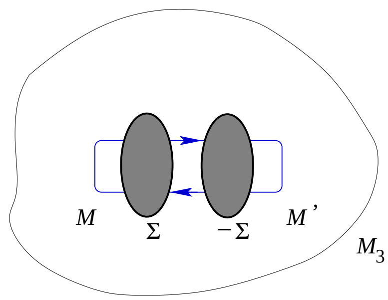

Figure 1. A Heegaard splitting of a three-manifold M_3. The three-manifold is cut along a Riemann surface Σ into two three-manifolds M and M', whose boundaries are identified by an orientation reversing homeomorphism as $\Sigma = \partial M$, $-\Sigma = \partial M'$. The closed curve represents a Wilson loop in the bulk.

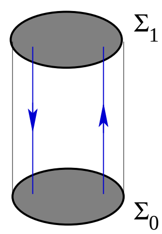

Figure 2. The three-manifold $M_3 = \Sigma \times [0,1]$. The Wilson lines propagate between the two boundaries Σ_0 and Σ_1, which are each copies of Σ but carry opposite orientations.

consisting of the Einstein-Hilbert and gravitational Chern-Simons actions in three dimensions, which will have the effect of inducing two-dimensional quantum gravity on the boundary Σ [12,13]. A further conformal coupling to a three-dimensional scalar field theory will then produce the dilaton field [14], and hence the string coupling g_s. Finally, minimal couplings of the gauge theory to charged matter fields in the bulk will yield deformations of the induced conformal field theory [15] enabling us to construct vertex operators and, ultimately, states corresponding to D-branes [16].

Let us conclude this introduction with some of the primary motivations for rewriting string theory this way in terms of topological membranes:

(1) Many aspects of string dynamics have natural interpretations in terms of the dynamics of gauge and gravitational fields in the bulk.
(2) Various algebraic properties of two-dimensional conformal field theories can be understood geometrically and dynamically in the three-dimensional picture. In this sense, important dynamical effects are responsible for fundamental properties of the induced conformal field theory. This yields new dynamical perspectives on string construc-