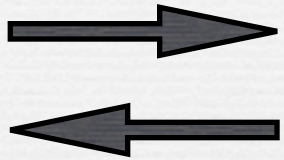
New TeV scale physics



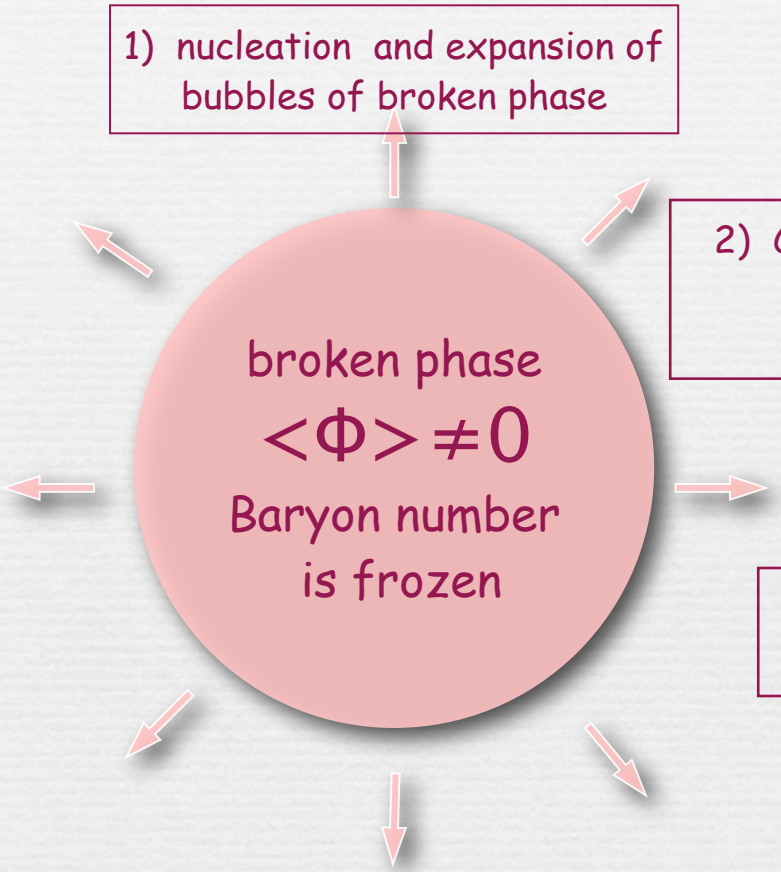
Cosmology

cosmological probes of the EW symmetry breaking mechanism

- baryogenesis
- dark matter

Géraldine SERVANT
CERN-TH & IPhT CEA Saclay

Baryon asymmetry and the EW scale



1) nucleation and expansion of bubbles of broken phase

2) CP violation at phase interface responsible for mechanism of charge separation

3) In symmetric phase, <Φ>=0, very active sphalerons convert chiral asymmetry into baryon asymmetry

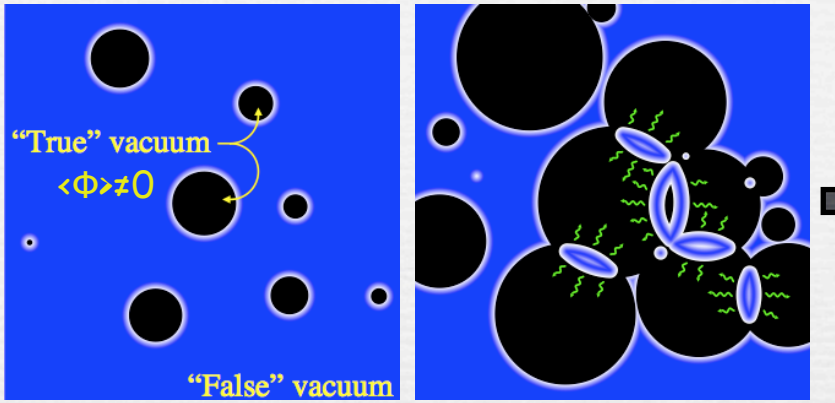
Chirality Flux
in front of the wall

Electroweak baryogenesis mechanism relies on a first-order phase transition

wall velocity is a crucial quantity

Bubble nucleation

Bubble percolation

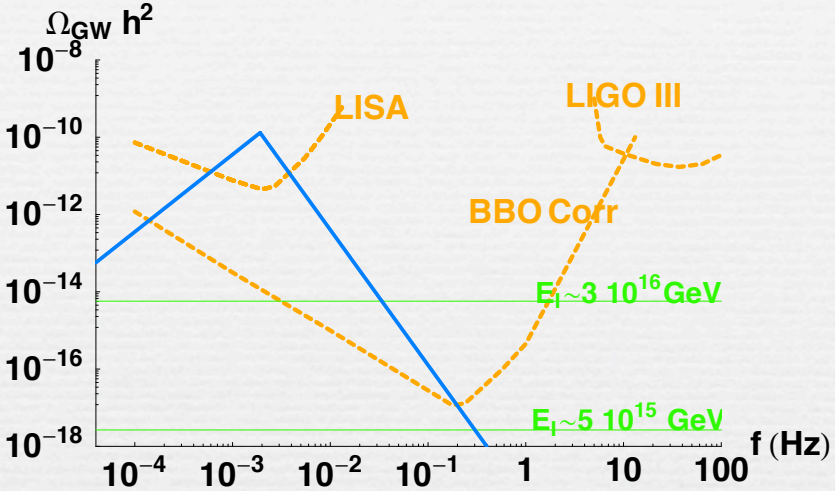


Fluid flows

turbulence

Magnetic fields

Stochastic background of gravitational radiation



$$\Omega_{GW} \sim \kappa^2$$

fraction κ of vacuum energy density ϵ converted into kinetic energy

$$\kappa = \frac{3}{\epsilon \xi_w^3} \int w(\xi) v^2 \gamma^2 \, \xi^2 \, d\xi$$

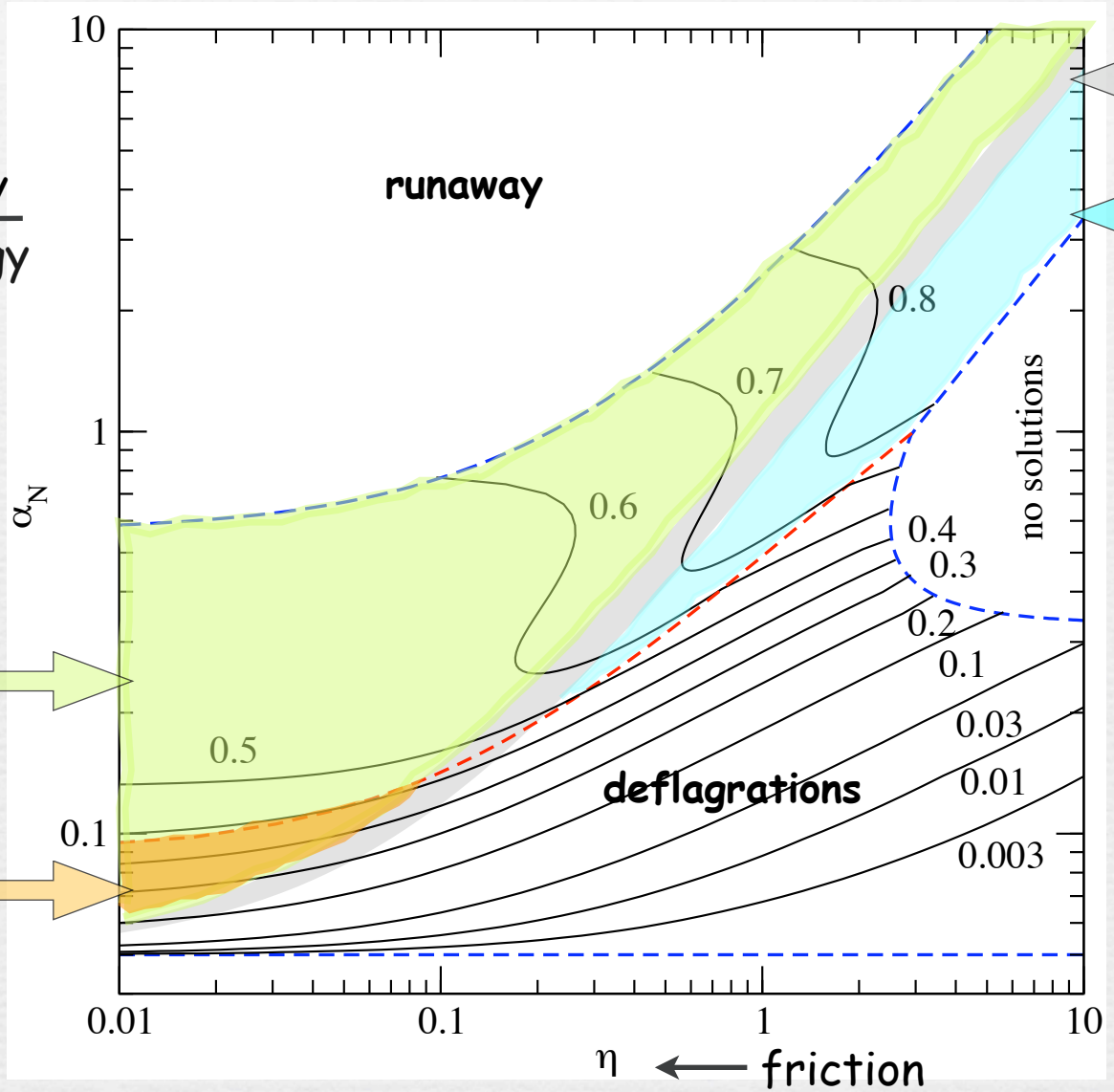
wall velocity

fluid velocity

$$\rightarrow \Omega_{GW} \sim v^4$$

Model-independent κ contours

Espinosa, Konstandin, No, Servant'10



vacuum energy / radiation energy

detonations

deflagrations

runaway & hybrids

runaway & deflagrations

$$\eta_{\rm SM} \sim 10^{-3}$$

$$\eta_{\rm MSSM} \sim 10^{-2} \qquad v \sim 0.05 - 0.1$$

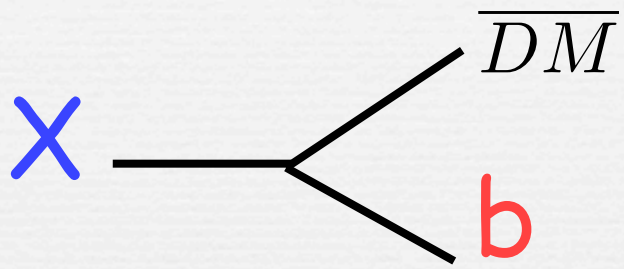
Baryogenesis without ~~B~~ nor ~~L~~ nor ~~CPT~~

Possible if dark matter carries baryon number

Farrar-Zaharijas hep-ph/0406281
Agashe-Servant hep-ph/0411254

In a universe where baryon number is a good symmetry, Dark matter would store the overall negative baryonic charge which is missing in the visible quark sector

asymmetry between b and $\bar{b}$ is created via the out-of-equilibrium and CP-violating decay :



$$Q_{\rm DM}(n_{\overline{\rm DM}} - n_{\rm DM}) = Q_b(n_b - n_{\bar{b}})$$

out-of equilibrium and CP violating decay of X sequesters the anti baryon number in the dark sector, thus leaving a baryon excess in the visible sector

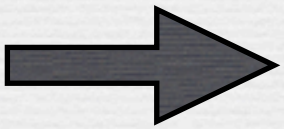
If efficient annihilation between DM and $\overline{DM}$, and b and $\bar{b}$

$$\rho_{\rm DM} = m_{\rm DM} n_{\overline{\rm DM}} \approx 6\rho_b \rightarrow m_{\rm DM} \approx 6\frac{Q_{\rm DM}}{Q_b}\ {\rm GeV}$$

A unified explanation for DM and baryogenesis

$$\Omega_b \approx \frac{1}{6}\Omega_m$$

turns out to be quite natural in warped GUT models...



GUT baryogenesis at the TeV scale !

Agashe-Servant-Tulin in progress

In parallel, also interested in collider phenomenology, in particular:

Search for new physics in $t\bar{t}+\bar{X}$ production at the LHC

→ $t\bar{t}$ **with Degrande, Gérard, Grojean, Maltoni, '10**

→ $t\bar{t}WW, t\bar{t}W$ from $p\bar{p} \to T\bar{T}, T\bar{t}$ where $T \to tW$

with Contino '08

→ $t\bar{t} + \not{E}_T$ from $p\bar{p} \to T\bar{T}$ where $T \to t$ DM

with Mahbubani, in progress

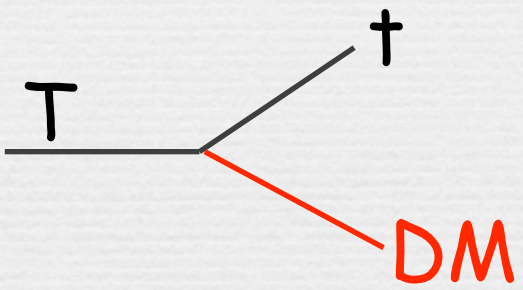
→ $t\bar{t}t\bar{t}$ **with Gauthier, in progress**

Z_2 versus Z_3 Dark Matter

Agashe et al, 1003.0899
Mahbubani-Servant, in progress.

Most Dark Matter models rely on a Z_2 symmetry. However, other symmetries can stabilize dark matter. Can the nature of the underlying symmetry be tested?

Z_2



Z_3 (+1=-2)