A heterotic G_2 system is, by definition, the quadruple

$$[(Y, \varphi), (V, A), (TY, \Theta), H]$$

where φ is an integrable G_2 structure on a 7-dimensional manifold Y, V is a gauge bundle with instanton connection A, Θ is a connection on the tangent bundle TY of Y which is also an instanton, and H is a three form defined by the anomaly cancellation condition $H = \mathcal{D}B + \frac{\alpha'}{4}(\mathcal{CS}(A) - \mathcal{CS}(\Theta))$. In string theory, such systems solve the Killing spinor equations and Bianchi identity of the heterotic string, provided that the three-form H equals the torsion of the G_2 structure. As such, they provide an interesting class of effectively 3 dimensional supergravity theories, which are largely determined by the geometry of the compactification. It is a goal in physics to determine this effective field theory.

In this talk, I will discuss the mathematical structure of heterotic G_2 systems. We will see that the heterotic G_2 systems can be rephrased in terms of a differential $\check{\mathcal{D}}$ acting on a complex $\check{\Omega}^*(Y, \mathcal{Q})$, where $\mathcal{Q} = T^*Y \oplus \mathrm{End}(TY) \oplus \mathrm{End}(V)$ and $\check{\mathcal{D}}$ is an appropriate projection of an exterior covariant derivative $\mathcal{D}$ which satisfies an instanton condition. The infinitesimal moduli are further parametrised by the first cohomology $H^1_{\check{\mathcal{D}}}(Y, \mathcal{Q})$. Finally, I will present a superpotential whose critical loci correspond to heterotic G_2 systems.

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