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SUPPLEMENTARY INFORMATION

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Gate-induced superconductivity in atomically thin MoS_2 crystals

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Analysis of the *I-V* curves of superconducting 4L MoS_2 in terms of a Berezinskĭi-Kosterlitz-Thouless scenario.

The electrostatically induced superconducting state at the surface of an ionic-liquid gated MoS_2 transistor is expected to have a two-dimensional (2D) character, since the electrostatic screening length at a carrier density of 10^{14} cm^{-2} is approximately 1 nm[1]. According to the Mermin-Wagner theorem, in 2D systems, long-range order is suppressed by thermal fluctuations[2]; quasi-long-range ordering, however, can still occur. This quasi long-range ordering is characteristic of the Berezinskĭi-Kosterlitz-Thouless (BKT) mechanism for superconductivity, through which a coherent superconducting state occurs at a temperature T_{BKT}, lower than the mean-field critical temperature[3 4].

There are different experimental manifestations of the BKT regime that can be looked for in the experiments, to see whether the observed behavior is compatible with that expected for 2D superconductivity. A well-known aspect of the BKT transition is the occurrence of power-law *I-V* characteristics: $V \propto I^{\alpha}$ where $\alpha = 1$ for T well above T_{BKT}, $\alpha = 3$ for $T = T_{BKT}$, and $\alpha > 3$ for $T < T_{BKT}$ [5 6]. We have looked for such a behavior in the *I-V* curves measured in our devices. Fig. S1a shows the *I-V* characteristic of a 4L MoS_2 FET (in log-log scale) measured below the onset temperature of superconductivity. A linear regime is clearly visible, whose slope α (the exponent of the power law) increases upon lowering temperature, as expected. The exponent α is obtained from fits of the slope for each temperature (black lines in Fig. S1a), and plotted as a function of temperature in Fig. S1b. α increases with lowering T for temperatures well below the onset temperature, and $\alpha = 3$ at $T = 7.4$ K, providing a first estimate of T_{BKT}.

To confirm the BKT nature of the transition, we also looked at the temperature dependence of the resistance close to T_{BKT}. Theory predicts that $R = R_0\exp(-bt^{-1/2})$, in contrast to the power law dependence expected in the Ginzburg-Landau theory (R_0 and b are material dependent parameters, and $t = T/T_{BKT} - 1$)[5,6] . This functional dependence can be tested by checking that $[d(\ln R)/dT]^{-2/3}$ varies linearly with T above T_{BKT} , and that it extrapolates at 0 for $T = T_{BKT}$. The data, shown in Fig. S1c, indeed displays the expected behavior. By extrapolating to zero the linear part of $[d(\ln R)/dT]^{-2/3}$ we find that T_{BKT} =7.4 K, in good agreement with the previous estimation from the *I*-*V* characteristic. The analysis of our experimental data is thus compatible with the theoretical expectation for a 2D BKT superconducting transition.

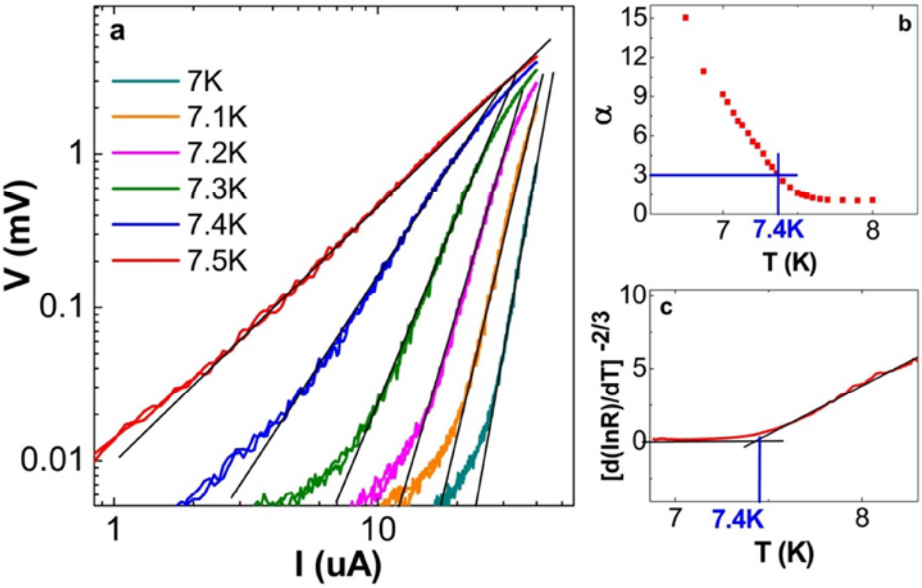

Fig. S1. Berenzinskiĭ-Kosterlitz-Thouless behavior in an ion-liquid gated 4L MoS_2 FET. **a.** Power-law dependence $V \propto I^{\alpha}$ of the *I*-*V* characteristics for different temperatures (below the onset of superconductivity) plotted in log-log scale. The solid black lines are best fits done to extract the exponent α. **b.** Temperature dependence of α. T_{BKT} corresponds to the value of T for which $\alpha = 3$, leading to $T_{BKT} = 7.4$ K. **c.** Linear behavior of $[d(\ln R)/dT]^{-2/3}$ as a function of temperature. The extrapolation to zero (black solid line) provides an independent estimate of T_{BKT}, which also gives 7.4 K, consistently with the analysis of *I*-*V* characteristics.

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