

Supersymmetry and the Higgs boson at the LHC

Kazuya Yonekura (YITP, Kyoto)

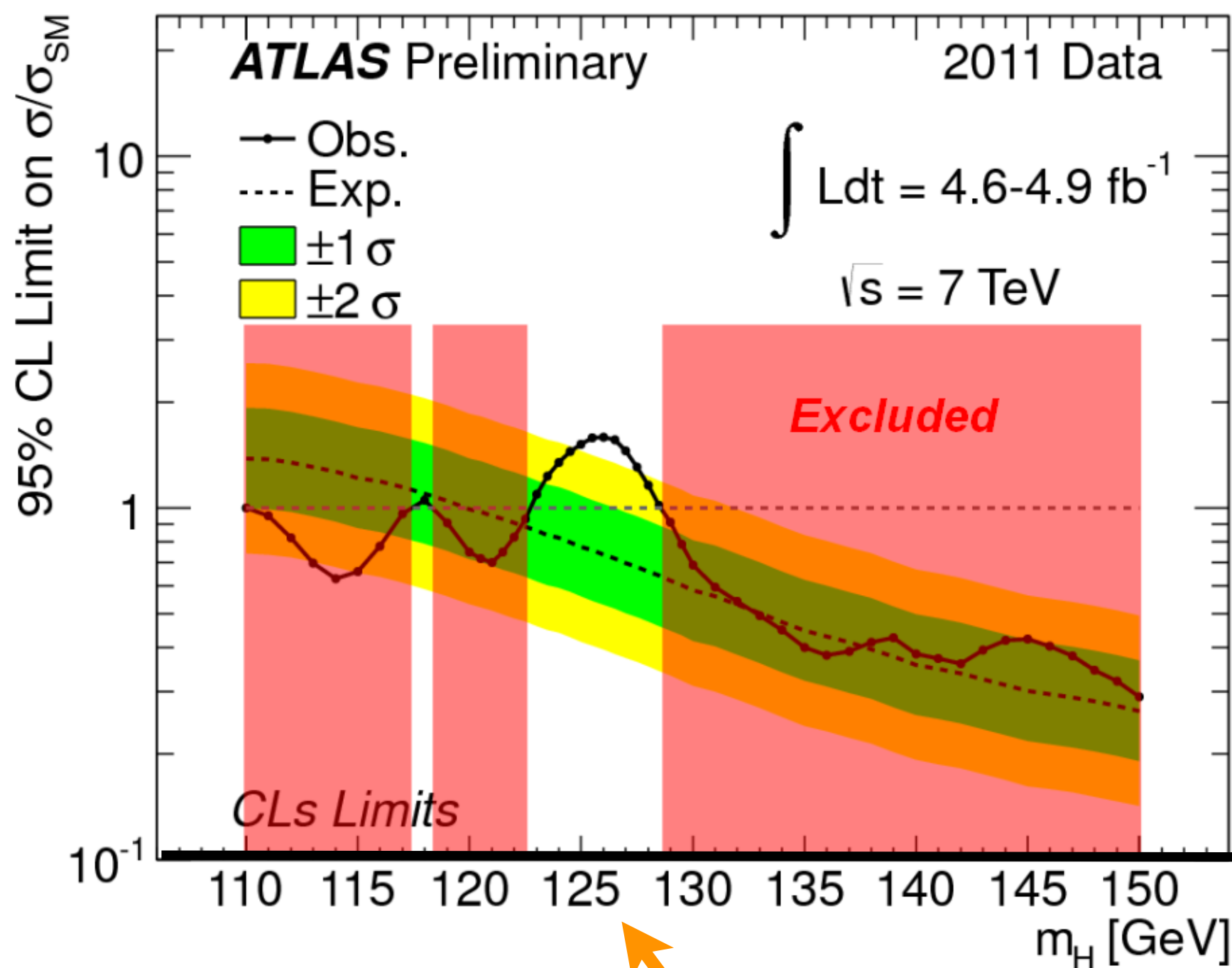
The Higgs boson

The Higgs boson:

- The final missing piece of the standard model.
- The main target of the Large Hadron Collider (LHC)

Experimentalists have not yet claimed the discovery of the Higgs boson, but....

The Higgs mass at 125 GeV?



**Red region:
excluded**

$\sim 125 \text{ GeV}$

Implication for SUSY

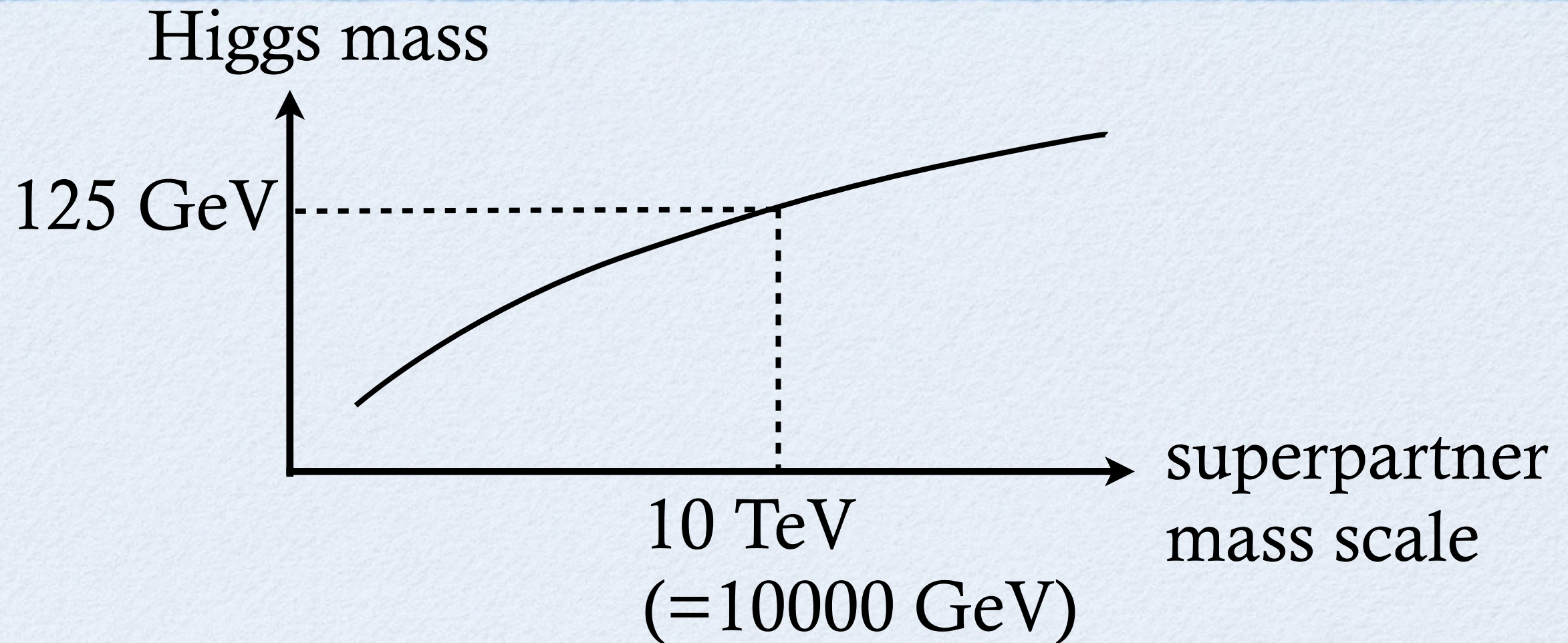
The Higgs mass in supersymmetric (SUSY) models are tightly constrained;

$$m_{\text{Higgs}}^2 \sim m_Z^2 \cdot \overset{\substack{\text{less than 1} \\ \downarrow}}{|\cos 2\beta|^2} + \underbrace{\frac{3y_t^2}{2\pi^2} m_{\text{top}}^2 \log \frac{m_{\text{super top}}}{m_{\text{top}}}}_{\substack{\uparrow \\ \text{radiative correction from} \\ \text{superpartner particles}}}$$

91GeV

The second term should be somewhat large.

Implication for SUSY

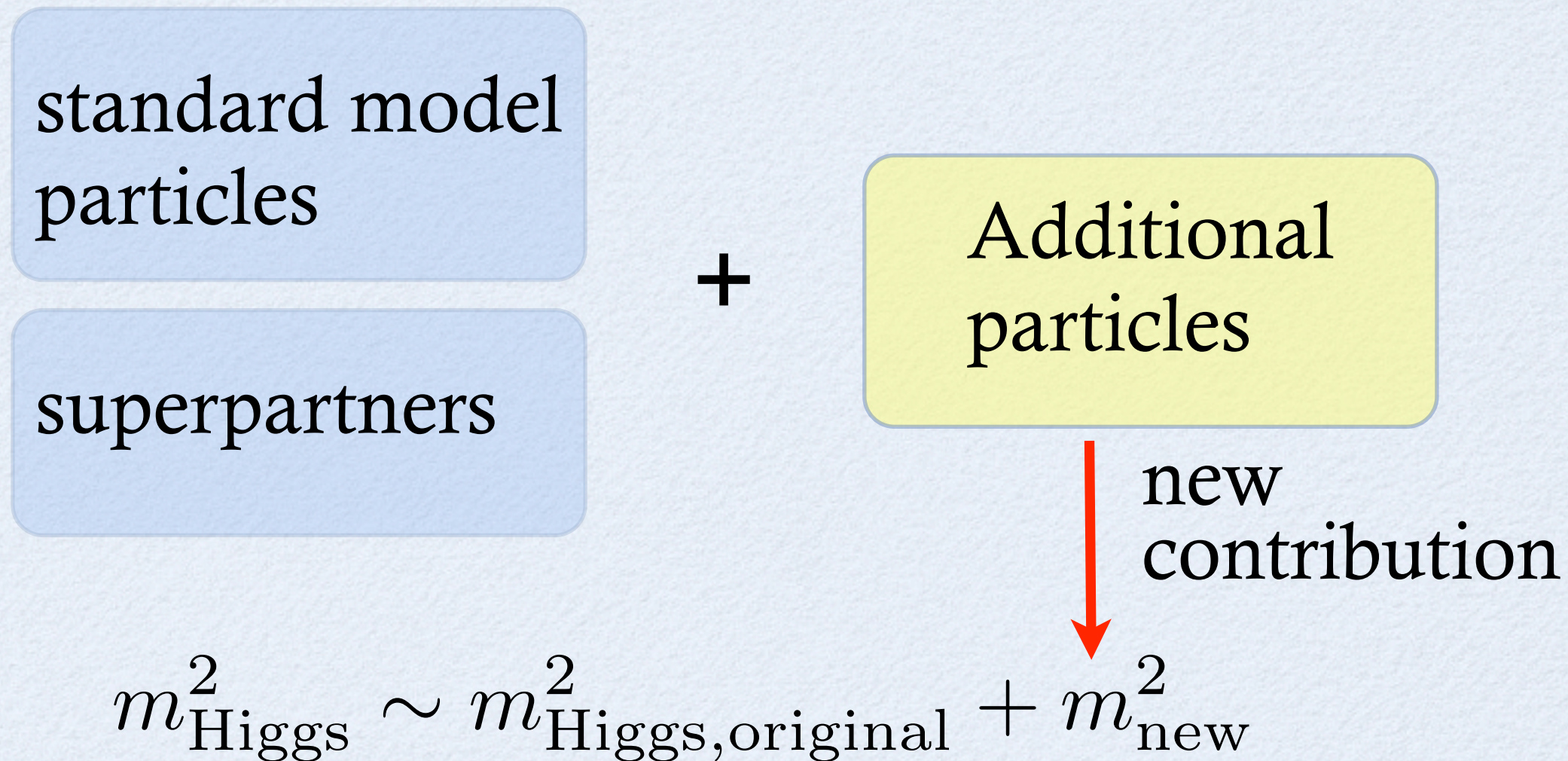


SUSY particles may be as heavy as 10 TeV.

- LHC may not be able to find SUSY particles.
- The fine tuning (hierarchy) problem is severe.

Implication for SUSY

Another possibility



The Higgs mass can be raised to 125 GeV
even if superpartner mass scale is around 1 TeV.

Summary of the situation

- **Possibilities often discussed recently:**

1. Superpartner particles may be as heavy as 10 TeV.
2. There may be new particles.
3. The standard model may be the correct theory.

The situation may not be so good, but there may be new possibilities.

New possibility (example)

standard model
particles

superpartners

+

Additional
particles

+

SUSY breaking
sector

always exist
to break SUSY

$$m_{\text{Higgs}} \sim m_{\text{Higgs,original}} + m_{\text{new}}$$

New possibility (example)

standard model
particles

superpartners

always exist
to break SUSY
+ SUSY breaking
sector

$$m_{\text{Higgs}} \sim m_{\text{Higgs,original}} + m_{\text{new}}$$

This is typically negligible, but is important in some cases.
E.g., in a class of **low scale gauge mediation models**,

$$m_{\text{new}} \sim 1 \text{ GeV} \cdot \left(\frac{A \cdot N_{\text{messenger}}}{5} \right)$$

[Yanagida, Yokozaki, KY (work in progress)]

$A, N_{\text{messenger}}$:
parameters of
order one

Summary (personal opinion)

- There are perhaps many other possibilities which we have not yet thought of.
- Keep trying and wait for new results at the LHC!