

Indian Institute of Technology, Kanpur

Proposal for a New Course

1. Course No: A **600-level Elective** number is requested.
2. Course Title: ***Effective Field Theory***
3. Per Week Lectures: 3 (L), Tutorial: 0 (T), Laboratory: 0 (P), Additional Hours[0-2]: 0 (A),
Credits ($3*L+0*T+P+A$): 09 Duration of Course: Full Semester
4. Proposing Department: PHY.
Other faculty members interested in teaching the proposed course: Sabyasachi Chakraborty, Sanmay Ganguly, Diptarka Das, Nilay Kundu, Debtosh Chowdhury, Goutam Das
5. Proposing Instructor: Joydeep Chakraborty (PHY)
6. Course Description: The dynamics of sub-atomic particles are very much dependent on the energy scale. The physics at low energies may contain the footprints of physics at high energies. It is possible to capture those effects, even without knowing them in detail, by employing the notion of Effective Field Theory (EFT). EFT sets a platform to compare different theoretical proposals in the light of experimental data. In summary, to connect physics of varying energy scales.

A) Objectives: In this course, the field-theoretic techniques related to the EFT will be developed. By the end of this course, students are expected to learn the EFT formalism and will be ready to implement it for realistic scenarios.

B) Contents:

S. No.	Broad Title	Topics	No. of Lectures
	Basics of Functional Integral	Brief introduction to Path Integral formalism. Quantization of Gauge Theory. 1-loop Effective Action construction. Introduction to Heat-Kernel	5
	Introduction to EFT	Basic idea of EFT, Local vs non-Local operators, Classification of Operators:	4
	Hilbert Series and EFT	Hilbert Series method to compute the symmetry invariant effective Operators.	6
	NREFT, Chiral EFT, SCET	Basics of Non-relativistic, Chiral and Soft Collinear Effective Field Theory	6
	Integrating out Heavy Fields	Methods to Integrate out heavy fields: Computation of Effective Operators and the respective Wilson Coefficients (WCs).	6
	EFT at Finite Temperature	Hilbert Series construction and Integrating out heavy Fields at Finite Temperature.	6
	SMEFT	Matching of SM-EFT and the BSM physics. With Examples	3
Total number of lectures:			36

C) Pre-requisites, if any: Quantum Field Theory-I

(1/1)

D) Short summary for including in the Courses of Study Booklet: Functional Method, I-PI Effective Action, Local vs non-local operators, Integrating out heavy Fields, Hilbert Series, Low Energy EFT, Chiral EFT, Fitting of Wilson coefficients.

7. Recommended References:

- (i) H. Georgi, On-shell effective field theory, Nucl. Phys. B361 (1991) 339–350.
- (ii) M. K. Gaillard, The Effective One Loop Lagrangian With Derivative Couplings, Nucl. Phys. B268 (1986) 669–692
- (iii) D. B. Kaplan, Five lectures on effective field theory, 2005. nucl-th/0510023.
- (iv) A. V. Manohar, Effective field theories, Lect. Notes Phys. 479 (1997) 311–362, [hep-ph/9606222].
- (v) C. P. Burgess, Introduction to Effective Field Theory, Ann. Rev. Nucl. Part. Sci. 57 (2007) 329–362, [hep-th/0701053].
- (vi) I. Z. Rothstein, TASI lectures on effective field theories, 2003. hep-ph/0308266.

Any other remarks: None

Dated: 1 September, 2018. Proposer: Joydeep Chakraborty (*Joydeep Chakraborty*)

Dated: _____ DPGC Convener (PHY): _____

The course is approved / not approved

Chairman, SPGC

Dated: _____