Tunneling at $\nu_T = 1$ in a bilayer quantum Hall exciton condensate

D. NANDI, T. KHAIRE, A.D.K. FINCK, J.P. EISENSTEIN, California Institute of Technology, L.N. PFEIFFER, K.W. WEST, Princeton University — Closely-spaced bilayer quantum Hall systems at total filling factor $\nu_T = 1$ exhibit spontaneous interlayer phase coherence. This phase coherence, which is tantamount to excitonic Bose condensation, is most dramatically revealed via interlayer tunneling measurements. In the condensed phase the tunneling current-voltage ($IV$) characteristic of this semiconductor system strongly resembles the dc Josephson effect observed in superconducting tunnel junctions. Here we report on a detailed study of this phenomenon. We find the maximum, or critical tunneling current $I_c$ to be a well-defined global property of the macroscopic tunnel junction, insensitive to external circuit elements and the precise contact configuration used to observe it. Interestingly, the temperature dependence of $I_c$ displays an unexpected scaling behavior. At the lowest temperatures the slope of the “supercurrent” branch of the tunneling $IV$ curve, while extremely large, remains finite. Careful measurements in this regime suggest that dissipative processes arising from in-plane exciton transport limit the maximum tunneling conductance. Finally, comparisons of the experimentally observed $IV$ with recent theoretical predictions will be discussed.

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