

南开TeV物理研究计划

TeV物理工作组第一次会议
清华, 05.12.18.

廖益

Topics

- Field theory on noncommutative (NC) spacetime and phenomenology of NCSM
- Phenomenology of other beyond-SM phys, e.g., little Higgs, TC
- Study of cosmological problems at colliders

NC field theory

* Why noncommutative spacetime?

‘pointless phys’ at extremely short distaces

mimicking pointless spacetime by NC spacetime:

$$[\hat{x}_\mu, \hat{x}_\nu] = i\theta_{\mu\nu}, \quad \theta_{\mu\nu} : \text{const.}, [\text{L}]^2$$

$$\text{NC phys scale } \Lambda \approx |\theta|^{-\frac{1}{2}}$$

NC field theory

* Field theory on NC spacetime

Moyal-Weyl correspondence:

C spacetime

NC spacetime

$$f(x)$$

$$\hat{f}(\hat{x})$$

$$(f_1 * f_2)(x)$$

$$\hat{f}_1(\hat{x}) \hat{f}_2(\hat{x})$$

Moyal star product:

$$(f_1 * f_2)(x) = \left[\exp\left(\frac{i}{2} \theta^{\mu\nu} \partial_\mu^x \partial_\nu^y\right) f_1(x) f_2(y) \right]_{y \rightarrow x}$$

NC field theory

Example:
$$L = \frac{1}{2} \partial^\mu \varphi^* \partial_\mu \varphi - \frac{1}{2} m^2 \varphi^* \varphi - \lambda \varphi^* \varphi^* \varphi^* \varphi$$

Alternative: θ -expanded field theory via
Seiberg-Witten map

→ EFT at $k \ll \Lambda$

NC field theory

* New features of NC field theory

e.g., φ^3 vertex $\propto \exp\left[\frac{i}{2}\theta_{\mu\nu}p_1^\mu p_2^\nu\right] + \text{perm.}$

nonlocal:

unitarity, causality, UV/IR mixing, etc

Model building of NC gauge theory

QED? SM? GUTs? ...

* Very restrictive constraints due to NC:

(1) Allowed group: $U(N)$

(2) Allowed reps: fundamental, adjoint;
impossible to be charged under more
than 2 groups;

(3) Allowed charges for $U(1)$: 0, 1, -1

(4) Must be vector-like

Model building of NC gauge theory

* Status of NCSM building

(1) First attempt by Helsinki group:
unsuccessful

(2) Preliminary result of Durham group:
very promising (decoupling of trace $U(1)$
at IR);
to be completed in flavor and scalar
sectors

Model building of NC gauge theory

(3) θ -expanded NCSM, NCGUTs by
Munich group

Model building of NC gauge theory

- * Unique features of NC gauge models
exotic interactions like
 $WWgg$, QED of neutral particles
- * Status of phenomenological study
mainly NCQED processes at linear colliders;
partial results based on ill-defined NCSM

What to do

- * Completing and simplifying NCSM building along the lines of Durham group
- * Phenomenology at linear and hadron colliders
- * Possible applications to astrophys