

Index for Ohashi Lecture series

Lecture I: Domain walls and Vortices

- (a) The simplest soliton: domain wall
- (b) Axially symmetric vortex in Abelian-Higgs theory
- (c) Asymptotic behaviors and inter-soliton forces
 - i. type I and type II vortex
- (d) Derrick's theorem

Lecture II: Supersymmetry and superfields

- (a) Supersymmetry algebra
- (b) chiral superfield
 - i. Kähler potential and Kähler trf.
 - ii. super potential
- (c) vector superfield
 - i. super gauge trf. and WZ gauge
 - ii. FI term
- (d) supersymmetric gauge-Higgs model
 - i. D -term and F -term conditions for vacua

Lecture III: Non-linear sigma model (NL σ M) on Kähler manifold \mathcal{M}

- (a) Strong coupling limit of SUSY gauge-Higgs theory
- (b) Target manifold \mathcal{M} and vacua in the Higgs phase
- (c) Projective space $\mathbb{C}P^{N_f-1}$ and Grassmannian manifold $Gr_{N_f, N}(\mathbb{C})$
 - i. Patches, transition functions and Kähler trf.
 - ii. Fubini-Study metric for $\mathcal{M} = \mathbb{C}P^{N_f-1}$
 - iii. Baryonic fields B and Plücker relations
 - iv. Kähler potential $K(B, B^\dagger)$
 - v. Duality between $U(N)$ and $U(N_f - N)$
- (d) Target space \mathcal{M} for $G = SO(N), USp(2N)$
 - i. 'Meson' M as the $G^{\mathbb{C}}$ invariant
 - ii. Kähler potential $K(M, M^\dagger)$

Lecture IV: BPS domainwalls in $U(N)$ gauge Higgs theory

- (a) Discrete vacua with non-degenerate mass terms
- (b) Bogomol'nyi bound, BPS equations and Killing spinors
- (c) The moduli matrix and the master equation
 - i. All exact solutions at the strong coupling limit
 - ii. Complexified gauge trf.(V -trf)
 - iii. $Gr_{N_f, N}(\mathbb{C})$ as a moduli space for BPS domainwalls
- (d) Examples for $U(1)$
 - i. Center of mass as a Goldstone mode
 - ii. Single wall solution
 - iii. Position moduli for a multi-wall solution in $\mathbb{C}P^{N_f-1}$
 - iv. Topological sector and cell decomposition of $\mathbb{C}P^{N_f-1}$
- (e) Example for $U(N)$
 - i. patches for the manifold $Gr_{N_f, N}(\mathbb{C})$
 - ii. walls for $Gr_{3,1}$ $Gr_{4,2}$
 - iii. domainwall solutions and string theory perspective

Lecture V: BPS vortices

- (a) A vacuum and BPS equations
- (b) The moduli matrix and constraints on the $G^{\mathbb{C}}$ invariant
- (c) Semilocal vortex for $G = U(1)$ and lump in NL σ M on $\mathbb{C}P^{N_f-1}$
 - i. $\pi_2[\mathcal{M}]$ and lump solutions
 - ii. scale moduli and small lump singularity
- (d) Vortex moduli space \mathcal{M}_v for $G = U(N)$
 - i. Fixing V -trf and coordinate patches of \mathcal{M}_v
 - ii. Transition functions
- (e) Local vortex for $G = U(N), N_f = N$
 - i. Positions of vortices
 - ii. orientational moduli $\mathbb{C}P^{N-1}$ as Goldstone modes
- (f) Vortices (lumps) for $G = U(1) \times SO(N)$
 - i. Local vortex with a strong condition and orientational moduli
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Lecture VI: Vortex moduli space and string theory perspective

- (a) Hannany-Tong model from string theory perspective
 - i. D -term condition and a moduli space \mathcal{M}'_v
- (b) Kähler quotient construction of the vortex moduli space
 - i. half-ADHM relation
 - ii. Topological isomorphism between \mathcal{M}_v and \mathcal{M}'_v
 - iii. Axially symmetric vortex and Young tableau

Lecture VII: Composite solitons as 1/4 BPS states

- (a) Composite solitons in 5D
 - i. BPS equations and instanton charge
 - ii. Moduli matrix
 - iii. Intersection of vortices
 - iv. Instantons in a vortex
- (b) Composite solitons in 4D with non-degenerate mass terms
 - i. BPS equations and monopole charge
 - ii. Moduli matrix
 - iii. Junctions of walls and vortices
 - iv. Monopoles in a vortex

Lecture VIII: Formula for effective actions on Solitons

- (a) Mass gap, higher derivative expansion and an effective action
- (b) Effective action on BPS domainwalls
 - i. Effective action formula in superspace
 - ii. Exact examples with the strong coupling limit
- (c) Effective action on BPS vortices
 - i. Effective action formula in superspace
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 - iv. Effective action for a well separated vortices