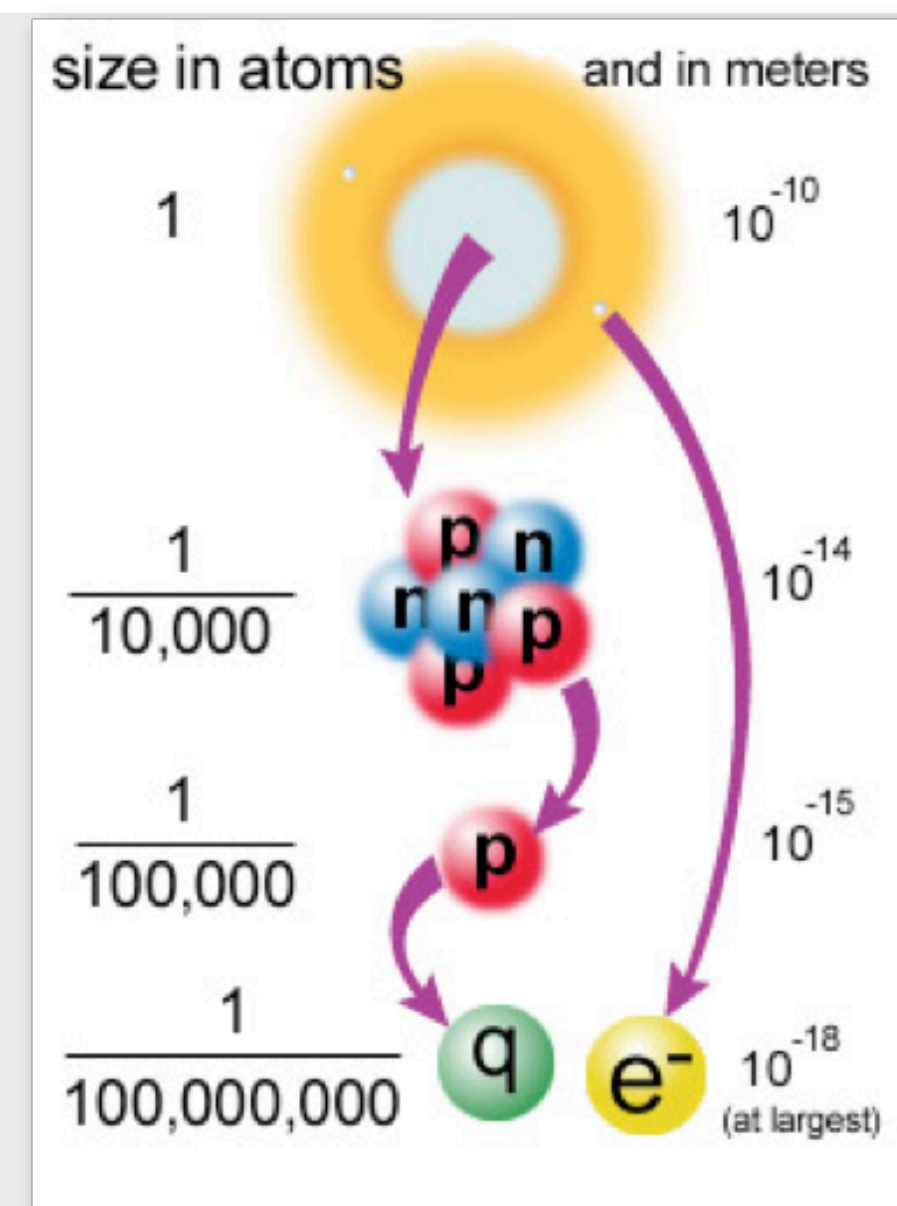
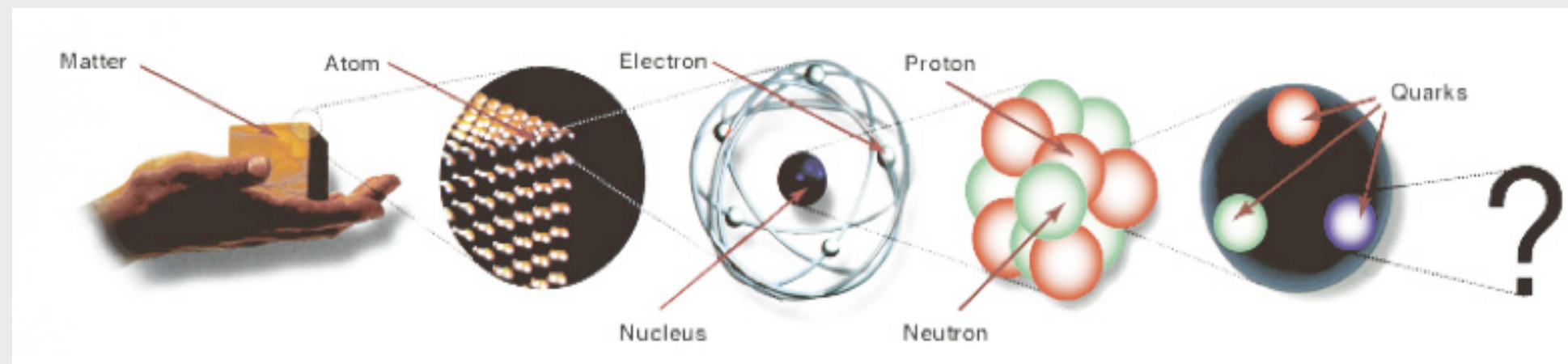


# Particle Phenomenology

## What is Particle Physics?

Description of the fundamental constituents of matter and their interactions



Built upon the two pillars of the XXth century physics

### Quantum Mechanics

multiple-trajectory

quantum fussiness  
(Heisenberg inequalities)

### Special Relativity

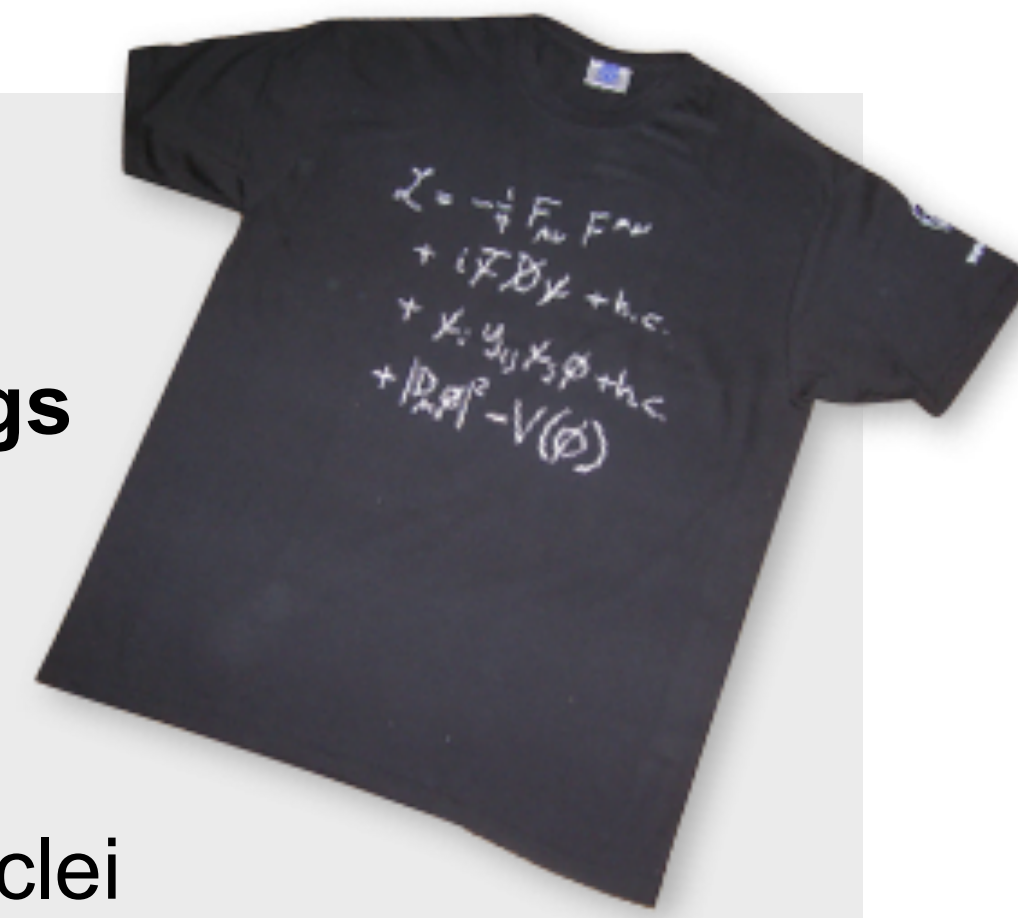
space-time

mass = energy



## The World with a Higgs Boson

The knowledge of the values of the **Higgs couplings** is essential to our understanding of the deep structure of matter



- Coupling to up- and down-quarks → stability of nuclei
- Coupling to electrons → size of the atoms (and the size of the Universe?)
- Coupling to top quarks → stability of the vacuum & lifetime of world
- Higgs self-coupling → (dynamics of the EW phase transition (t~10^-10s) → dominance of matter over antimatter in the Universe

## New Physics and Model Building

Problems with plausible solutions

- Dark Matter
- Baryogenesis
- Strong interaction preserve CP symmetry
- Fermion spectrum/mixing

Mysteries challenging quantum nature

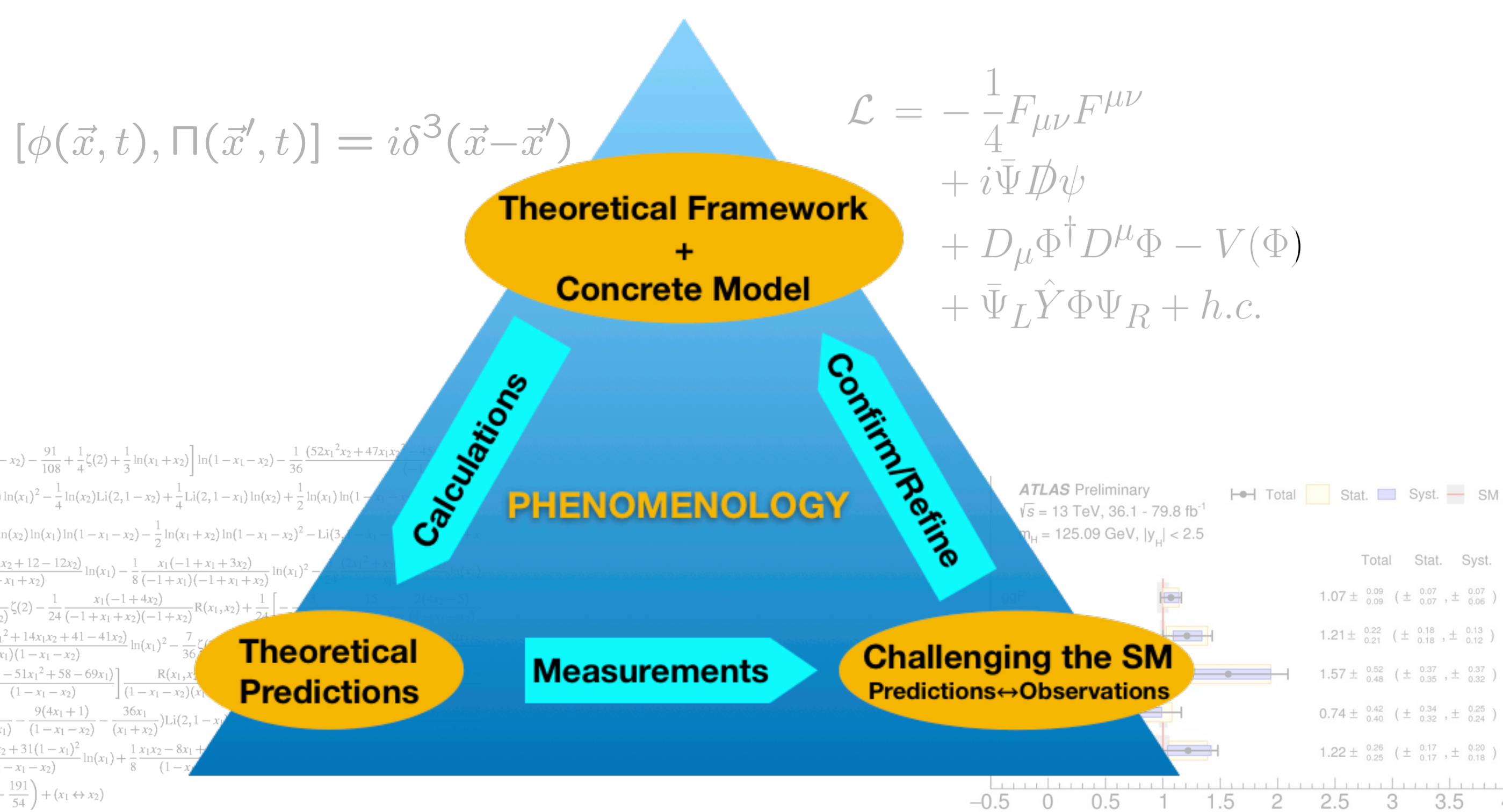
- Cosmological constant
- Weak scale hierarchy
- BH information paradox
- Very early universe

Absence of new physics at LHC — Traditional models under siege  
New approaches / interplay w. cosmology

## Particle Phenomenology: the Daily/Big Questions

- What is the spectrum of fundamental particles?
- What is the nature of their interactions?
- How do elementary particles acquire their mass?
- Do all the forces of nature arise from a single fundamental interaction?
- How did the effects of particle physics influence the early evolution of our universe?
- Are there more than three dimensions of space?
- What is dark matter? Can it be produced in the laboratory?

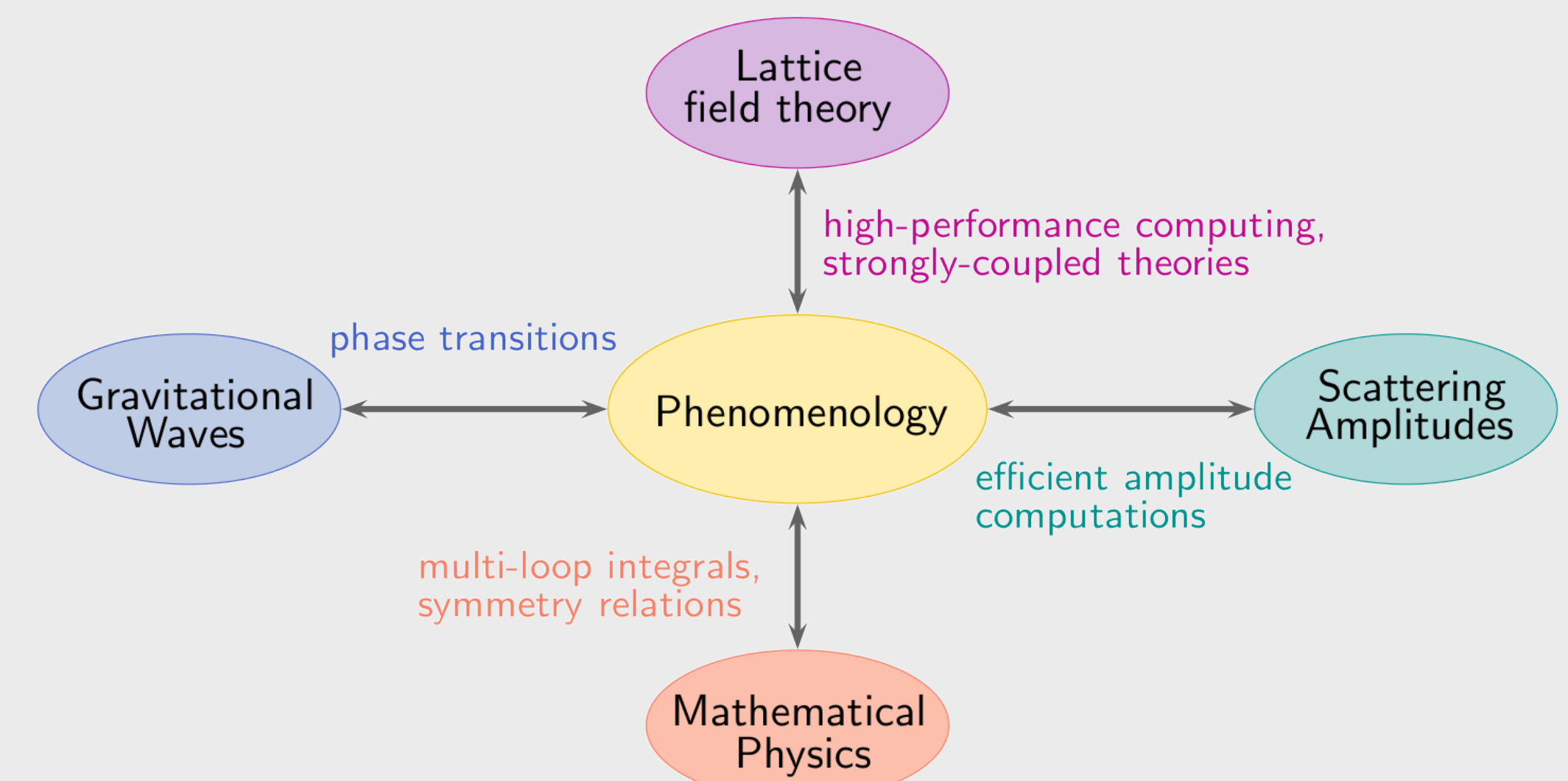
## Challenging the Standard Model — From First Principles to Phenomenology —



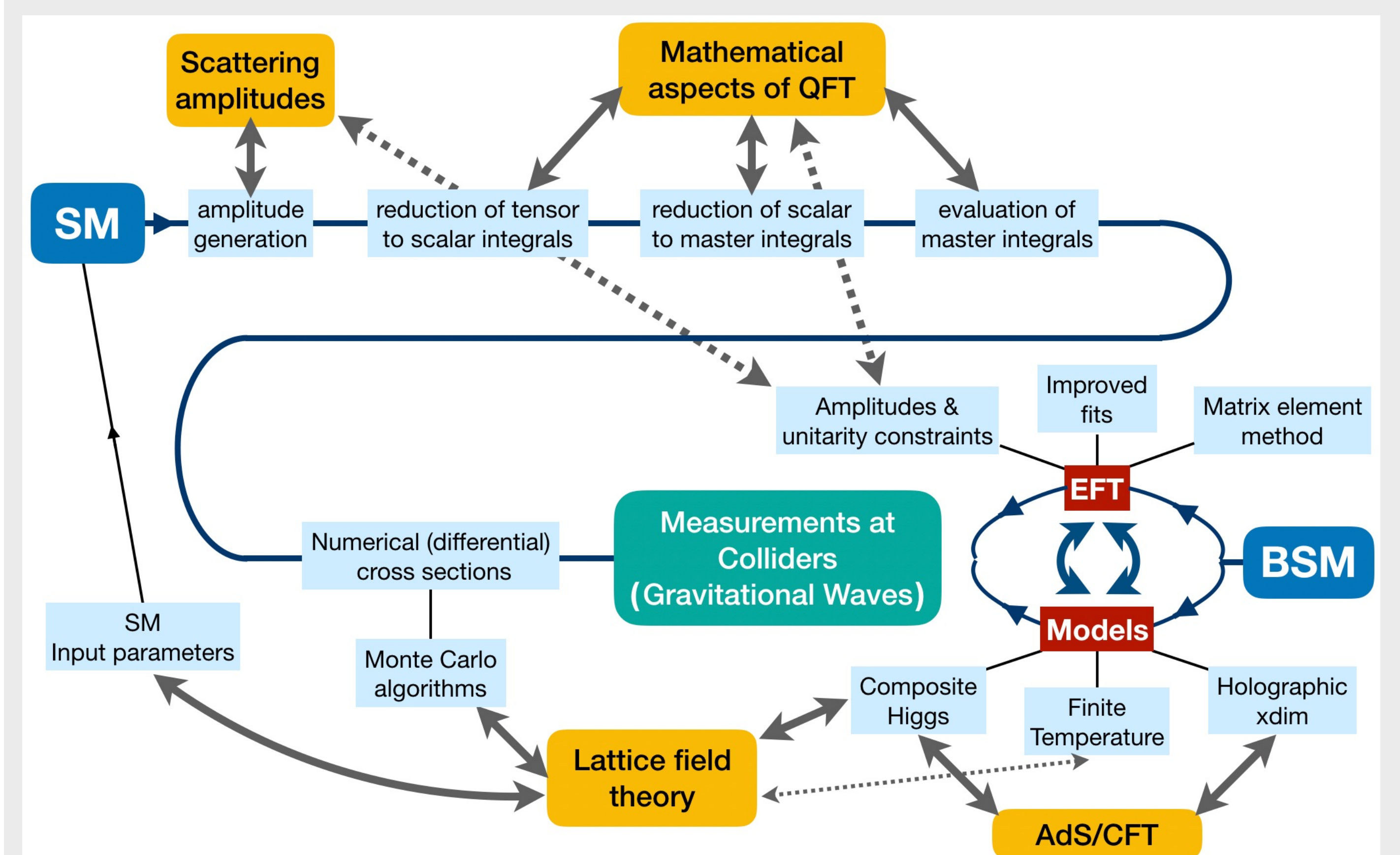
Challenging the SM — Precision physics — Model independent  
Direct searches — Model dependent

- Research directions
- Develop new methods for making better theory predictions
  - Search and characterise new physics beyond the Standard Model
  - Build models of new physics to tackle open questions of the Standard Model

## Particle Phenomenology and the Rest of the World



## Workflow



For further discussion, come and visit the theory group:

