



Higgs connections: Electroweak stability and cosmology

Giuseppe Iacobellis

Supervisor: dr. Isabella Masina

University of Ferrara and INFN - Ferrara

Bari Theory Xmas Workshop 2016

Bari, 22th December 2016

Stability vs metastability

EW
stability
and
cosmology

**Giuseppe
Iacobellis**

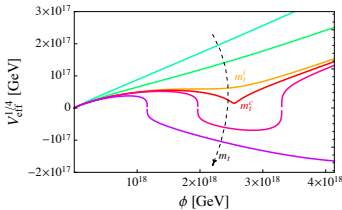
Living on
the edge

Stability
and
inflation
point

ξ -inflation

$U(1)_{B-L}$

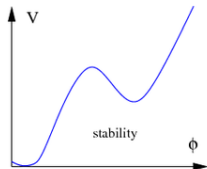
How fast
Santa
should be?



SM Higgs potential

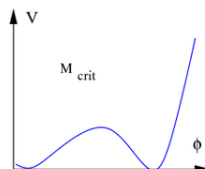
$$V_0 = \frac{\lambda}{6} \left(|\mathcal{H}|^2 - \frac{v^2}{2} \right)^2 \sim \frac{\lambda}{24} \phi_H^4$$

Stationary configurations: m_t^c and m_t^i



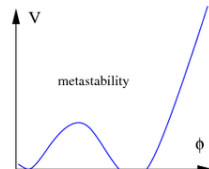
Fermi

Planck



Fermi

Planck



Fermi

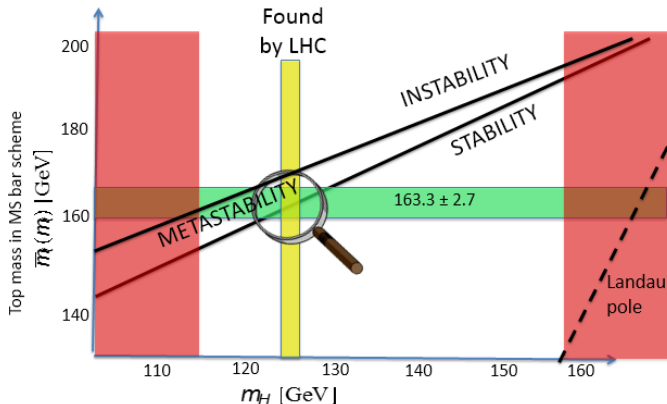
Planck

$\lambda \phi^4$, plateau, ...

Degenerate vacua

$\tau > \tau_{\text{universe}}$

Higgs discovery (2012)



Masina, Talk in Padua(2014)

Is Nature trying to tell us something?

Stability results: degenerate vacua

(GI and Masina, Phys. Rev. D94(2016) 073005)

EW
stability
and
cosmology

Giuseppe
Iacobellis

Living on
the edge

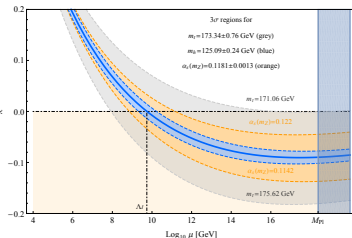
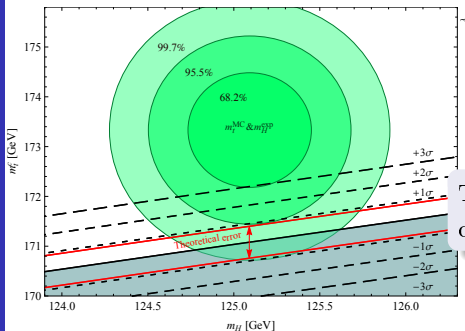
Stability
and
inflation
point

ξ -inflation

$U(1)_{B-L}$

How fast
Santa
should be?

Only 1.5σ deviation from stability!



The running of λ is heavily
dependent on y_t

Inflection point configuration: results

(GI and Masina, Phys. Rev. D94(2016) 073005)

EW
stability
and
cosmology

**Giuseppe
Iacobellis**

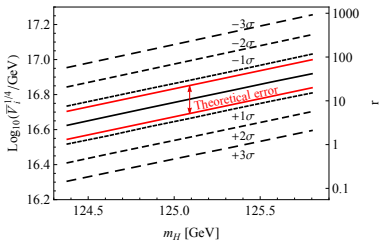
Living on
the edge

Stability
and
inflection
point

ξ -inflation

$U(1)_{B-L}$

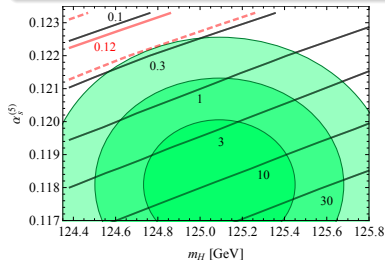
How fast
Santa
should be?



A **tension** of at least 3σ
appears: all the false vacuum
inflationary models seem to be
ruled out

$$V \approx \frac{3\pi^2 A_s}{2} r$$

The potential spans one order of
magnitude for decreasing α_s :
dramatic variation of r



$$\log_{10} \bar{V}_i^{1/4} = 16.77 \pm 0.11_{\alpha_s} \pm 0.05_{m_H} \pm 0.08_{\text{th}}$$

ξ -inflation: predictions and constraints

(GI and Masina, in preparation)

EW
stability
and
cosmology

**Giuseppe
Iacobellis**

Living on
the edge

Stability
and
inflation
point

ξ -inflation

$U(1)_{B-L}$

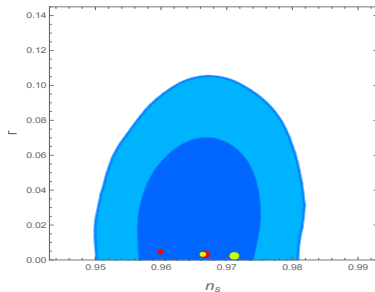
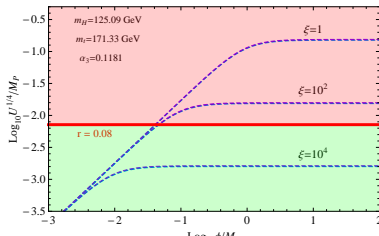
How fast
Santa
should be?

Action in the Jordan frame

Scalar fields can (should?) be non-minimally coupled to gravity

$$\mathcal{S}_J = \int d^4x \sqrt{-g} \left[\frac{M_P^2}{2} R - \xi \mathcal{H}^\dagger \mathcal{H} R \right]$$

Weak constraint on ξ



We see that a critical low ξ scenario is no more viable:

Unitarity issue!

Stabilisation of the potential: $U(1)_{B-L}$ extension

(GI and Masina, in preparation)

EW
stability
and
cosmology

**Giuseppe
Iacobellis**

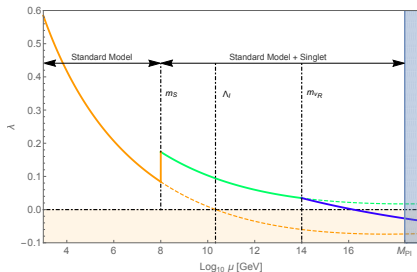
Living on
the edge

Stability
and
inflation
point

ξ -inflation

$U(1)_{B-L}$

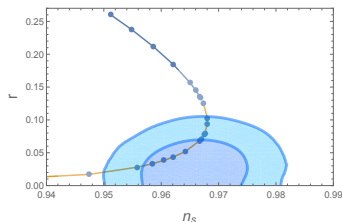
How fast
Santa
should be?



Threshold effect

the scalar lifts up λ , while
neutrinos pull down the running

Majoron inflation
small room
to accomplish both tasks!





Merry Xmas and Happy New Year!

EW
stability
and
cosmology

Giuseppe
Iacobellis

Living on
the edge

Stability
and
inflation
point

ξ -inflation

$U(1)_{B-L}$

How fast
Santa
should be?

THE PHYSICS OF SANTA

Every year, Santa must deliver gifts to 200 million children spread over 200 million square miles in 24 hours. With 2.67 children in each household, 75 million homes to visit, and an average distance of 1.63 miles between homes, **how fast does Santa need to travel?**

