The Early Universe

Two main topics:

EXOTIC PHYSICS
+
(POST-)INFLATIONARY PHYSICS

Christian Byrnes replacing session chair Daniel Figueroa

Exotic Physics

Contributors
Hogan, Paul, Hajdukovic

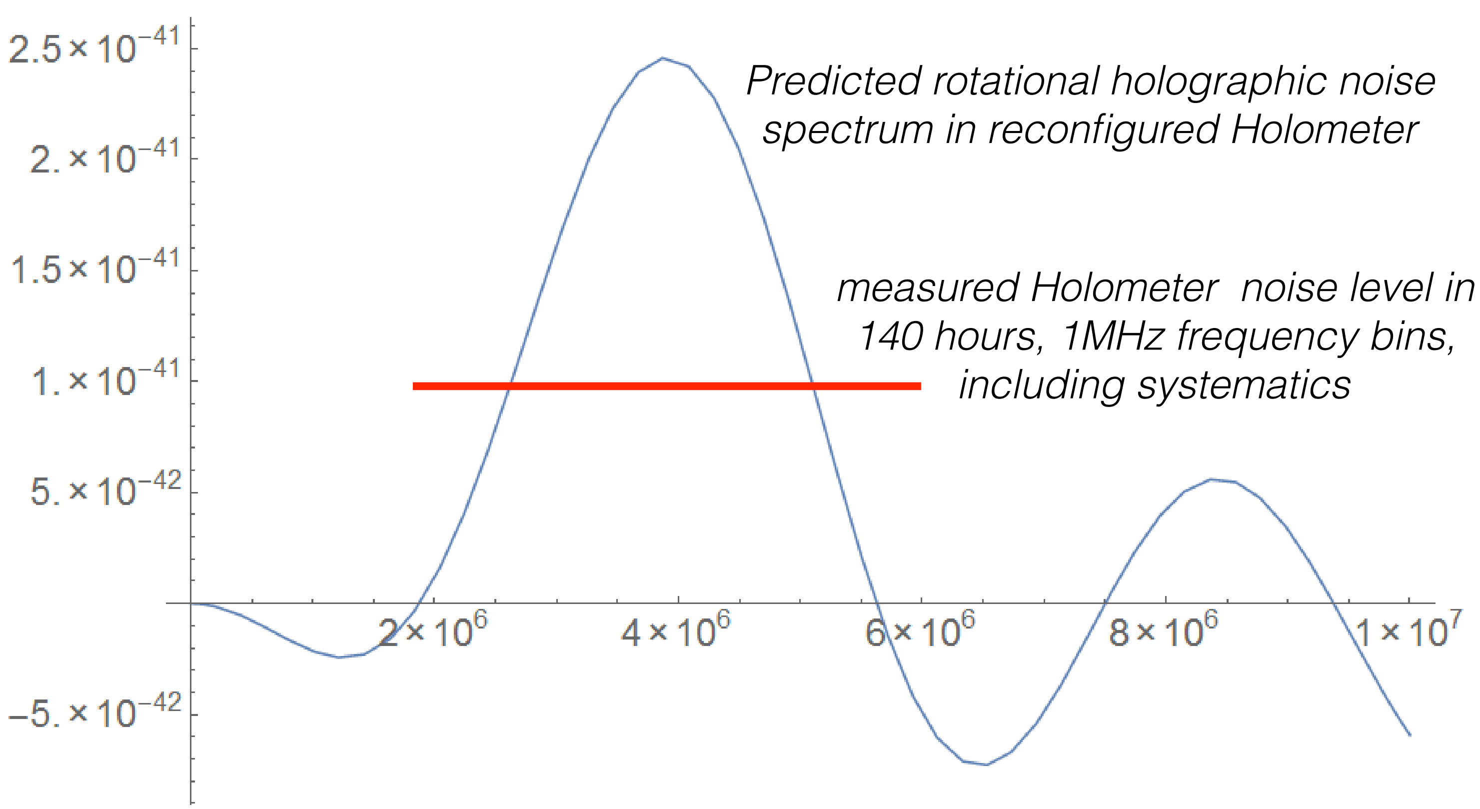
Exotic Rotational Correlations in Emergent Quantum Geometry

by Craig HOGAN

* Emergence of inertial frames in quantum gravity can lead to nonlocal, exotic rotational correlations in positions of bodies.

Predicted rotational noise spectrum in the frequency domain compared with current Holometer sensitivity

The resulting $\Xi(f)$ versus f (in units m^2/Hz vs Hz) plot is shown below:



* Even without a theory of quantum gravity, we can predict the exact form of exotic correlations in the signal of an interferometer.

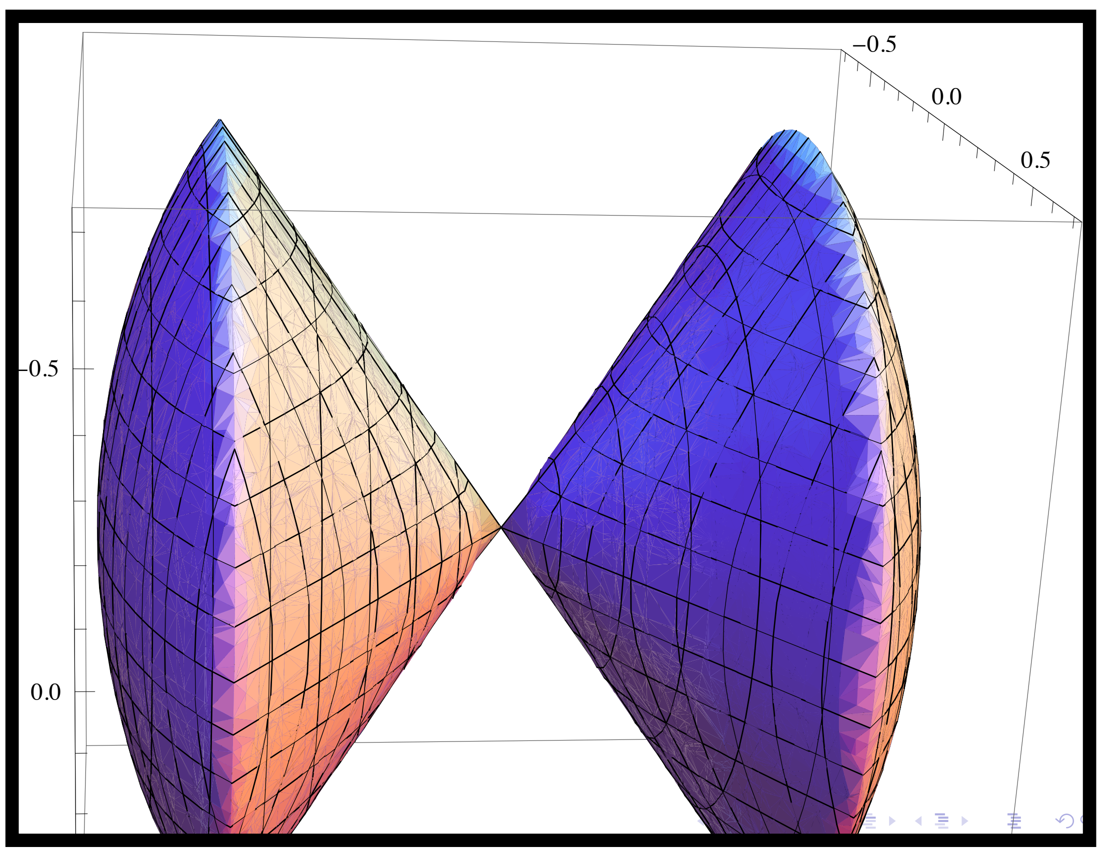
* The prediction can be tested with a reconfiguration of the Fermilab Holometer (holographic interferometer).

Creation of Emergent Universe with Wormholes

by Bikash Chandra PAUL

* Emergent universe (EU) scenarios can circumvent the big-bang singularity.

* From the presence of gravitational instanton solutions in the very early universe, a static Einstein universe emerges, leading to a cosmologically viable Emergent Universe in the framework of massive gravity.



A Cyclic Universe alternatively dominated by matter and antimatter

by Dragan HAJDUKOVIC

* If quantum vacuum fluctuations are virtual gravitational dipoles, we might live in a cyclic universe with cycles alternatively dominated by matter and antimatter.

* Phenomena usually attributed to dark matter and dark energy, may be the consequence of the gravitational polarization of the quantum vacuum by the immersed Standard Model matter.

(post-)Inflationary Physics

Contributors

Braden, Heisenberg, Shkerin, Figueroa, Cefala, Orani, Patil and Byrnes

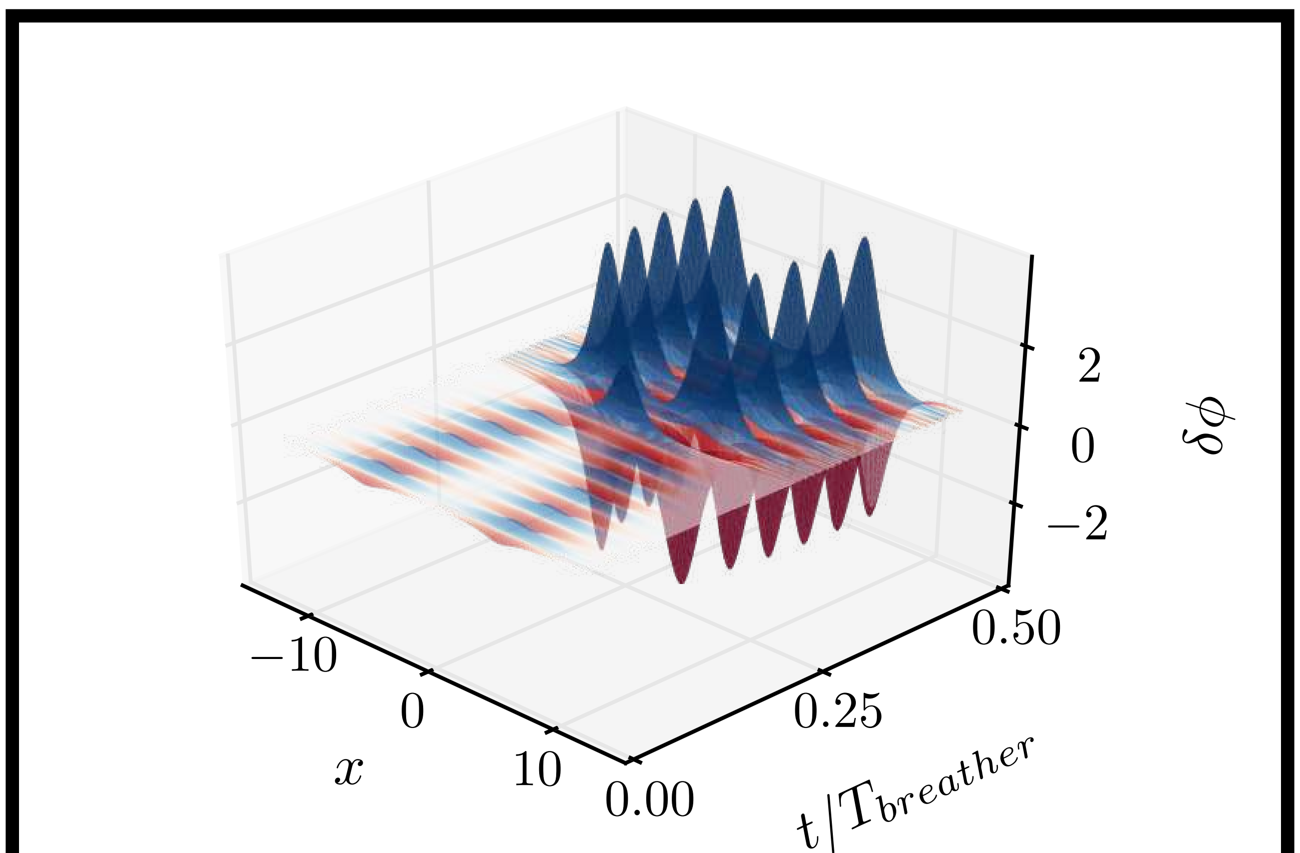
Some shift of focus from inflation to reheating in the post Planck satellite universe

3D Quantum Bubble Collisions

by Jonathan BRADEN

* First-order phase transitions proceed through the nucleation and subsequent collision of bubbles.

* First results for the full 3D nonlinear dynamics of pairwise bubble collisions, including the effect of (initially small) quantum fluctuations.



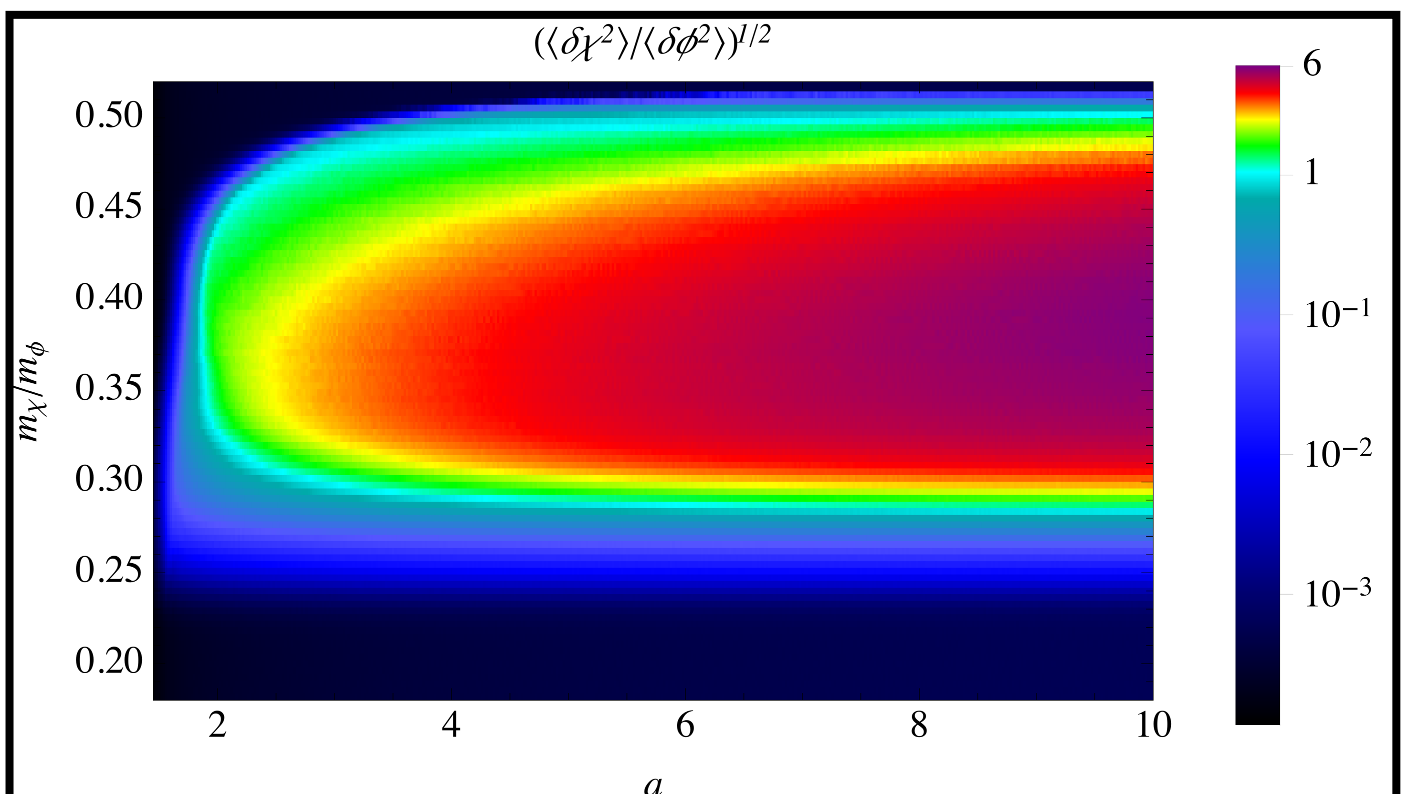
* Accounting for the dynamics of these fluctuations: leads to a complete breakdown of the SO(2,1) symmetry in a wide class of potentials, leaving behind a population of 'oscillons'. This has implications for the production of gravitational waves or black holes during bubble collisions.

Parametric resonance after hilltop inflation caused by an inhomogeneous inflaton field

by Francesco CEFALÀ

* During preheating after hilltop inflation, the inflaton becomes rapidly inhomogeneous.

* Considering an interaction between the inflaton and a second scalar field allows for an additional phase of parametric resonance caused by the inhomogeneous inflaton.



* During this stage, the initial vacuum fluctuations of the second field can be amplified up to amplitudes of the order of the inflaton and even larger. This has an impact on the thermalization of the universe after inflation.

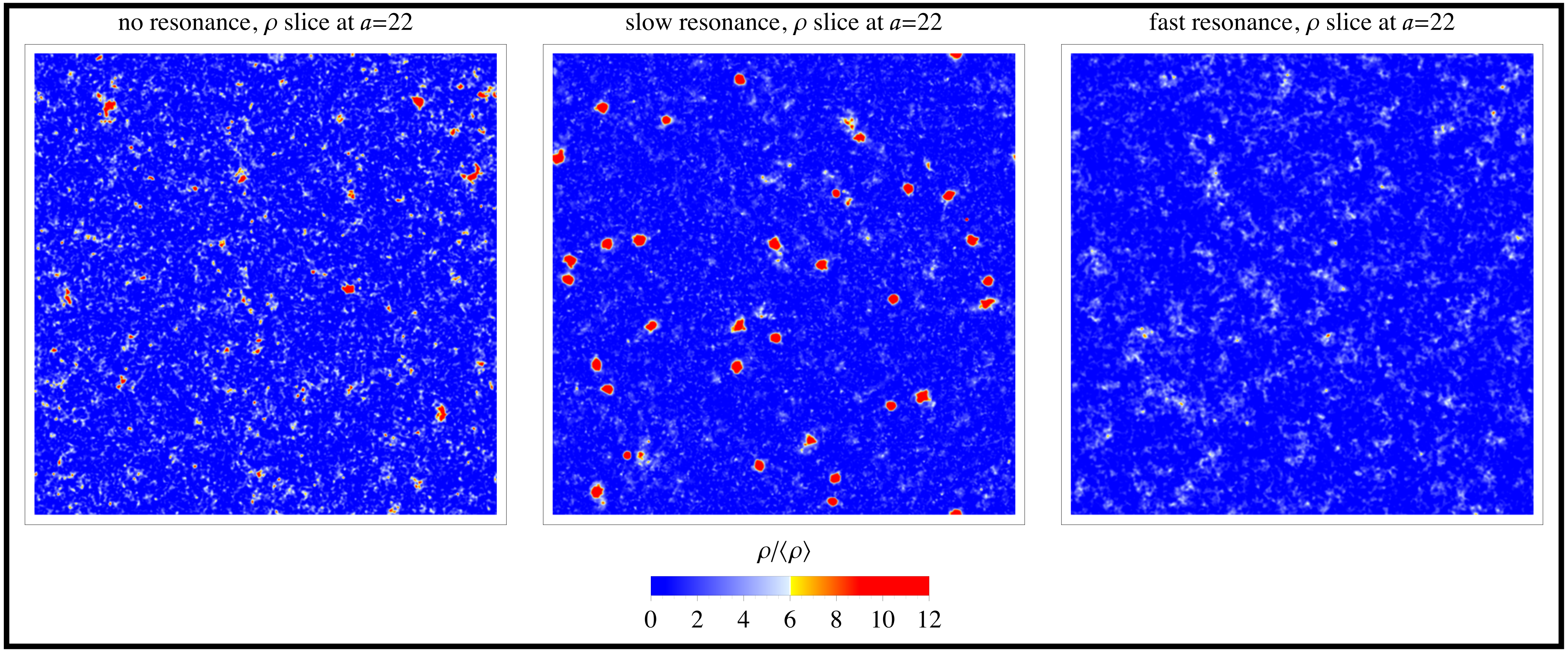
Preheating after hilltop inflation

by Stefano ORANI

* Oscillons (localized oscillating configurations of the inflaton field) form after hilltop inflation.

* When the inflaton is coupled to another scalar field, the latter can be resonantly amplified after the oscillons have formed.

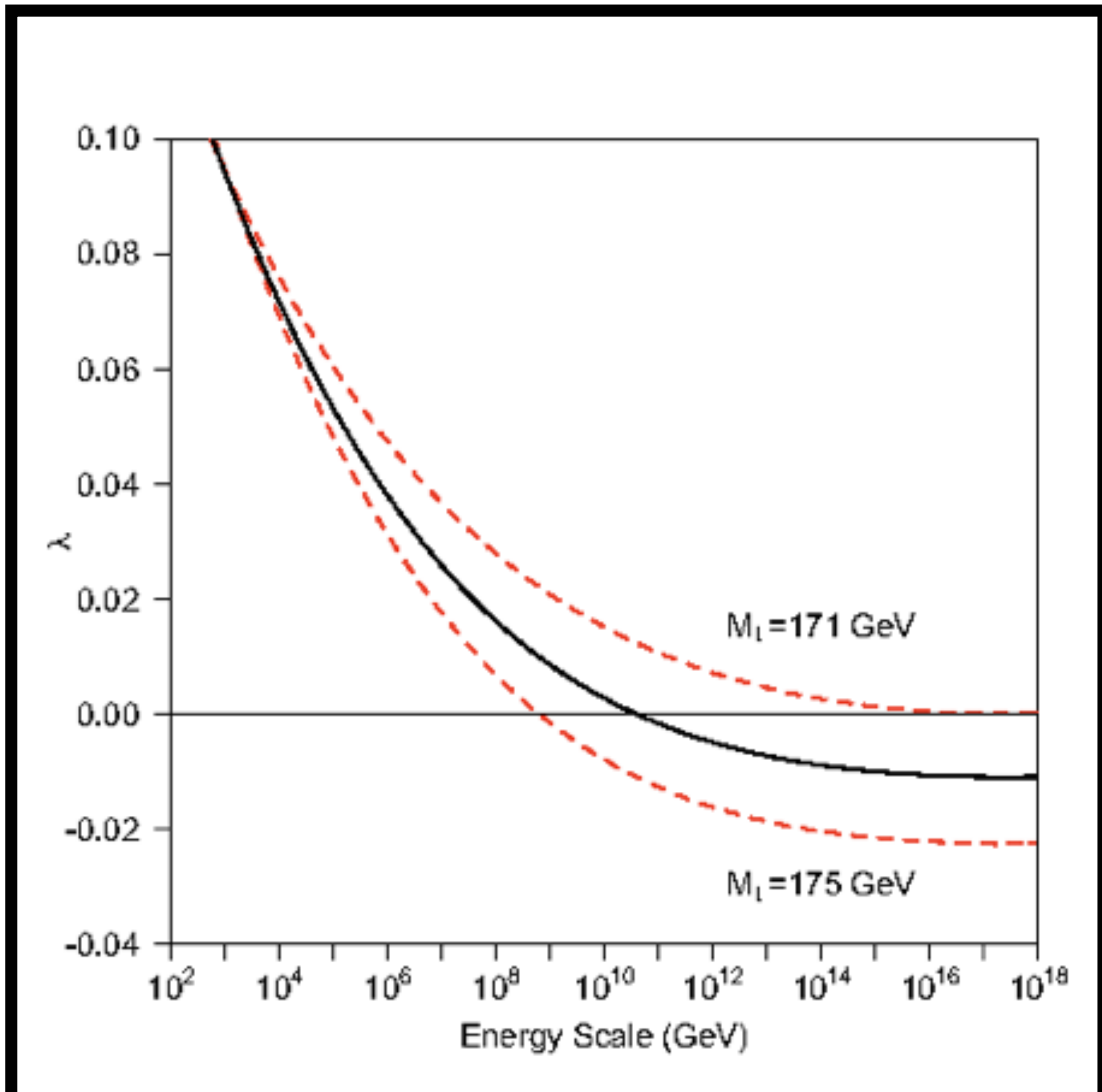
* Depending on the timing and strength of the resonance, the lifetime of the oscillons can be suppressed, amplified or unaffected, leading to potentially observable signatures from preheating.



On stability of electroweak vacuum during inflation

by Andrey SHKERIN

* Coleman – De Luccia tunneling of the Standard Model Higgs field during inflation is considered when the electroweak vacuum is metastable.



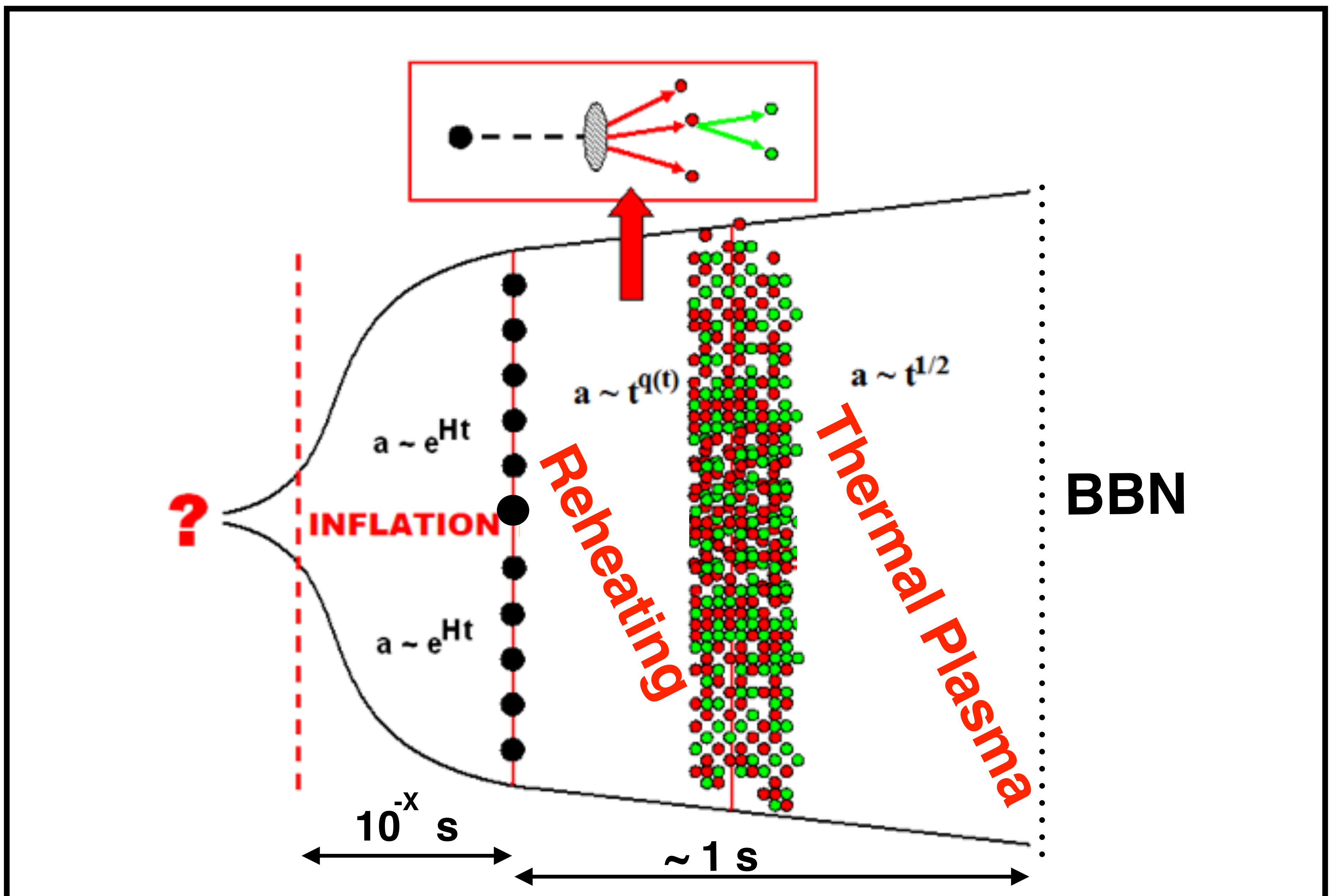
* It is verified that the tunneling rate is exponentially suppressed; the main contribution to the suppression being the same as in flat space-time.

* Analytical estimations of the corrections due to the expansion of the universe, and of an effective mass term in the Higgs potential (that can be present at inflation) were presented.

A Stiff HIGGStory of the Universe

by Daniel G. FIGUEROA

* The decay of the Standard Model Higgs after Inflation was discussed, assuming a post-inflationary/pre-BBN expansion history driven by a stiff source (EoS w > 1/3)



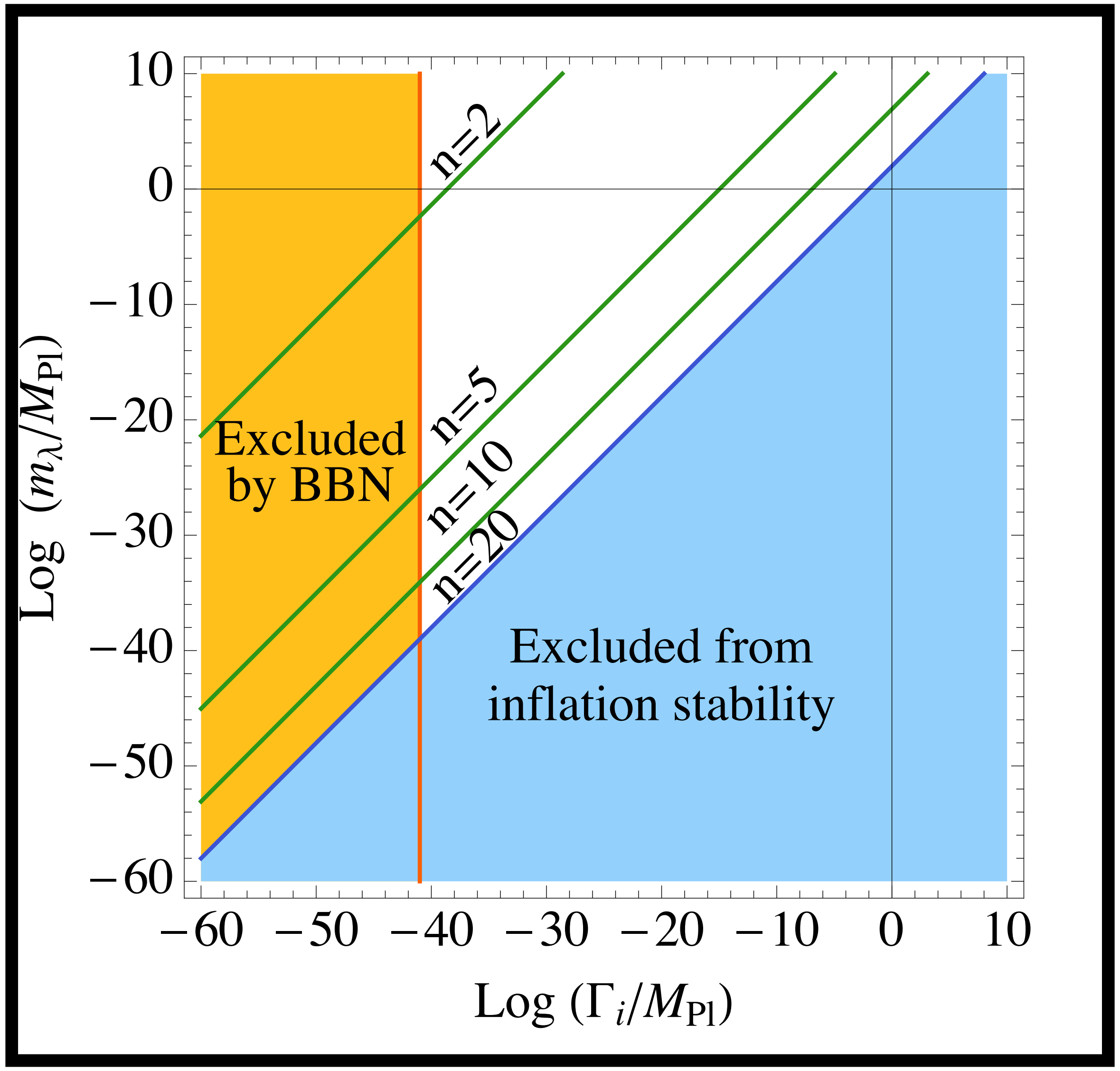
* It was showed that a Kination-domination stage after inflation, leads to a successful 'reheating' mechanism

* Consequences due to Reheating then follow: GW are produced by the Higgs decay products, and the inflationary GW background develops a significant blue-tilt.

Born-Infeldizing gravity

by Lavinia HEISENBERG

* To regularize the energy of point-like charged particles, Born and Infeld introduced a modification of the Maxwell lagrangian, naturally imposing an upper bound on electromagnetic fields.



* This approach was later taken by Deser and Gibbons to propose an analogous modification for gravity.

* These ideas are implemented in a scenario where inflation could be supported by a set of massive particles within the context of these theories.

The Effective Strength of Gravity and the scale of Inflation

by Subodh PATIL

- At any given energy, gravitational interactions have a strength set by a characteristic scale M_*, inferred from amplitudes calculated in an effective theory with a strong coupling scale M_{**}

- These are in general different from each other and $M_{\rm pl}$, the macroscopic strength of gravity as determined by (laboratory scale) Cavendish experiments.

- Consequences of this fact for inflationary cosmology and CMB observables, follow: in particular, the relation of the scale of inflation and the perturbations is different than in standard single field inflation:

$$\mathcal{P}_{\mathcal{R}} := \frac{H_*^2}{8\pi^2 M_{*s}^2 \epsilon_*}; \quad \epsilon_* := -\dot{H}_*/H_*^2,$$

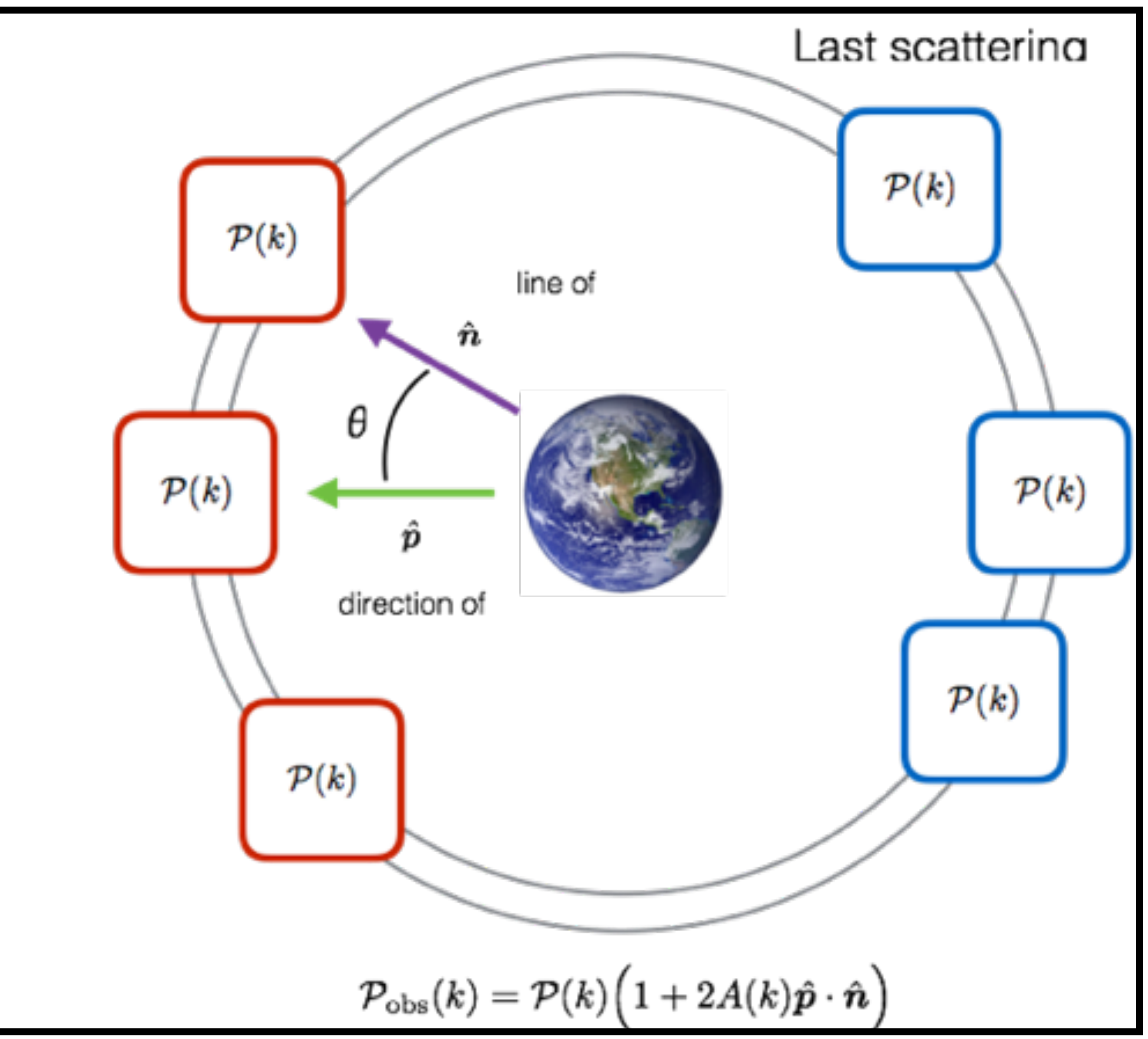
$$M_{*s}^2 = M_{\rm pl}^2 \frac{F^2(\eta_*)}{F^2(\eta_0)} \approx \frac{M_{\rm pl}^2}{1+\widetilde{N}_*}$$

$$N_* = num.\ species$$

Implications of the primordial power asymmetry for inflation

by Chris BYRNES

* Anomalies may provide the first clue to new observables beyond the amplitude and spectral index of the primordial perturbations.



* However, explaining the observed (strongly scale dependent) power asymmetry is challenging, with models typically generating additional observational signatures which rule out the model.

* Conclusion: Working models are too complicated compared to the significance of the anomaly.