

# Wall-Crossing, Quiver Invariants, and Index for $d=1$ GLSM

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Witten index of  $d=1$   $N=2,4$  supersymmetric gauged quantum mechanics is considered. A canonical set of examples is the  $N=4$  quiver dynamics, well-known to capture wall-crossing behaviors of BPS states of  $d=4$   $N=2$  theories. Such wall-crossing behaviors, as we change FI constants continuously, is in fact generic for these supersymmetric theories.

For  $N=4$  quivers, index were traditionally computed either by Coulomb or Higgs approximations. However, this is neither the most efficient nor the most complete computation. The Coulomb one in particular is known to miss a large number of wall-crossing-safe states, known as quiver invariants. After outlining recent progress on this front, we turn to honest and complete Witten index computation via localization.

While the naive localization argument seems to preclude wall-crossing behavior, this is merely due to neglecting important subtleties with new flat or runaway asymptotic direction that emerges when some of FI constant vanishes. After taking account of this subtlety, one arrives at universal index formula, via JK residue, determined entirely by field contents and R-charge assignment, which reproduces most up-to-date results in literature, also reproducing many wall-crossing formulae. We close with diverse examples, and illustrate how invariant  $d=2$  indices and wall-crossing  $d=1$  indices should be related. Also, we comment on the wall-crossing-safe subsector of  $d=1$  GLSM, analogous to the quiver invariants, and propose how this invariant subsector might be counted again as a path integral.

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