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Toric geometry of moduli spaces of principal bundles on a curve.

For C a smooth projective curve, and G a simple, simply connected complex group, let $M_C(G)$ be the moduli space of semistable $G-$principal bundles on C. As the curve C moves in the moduli $\mathcal{M}_g$ of smooth curves, the spaces $M_C(G)$ are known to define a flat family of schemes, and this family can be extended to the Deligne-Mumford compactification $\bar{\mathcal{M}}_g$. We describe the geometry of the fibers of this family which appear at the stable boundary, in particular we discuss a recent result which shows that the fibers over maximally singular curves contain an important and ubiquitous moduli space, the free group character variety $\mathcal{X}(F_g, G)$, as a dense, open subspace. The latter is a moduli space of representations of the free group F_g in G, and naturally appears as an object of interest in Teichmüller theory, the theory of geometric structures, and the theory of Higgs bundles. For $G = SL_2(\mathbb{C})$ and $SL_3(\mathbb{C})$ we describe maximal rank valuations on the coordinate rings of these spaces, and how the associated Newton-Okounkov polyhedra can be used to study the geometry of both $\mathcal{X}(F_g, G)$ and $M_C(G)$.