Course Title (in English) | Supersymmetric gauge theories  
---|---  
Course Title (in Russian) | Суперсимметричные калибровочные теории  
Lead Instructor(s) | Gavrylenko, Pavlo  
| Marshakov, Andrei  
| Yung, Alexei  
Is this syllabus complete, or do you plan to edit it again before sending it to the Education Office? | The syllabus is a work in progress (draft)  
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1. Annotation

Course Description

This course is an introduction to the supersymmetry, which is one of the main basic principles, being used both in field theory and in string theory. The main emphasis will be made on the consideration of dynamics of supersymmetric gauge field theories: in particular, at the non-perturbative level.

Course starts from the introduction of the main concepts: supersymmetric algebra, its representations, chiral and vector multiplets. One will consider Wess-Zumino model and introduce superpotential. Then one will consider supersymmetric quantum electrodynamics, discuss supersymmetric Higgs mechanism and Higgs branches. One will consider in detail supersymmetric quantum chromodynamics. Its vacuum structure at the classical level will be discussed. Then one will introduce instantons and explain how they change vacuum structure by generating Affleck-Dine-Seiberg superpotential. Finally we will consider Seiberg duality.

Course Prerequisites

Knowledge of quantum mechanics and classical field theory. Basic knowledge of quantum field theory.

2. Structure and Content
<table>
<thead>
<tr>
<th>Topic</th>
<th>Summary of Topic</th>
<th>Lectures (# of hours)</th>
<th>Seminars (# of hours)</th>
<th>Labs (# of hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N=1 supersymmetric QED</td>
<td>Supersymmetric Higgs mechanism. Higgs branches. Low-energy sigma-model on the Higgs branch. Kähler potential.</td>
<td>1</td>
<td>4</td>
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<tr>
<td>Instantons in supersymmetric QCD</td>
<td>Instantons in SU(2) gauge sector. Fermionic zero modes. ’t Hooft instanton. Instantons in supersymmetric QCD with single flavor. Zero modes and collective coordinates. Non-zero modes and instanton measure. Effective Lagrangian.</td>
<td>1</td>
<td>4</td>
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<tr>
<td>Non-perturbative dynamics in N=1 supersymmetric QCD</td>
<td>Affleck-Dine-Seiberg superpotential. Inclusion of the quark masses. Generalization to arbitrary number of colors and flavors. Gluino condensate in the Yang-Mills theory without matter. N_f=N_c case.</td>
<td>1</td>
<td>4</td>
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</tbody>
</table>

### 3. Assignments
### 4. Grading

<table>
<thead>
<tr>
<th>Type of Assessment</th>
<th>Activity</th>
<th>Activity weight, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attendance</td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>Homework Assignments</td>
<td></td>
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</tr>
</tbody>
</table>

#### Grading Scale

- **A:** 86
- **B:** 76
- **C:** 66
- **D:** 56
- **E:** 46
- **F:** 0

**Attendance Requirements:** Mandatory with Exceptions

### 5. Basic Information

**Students of Which Programs do You Recommend to Consider this Course as an Elective?**

<table>
<thead>
<tr>
<th>Masters Programs</th>
<th>PhD Programs</th>
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<tbody>
<tr>
<td>Mathematical and Theoretical Physics</td>
<td>Mathematics and Mechanics Physics</td>
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</tbody>
</table>
6. Textbooks and Internet Resources

7. Facilities

8. Learning Outcomes

<table>
<thead>
<tr>
<th>Knowledge</th>
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<tbody>
<tr>
<td>Basic knowledge about construction of supersymmetric gauge theories.</td>
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<tr>
<td>Knowledge about the structure of vacua in N=1 supersymmetric QCDs.</td>
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<tr>
<th>Skill</th>
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<tr>
<td>Ability to perform computations with superfields.</td>
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</table>

9. Assessment Criteria

Input or Upload Example(s) of Assignment 1:

Select Assignment 1 Type: Homework Assignments

Or Upload Example(s) of Assignment 1: https://ucarecdn.com/3023c47d-6323-49db-be15-7d0042f04c86/

Input or Upload Example(s) of Assignment 2:

Select Assignment 2 Type: Homework Assignments

Or Upload Example(s) of Assignment 2: https://ucarecdn.com/feb55105-326a-4db7-a087-cd4909c87884/

Input or Upload Example(s) of Assignment 3:

Input or Upload Example(s) of Assignment 4:

Input or Upload Example(s) of Assignment 5: