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Spaces of flat connections

Given a manifold M and a homomorphism from $\pi_1(M)$ into a Lie group G, one has an associated flat principal bundle over M. The space of flat connections on this bundle measures the failure of this construction to be an equivalence: more precisely, this space is the homotopy fiber of the map taking a homomorphism to the classifying map for its associated bundle.

In this talk, I'll survey results (some joint with T. Baird, and some due to my student A. Davis) on the homotopy type of spaces of flat connections, contrasting the case of surfaces (where Morse Theory for the Yang-Mills functional allows one to analyze flat connections directly) with the situation for higher-dimensional manifolds. In higher dimensions, rational cohomology of M and information about irreducible representations of $\pi_1 M$ can each be leveraged to produce topological information about flat connections.

Time permitting, I'll discuss some ideas for analyzing these phenomena at higher energy (that is, for connections on which the Yang-Mills functional is non-zero), based on work of Atiyah-Bott and Morrison.