Aspects of quantum field theory in curved spacetimes
(Aspekty kvantové teorie pole v zakřivených prostoročasech)

[Master thesis project]

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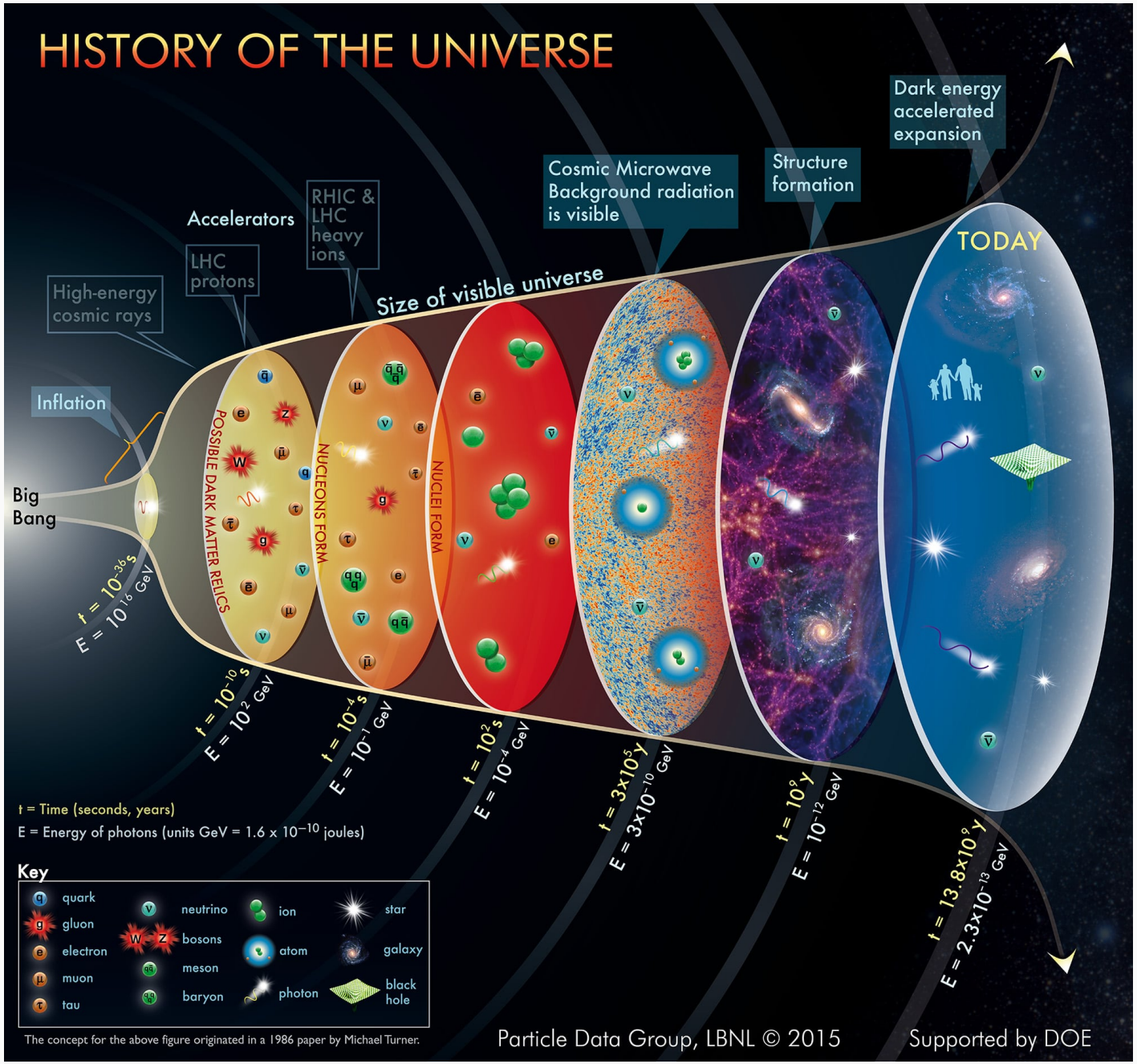
What can the primordial Universe tell us about the fundamental structure and laws of matter and (quantum) gravity?



credit: Particle Data Group @ Lawrence Berkeley National Lab.

■ COSMIC INFLATION

Brief period of rapid, almost exponential expansion of space

- Very brief era: $t \sim 10^{-36}\,\mathrm{s}$
- Extreme conditions: $E_{\mathrm{inf}} \sim 10^{16}\,\mathrm{GeV}$
- Universe volume inflated by a factor $\sim 10^{78}$

$\longrightarrow$ Can we imagine this?

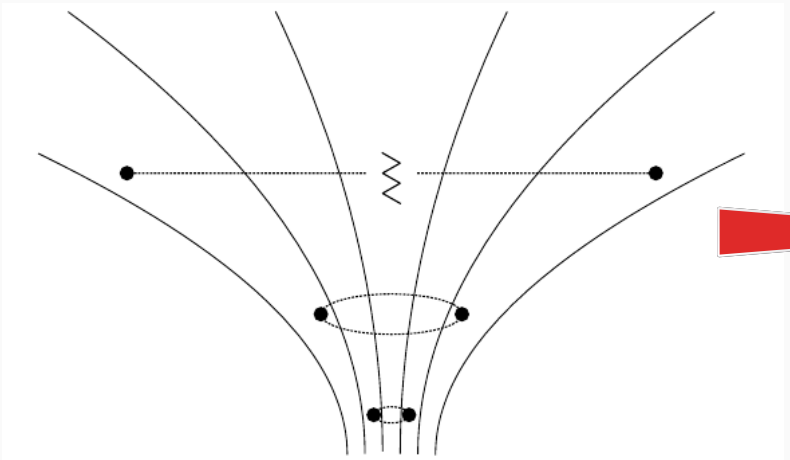
Large Hadron Collider (LHC): $E_{\mathrm{LHC}} \sim 10^{4}\,\mathrm{GeV}$

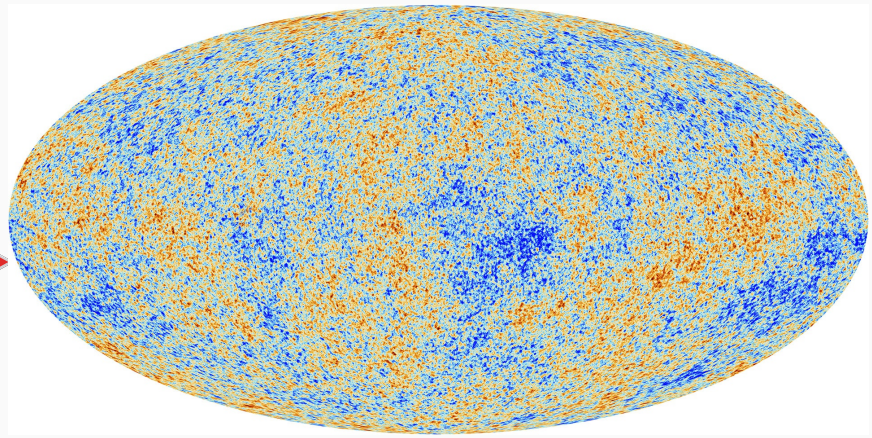
$$\boxed{E_{\mathrm{inf}}/E_{\mathrm{LHC}} \sim 10^{12}}$$

$\Rightarrow$ Can inflation serve as a *cosomological collider?*

■ QFT IN CURVED SPACE

Gravitational particle production — virtual pairs of particles ripped from vacuum into existence by the expansion





credit: ESA and the Planck Collaboration

■ PROJECT

• Introduction to QFT in curved space (and nonequilibrium QFT)

• Application to a particular problem (different definition of vacua, renormalization ambiguities in adiabatic subtraction, linearization instability in gauge theories)

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(dark energy, black holes, dark matter, modified gravity,...)