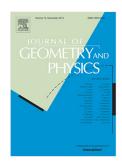
# **Accepted Manuscript**

Degenerate, strong and stable Yang-Mills-Higgs pairs

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# ACCEPTED MANUSCRIPT

### DEGENERATE, STRONG AND STABLE YANG-MILLS-HIGGS PAIRS

#### ZHI HU & PENGFEI HUANG

ABSTRACT. In this paper, we introduce some notions on the Hitchin pair consisting of a Chern connection and a Higgs field closely related to the first and second variation of Yang-Mills-Higgs functional, such as degenerate Hitchin pair, (strong) Yang-Mills-Higgs pair, stable Yang-Mills-Higgs pair. We investigate some properties of such pairs under the various contexts.

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#### 1. INTRODUCTION

Since 1950s, Yang-Mills theory first explored by several physicists had a profound impact on the developments of differential and algebraic geometry. A remarkable fruit owed to Donaldson is constructing invariants of 4-manifolds via studying the homology of the moduli space of anti-self-dual SU(2)-connections, where technical challenges come from Uhlenbeck compactification of moduli space and handling singularities through the metric perturbations[1, 2]. In 1987 Hitchin considered the 2-dimensional reduction of the self-dual Yang-Mills equations on  $\mathbb{R}^4$  as a manner of symmetry breaking, then he introduced a (1,0)-form  $\phi$  (valued in complex adjoint vector bundle), called the Higgs field for the Riemann surface, which is described by the so-called Hitchin self-duality equations[3]:

$$F_A + [\phi, \overline{\phi}] = 0,$$
  
 $d''_A \phi = 0.$ 

Influenced by Hitchin's work, Simpson generalized the conception of Higgs field to the higher dimensional case[4], and he made great innovations in various areas of algebraic geometry [5, 6, 7]. Since then Higgs bundles have emerged in the last two decades as a central object of study in geometry, with several links to physics and number theory.

Let us first recall some basic definitions.

**Definition 1.1.** ([8, 9, 10]) Let X be an n-dimensional compact Kähler manifold with Kähler form  $\omega$ , and let  $\Omega_X^1$  be the the sheaf of holomorphic 1-forms on X. A Higgs sheaf over X is a coherent sheaf E of dimension n over X, together with a morphism  $\phi : E \to E \otimes \Omega_X^1$  of  $\mathcal{O}_X$ -modules (that is usually called the Higgs field), such that the morphism  $\phi \wedge \phi : E \to E \otimes \Omega_X^2$  vanishes. A Higgs bundle is a locally-free Higgs sheaf. A subsheaf F of E is called the Higgs subsheaf if  $\phi(F) \subset F \otimes \Omega_X^1$ , i.e. the pair  $F = (F, \phi|_F)$  becomes itself a Higgs sheaf. Let  $(E_1, \phi_1)$  and  $(E_2, \phi_2)$  be two Higgs sheaves over X. A morphism between them is a map  $E_1 \to E_2$  such that the following diagram commutes

$$E_1 \xrightarrow{\phi_1} E_1 \otimes \Omega^1_X$$

$$f \downarrow \qquad f \otimes 1 \downarrow$$

$$E_2 \xrightarrow{\phi_2} E_2 \otimes \Omega^1_X.$$

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