Teichmüller TQFT, Complex Chern-Simons Theory and Duality

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Abstract: Teichmüller TQFT is a unitary 3d topological theory whose Hilbert spaces are spanned by Liouville conformal blocks. It is related but not identical to SL(2,R) Chern-Simons theory. It appears on the TQFT side of the 3d-3d correspondence for the squashed three-sphere. I will show that Teichmüller TQFT can be defined by an analytically-continued Chern-Simons path-integral over an unusual integration cycle. On a hyperbolic three-manifold, this cycle is the Lefschetz thimble for the conjugate geometric PSL(2) flat connection. Mathematically, this proposal translates a known conjecture by Andersen and Kashaev into a statement about the Kapustin-Witten equations. I will further show that Teichmüller TQFT is related by non-perturbative dualities to two different complex SL(2,C) Chern-Simons theories at integer levels k = 1 or k = -1. One of these theories was previously found by Cordova and Jafferis. I will identify the integration cycle in one of these complex Chern-Simons theories and will show, how in the semiclassical limit one can reproduce the round three-sphere partition function in the 3d SCFT labeled by the three-manifold.