Oberseminar Gauge Theory
On swimming, synthetic gauge fields and elementary particles

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Introduction to the subject

Gauge theory provides the geometric and calculational framework for the description of a variety of physical phenomena, ranging from biological and condensed matter systems over gravity to elementary particle physics. The seminar will address various fundamental questions concerning the formulation of classical gauge theories, their quantization as well as a number of selected applications. These applications include swimming in dense media, the emergence of artificial gauge fields in condensed matter systems, the formulation of gravity as a gauge theory, the appearance of topological excitations, connections to knot theory, the role of anomalies, etc.

1. Pass criteria (no grade):

   - Presentation of 75 minutes on the given subject (the usage of the blackboard is encouraged, but the beamer may be used as well/in addition when appropriate)
   - Preparation of a basic concept paper which can be scanned/copied and distributed among the participants (but feel free to write a slightly more extended summary if you like)
   - Regular participation and active contributions to the seminar

2. Get an idea of

   - Background (Year of study, lectures attended,...)
   - Scientific interests
   - Suggestions (should we add a particular topic?)

3. Distribution of talks

   In case of high demand preference is given to students

   - who have not yet attended a Oberseminar
   - who are enrolled in the master program, specialization GR/QFT
   - who have the required background, i.e. who attended the courses QFT and Geometry in Physics (or equivalent)

4. Preparation

   In order to ensure a consistent quality of the Oberseminar, the preparation of the talks will proceed in two steps. Each of the two steps gives you the chance of discussing with a supervisor the scientific content but also questions regarding structure and style of the presentation.

   - **Step 0:** Distribution of topics (first lecture)
   - **Step 1:** You read the suggested material, try to understand it and prepare a rough outline of how you would organize/present it. This will be discussed **two** weeks before your seminar.
   - **Step 2:** Taking into account the feedback of the first meeting, you are working out the full presentation. This will be discussed with your supervisor **one** week before your seminar.

−2 weeks	−1 week	Friday
Discussion of brief outline	Discussion of full presentation	Your talk (10:00h-11:30h)

Schedule

Week	Topic	Date	Speaker
1	Preliminary discussion and distribution of talks	23.10.2015	
2	[— No seminar (time required for preparation) —]	30.10.2015	
3	[— No seminar (time required for preparation) —]	06.11.2015	
Classical gauge theory			
4	Yang-Mills theory	13.11.2015	Kay Herklotz
5	Chern-Simons theory	20.11.2015	Carson Mosso
6	Gravity as a gauge theory	27.11.2015	Björn Ladewig
7	Field theory on curved space-times	04.12.2015	(Thomas Quella)
Aspects of quantization			
8	BRST approach to the quantization of gauge theories	11.12.2015	Lorenz Mayer
9	Anomalies and Wess-Zumino consistency conditions	18.12.2015	Charles Guggenheim
10	Renormalization group analysis and asymptotic freedom	08.01.2016	(Patrick Wong)
Applications			
11	Gauge theory of swimming in dense media	15.01.2016	N.N.
12	Synthetic gauge fields	22.01.2016	Patrick Wong
13	Monopoles and instantons	29.01.2016	Terenz Feng
14	Wilson loops and knot invariants	05.02.2016	Felipe Montealegre Mora
15	O(N) and $\mathbb{CP}^N$ non-linear σ-models	12.02.2016	(Vivek Lohani)

General hints for the preparation of your talk

- It is your task to turn the material related to your topic into a coherent story. This requires a detailed examination and understanding of the subject. Merely giving definitions without motivation and without pointing out the bigger picture is not sufficient.

- You will realize that time is rather limited and that you will need to focus on essentials.

- Personally, I am using 6-7 handwritten A4 pages for a 90 minutes lecture. It is recommended to aim at no more than 4-5 pages for your own presentation (and do not try to gain extra space by writing extra small).

- Please emphasize the physical ideas, not the mathematical formalism. Also avoid detailed calculations (except where they add to the conceptual understanding).

- In the two preparatory meetings you will be able to get feedback and assistance by your supervisor before you give your presentation, both on content and style. In order to maximize the benefit of these meetings it is important that you are well prepared.