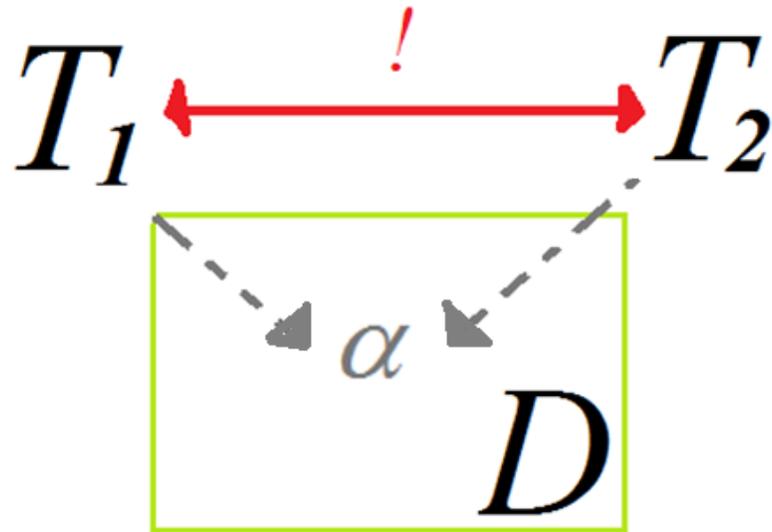
Observation



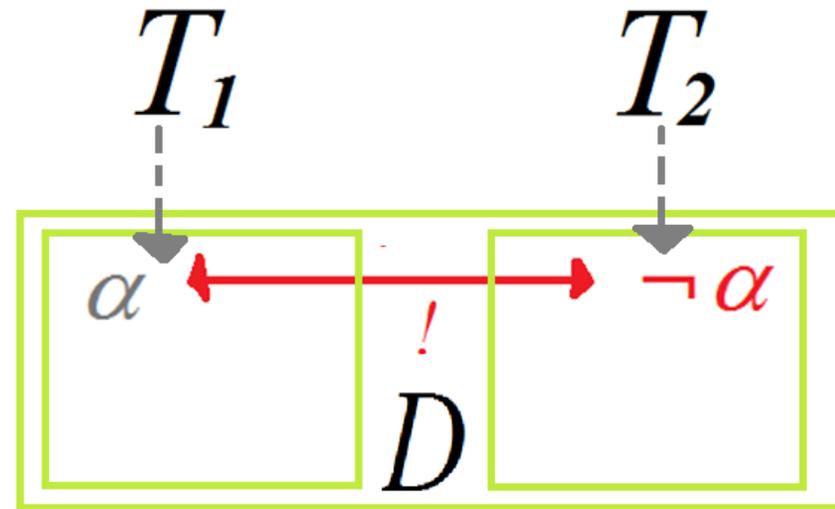
Ex. Perihelion of Mercury/ ‘Anomaly’

# A classification

Other theories



Ex. Description of liquid's behavior

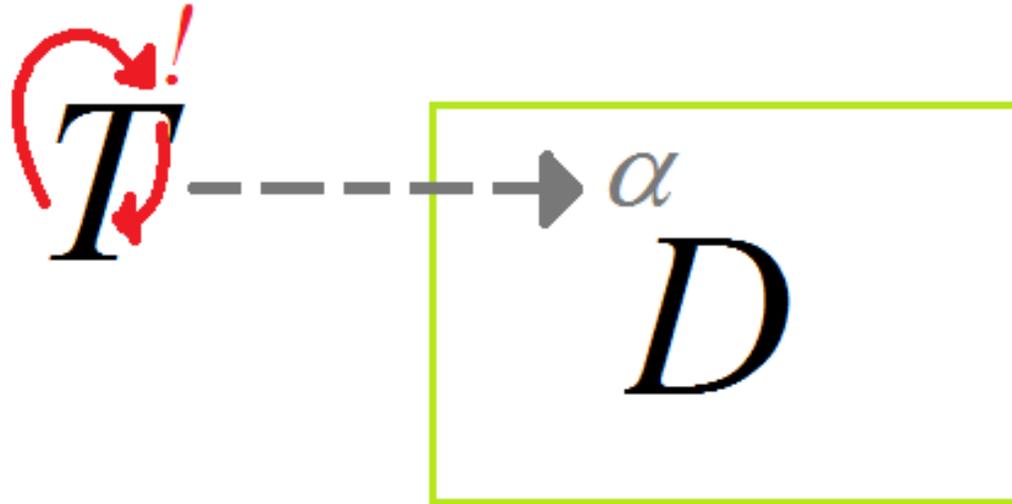


Ex. Age of the Earth

Differences on inconsistencies

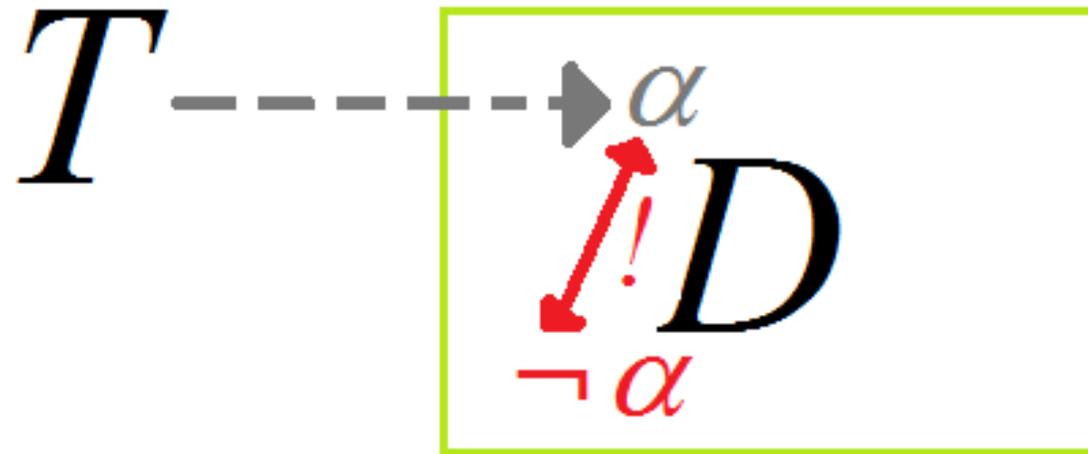
# A classification

Itself



Ex. Bohr's model of the atom

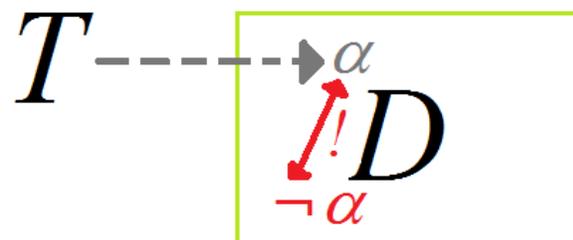
But if a theory behaves like this...



what makes us keep it in  
practice ?

- 1) ~~Classification.~~
- 2) FITs
- 3) Standard Solar Model & Solar Neutrinos's problem.
- 4) Conclusions.

But if a theory behaves like this...



what makes us keep it in  
practice ?

FITs

## Empirical **theory**

- "Systems of propositions in a convenient language, at least in general terms, are collections of sentences" [Da Costa, 1997, p. 181] such that talk about a particular phenomenal domain (D), and they are (mostly) able to be tested intensively.

# FITs

## Functional inconsistencies

- Empirical adequacy
- Solve old empirical problems/ propose new problems
- Scope, fruitfulness and simplicity
- Successful applications

~~1) Classification.~~

~~2) FITs~~

3) Standard Solar Model &  
Solar Neutrinos' problem.

4) Conclusions.

# Solar Neutrino Problem

1960-1970

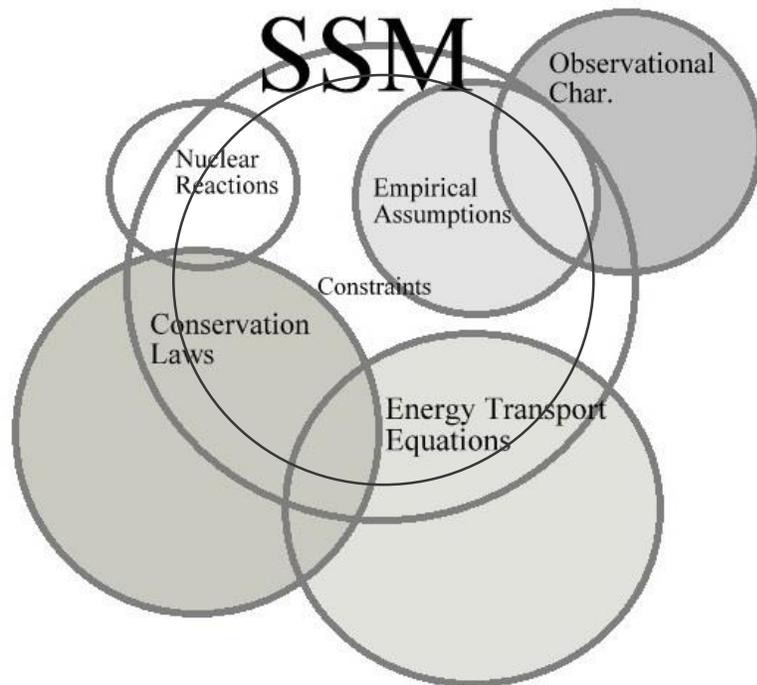
Standard Solar Model (SSM)

Measuring Solar Neutrino's  
flux

John Bahcall & Ray Davis' Experiment

Prediction \_ Observational outcome:  
+ 60% diff.

# What is the Standard Solar Model?



Particle physics and  
the standard cosmology

- \*Conservation laws and energy transport equations of physics,
- \*Sun's observable characteristics [observed radius and luminosity]
- \*Assumptions on the (steady) state of the Sun.
- \*Assumptions about the age and composition of the Sun.

...

Is SSM something like this?

# Empirical Theory

- "Systems of propositions in a convenient language, at least in general terms, are collections of sentences" [Da Costa, 1997, p. 181] such that talk about a particular phenomenal domain (D), and they are (mostly) able to be tested intensively.

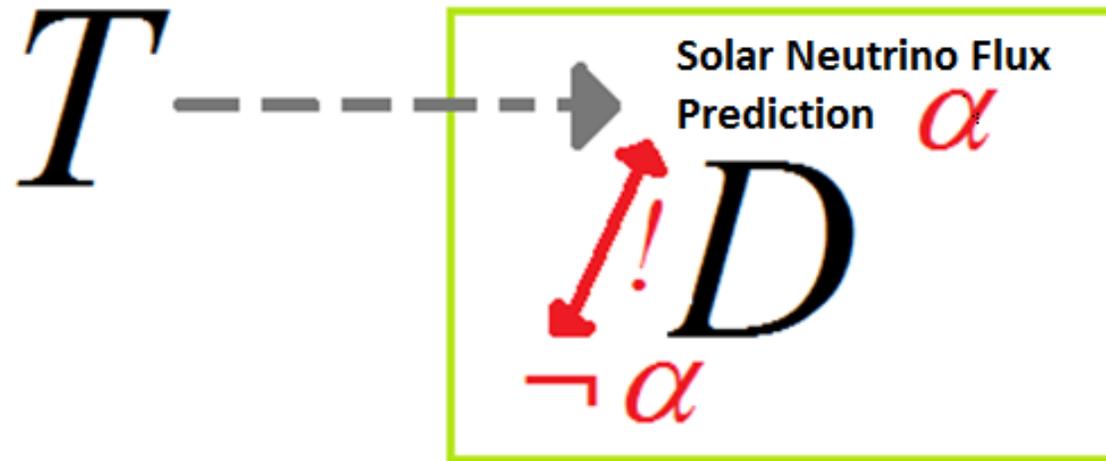
Does SSM behave like this?

# Functional inconsistent

- Empirical adequacy
- Solve old empirical problems/ propose new problems
- Scope, fruitfulness and simplicity
- Successful applications

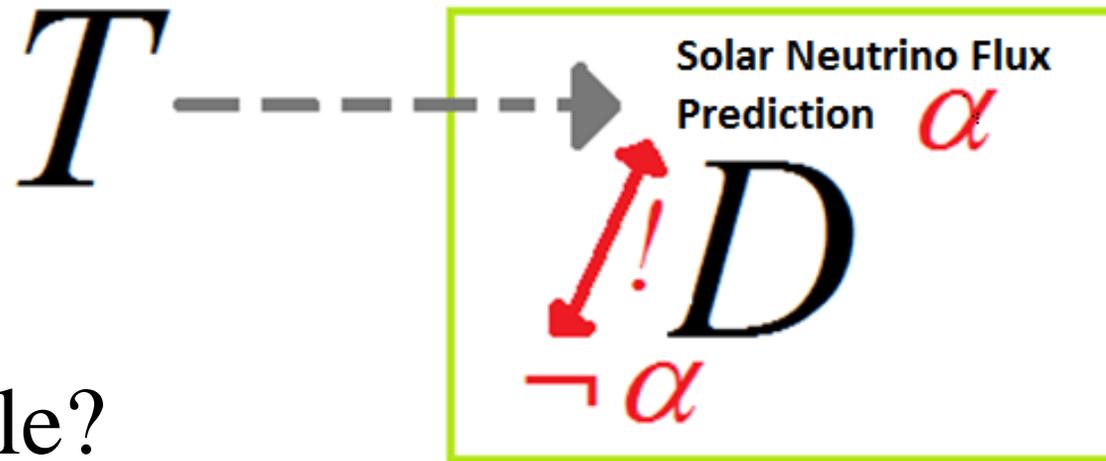
# Solar Neutrino Problem

How our classification would show us the situation?



# Solar Neutrino Problem

How our classification would show us the situation?

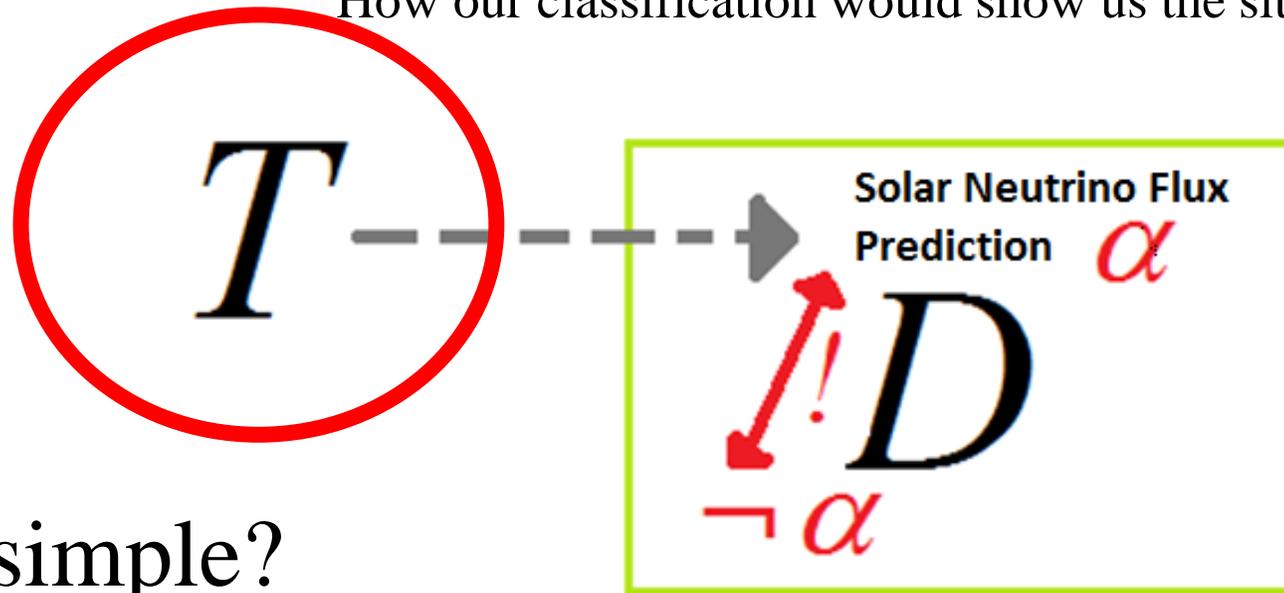


However,

Was it that simple?

# Solar Neutrino Problem

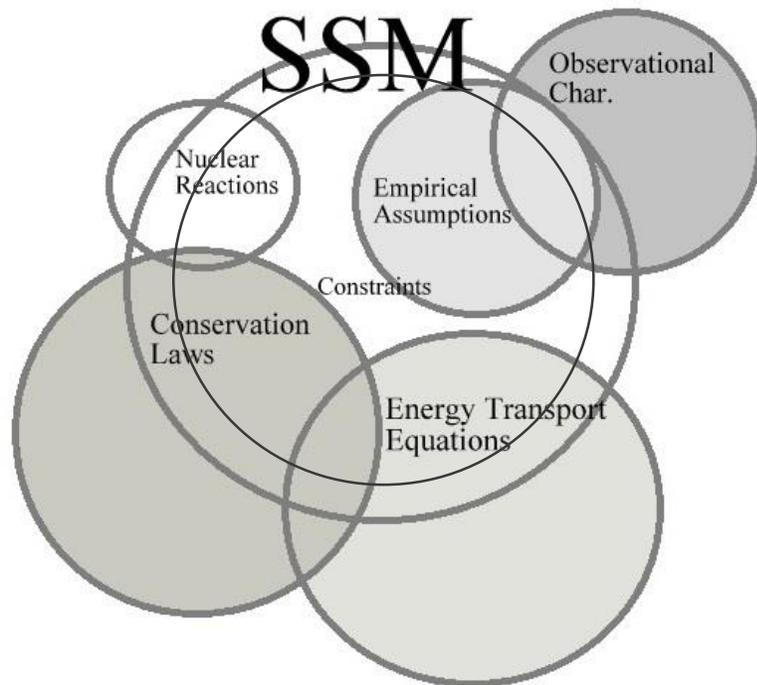
How our classification would show us the situation?



However,

Was it that simple?

# What is the Standard Solar Model?

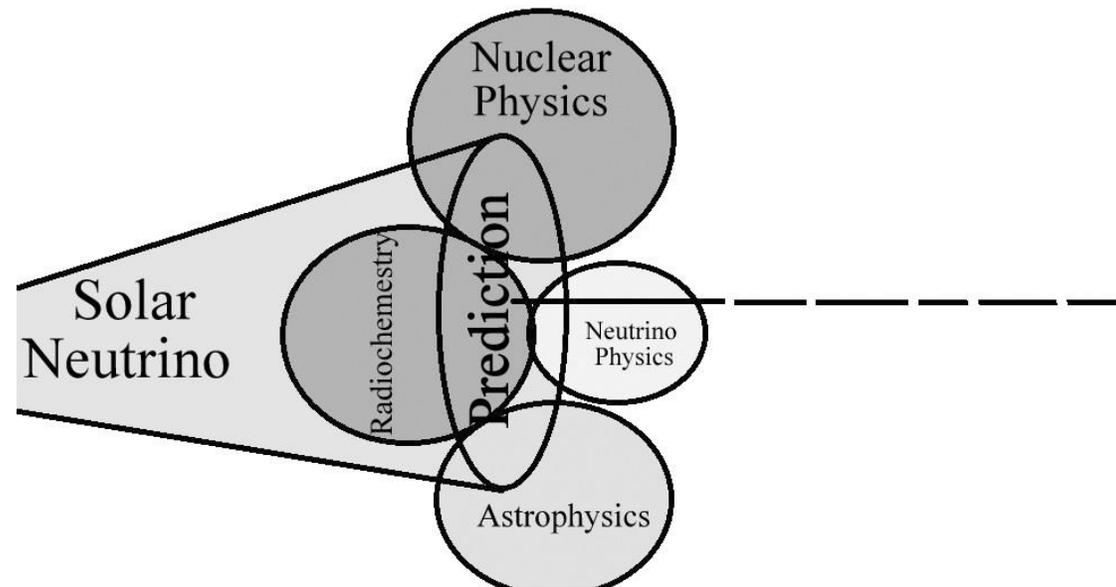


Particle physics and  
the standard cosmology

- \*Conservation laws and energy transport equations of physics,
- \*Sun's observable characteristics [observed radius and luminosity]
- \*Assumptions on the (steady) state of the Sun.
- \*Assumptions about the age and composition of the Sun.

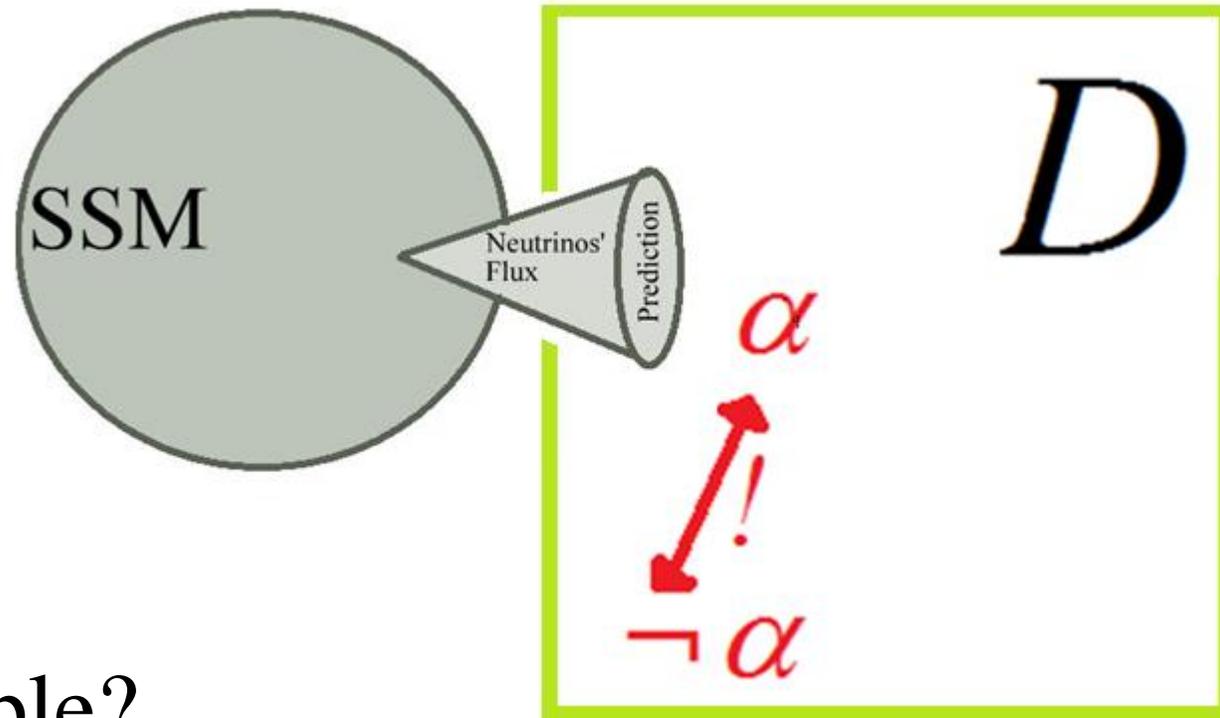
...

# What is the problem of Solar Neutrino Flux about?



# Solar Neutrino Problem

How our classification would show us the situation?

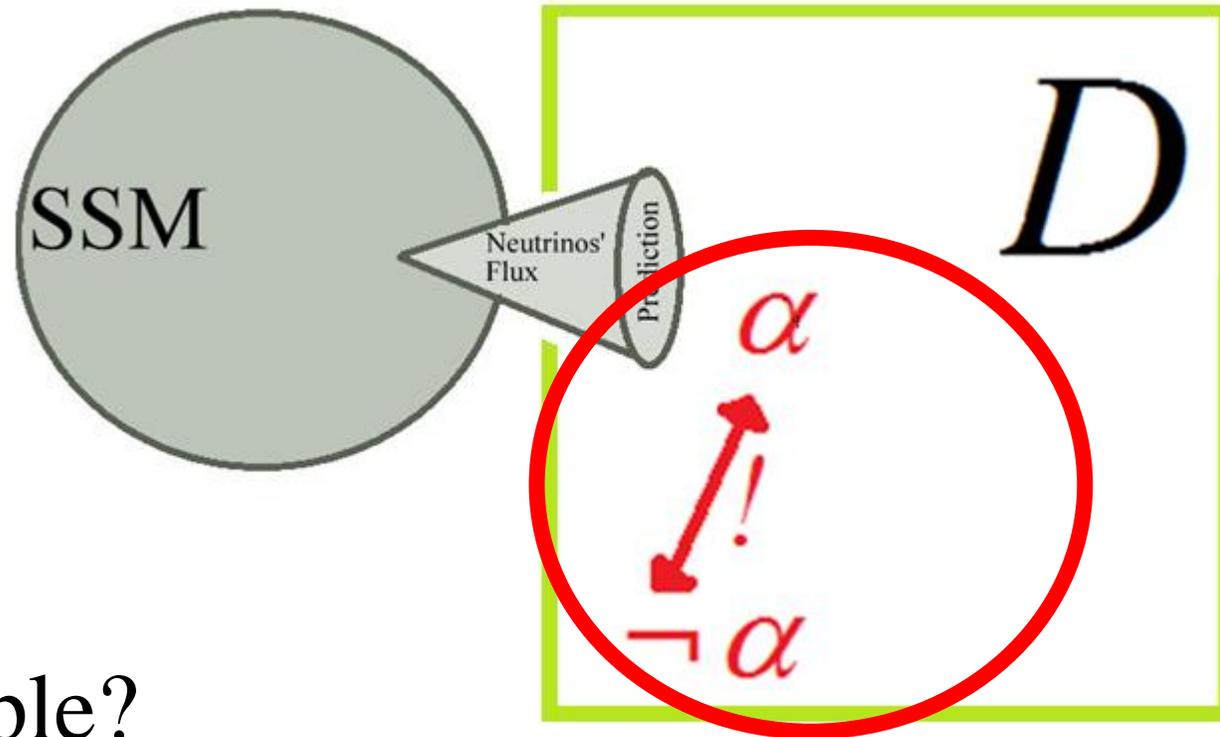


However,

Was it that simple?

# Solar Neutrino Problem

How our classification would show us the situation?

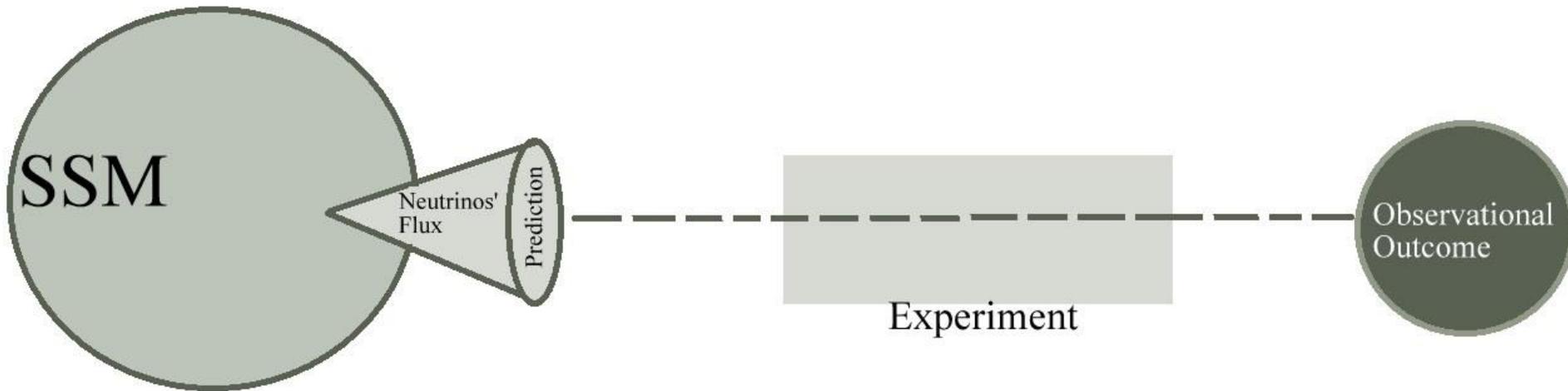


However,

Was it that simple?

What was expected to happen

While measuring  
**S**olar Neutrino Flux?



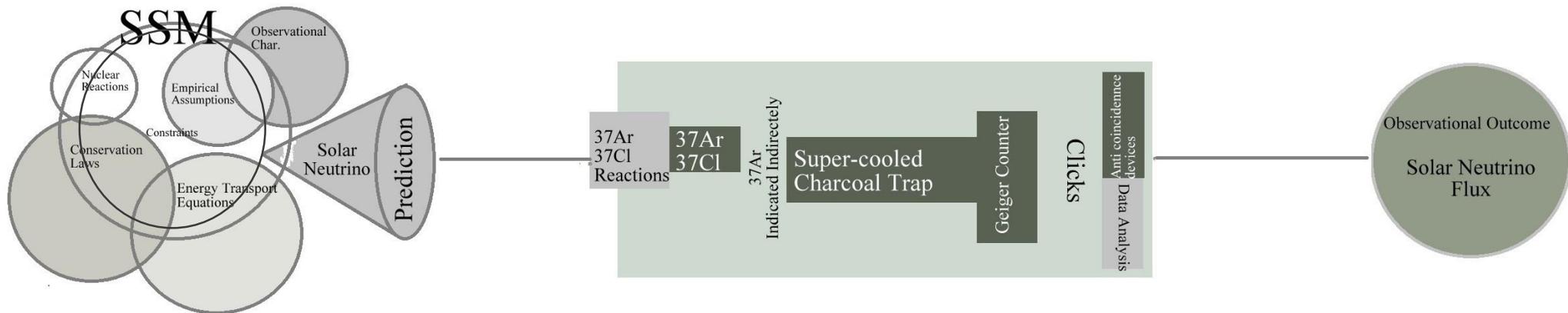
What was the experiment about

# While measuring Solar Neutrino Flux ?



What was the experiment about

# While measuring Solar Neutrino Flux ?



If we say that there was a contradiction  
**W**hat does it mean?



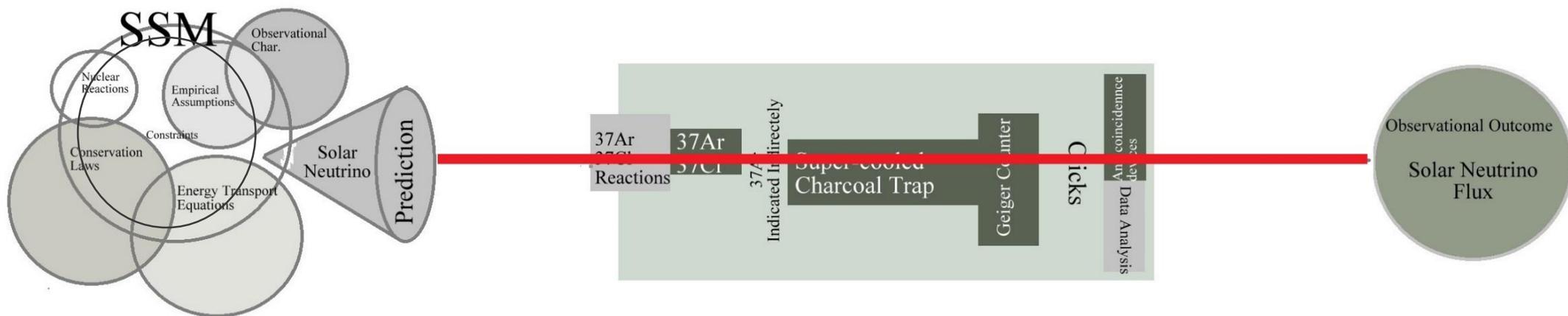
# W

ere we able to distinguish which was the trustable part of the theory?,

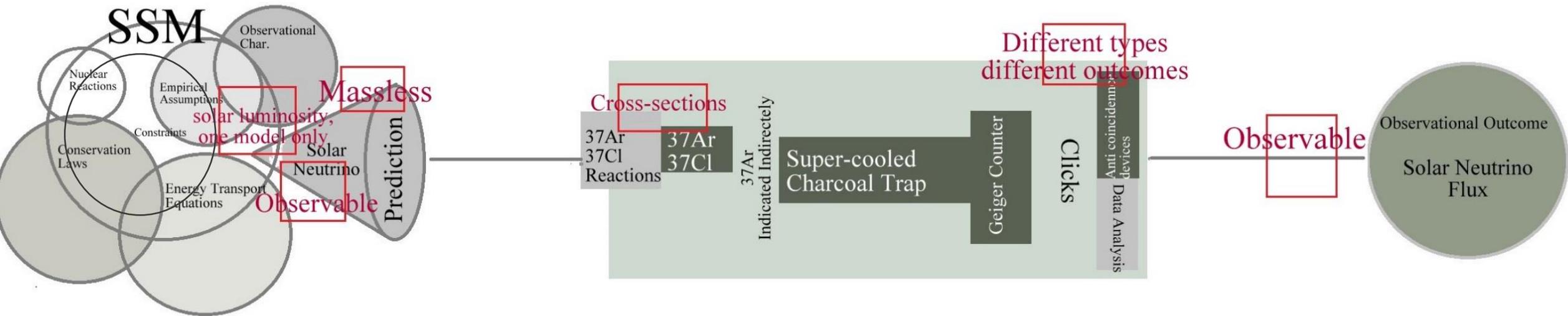
as any agreement about understanding where the problem was?

as it seen as an inconsistency?,

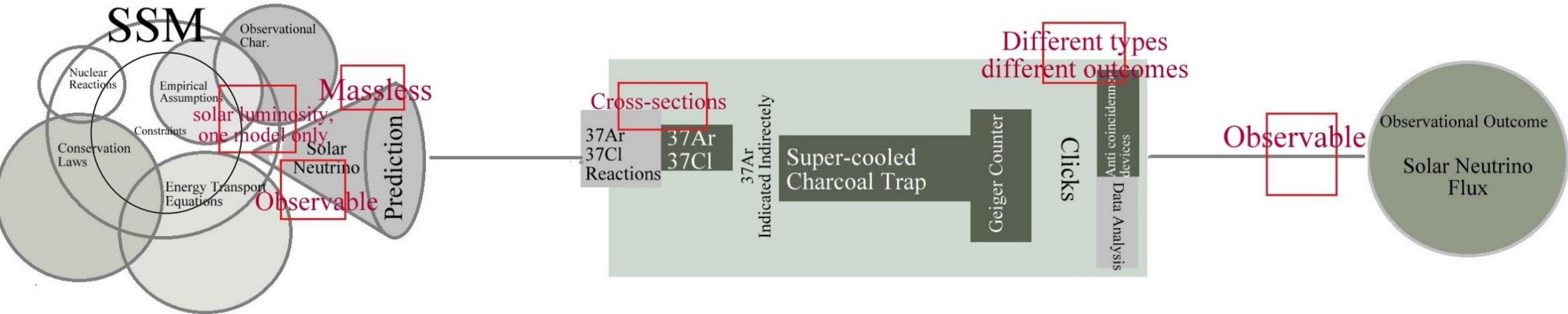
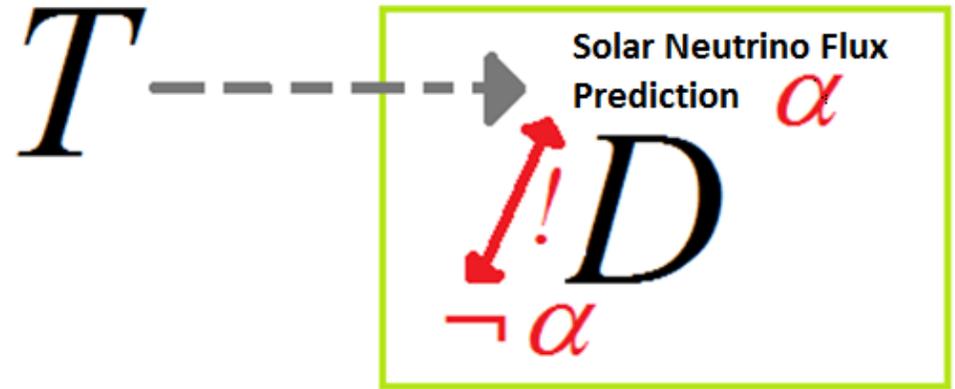
as the SSM application on Solar Neutrinos' flux still used?



# What went 'wrong'?



# How similar are they?

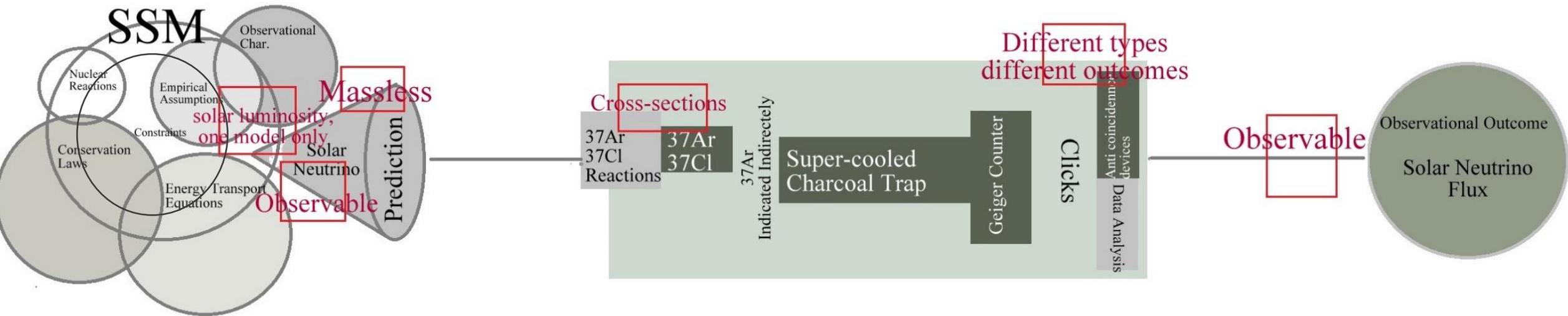


“*Faced with a theory that is known to be inconsistent, the scientist will still be able to trust consequences of the theory that are based on especially well confirmed parts of the theory*”

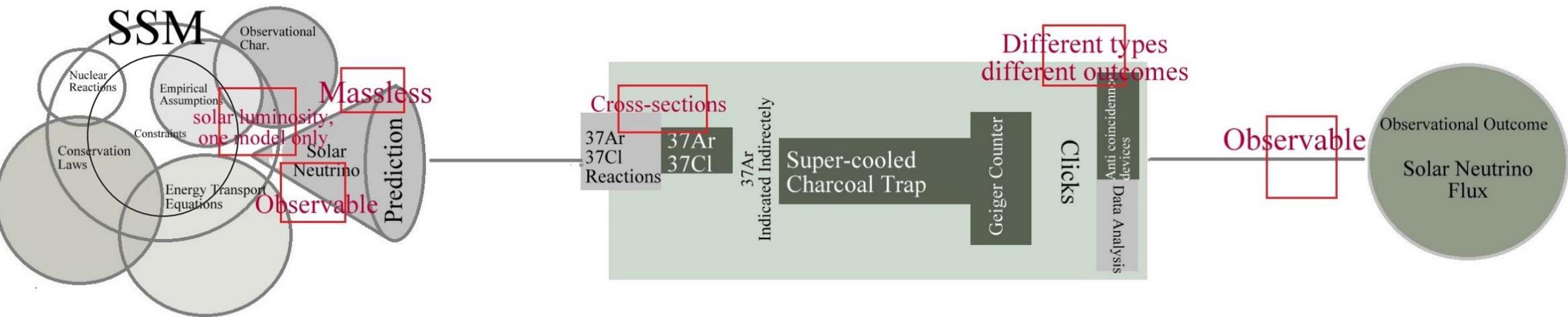
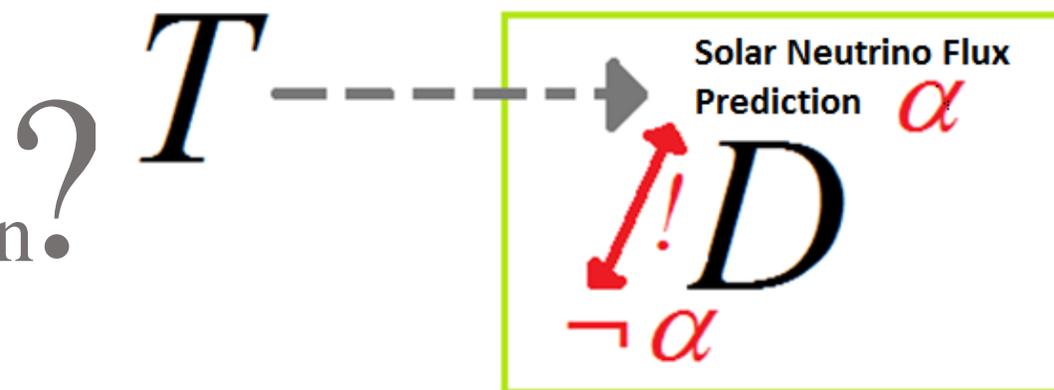
Davey [2014] Kevin

# What does it tell us

About “being able to trust consequences of the theory that are based on especially well confirmed parts of the theory”



What does it tell us  
About our classification?



Thank you!

# Functional & Inconsistent Scientific Theories

The Standard Solar Model and the Solar Neutrinos' Problem

Maria del Rosario Martinez Ordaz

UNAM-Mexico

# Functional & Inconsistent Scientific Theories

The Standard Solar Model and the Solar Neutrinos' Problem

Maria del Rosario Martinez Ordaz  
UNAM-Mexico