Supplementary material for "The two-dimensional disordered Mott metal-insulator transition"

M. Y. Suárez-Villagrán,[1] N. Mitsakos,[2] Tsung-Han Lee,[3] V. Dobrosavljević,[3] J. H. Miller, Jr.,[1] and E. Miranda[4]

[1] *Department of Physics and Texas Center for Superconductivity, University of Houston, Houston, Tx 77204-5002 USA*

[2] *Department of Mathematics, University of Houston, Houston, Tx 77204-5002 USA*

[3] *Department of Physics and National High Magnetic Field Laboratory, Florida State University, Tallahassee, Florida 32306, USA*

[4] *Gleb Wataghin Institute of Physics, University of Campinas (Unicamp), Rua Sérgio Buarque de Holanda, 777, CEP 13083-859, Campinas, Brazil*

I. SPATIAL PATTERNS OF THE MOTT TRANSITION FOR DIFFERENT TEMPERATURES

Here we show more extended data on the disordered Mott transition in the two-dimensional Hubbard model. We focus on $\mathrm{Im}G_i(\omega_1)$, the imaginary part of the local Green's function at the first Matsubara frequency, as a measure of metallic or insulating character of each site of the lattice. We obtain spatial maps of this quantity while scanning values of U spaced by $\Delta U = 0.008D$, from small to large values (metal to insulator) and from large to small (insulator to metal). The data are shown in Fig. 1 (from the metal to the insulator) and in Fig. 2 (from the insulator to the metal) for temperatures $T = 0.020D$, $T = 0.024D$, and $T = 0.028D$. The disorder strength was fixed at $W = 0.52D$ and $L = 20$. For each set, the direction of U-scanning is shown in the upper inset together with the bundle of hysteresis loops. The color scale is organized so that the largest values of $\mathrm{Im}G_i(\omega_1)$ correspond to red and the smallest values to blue.

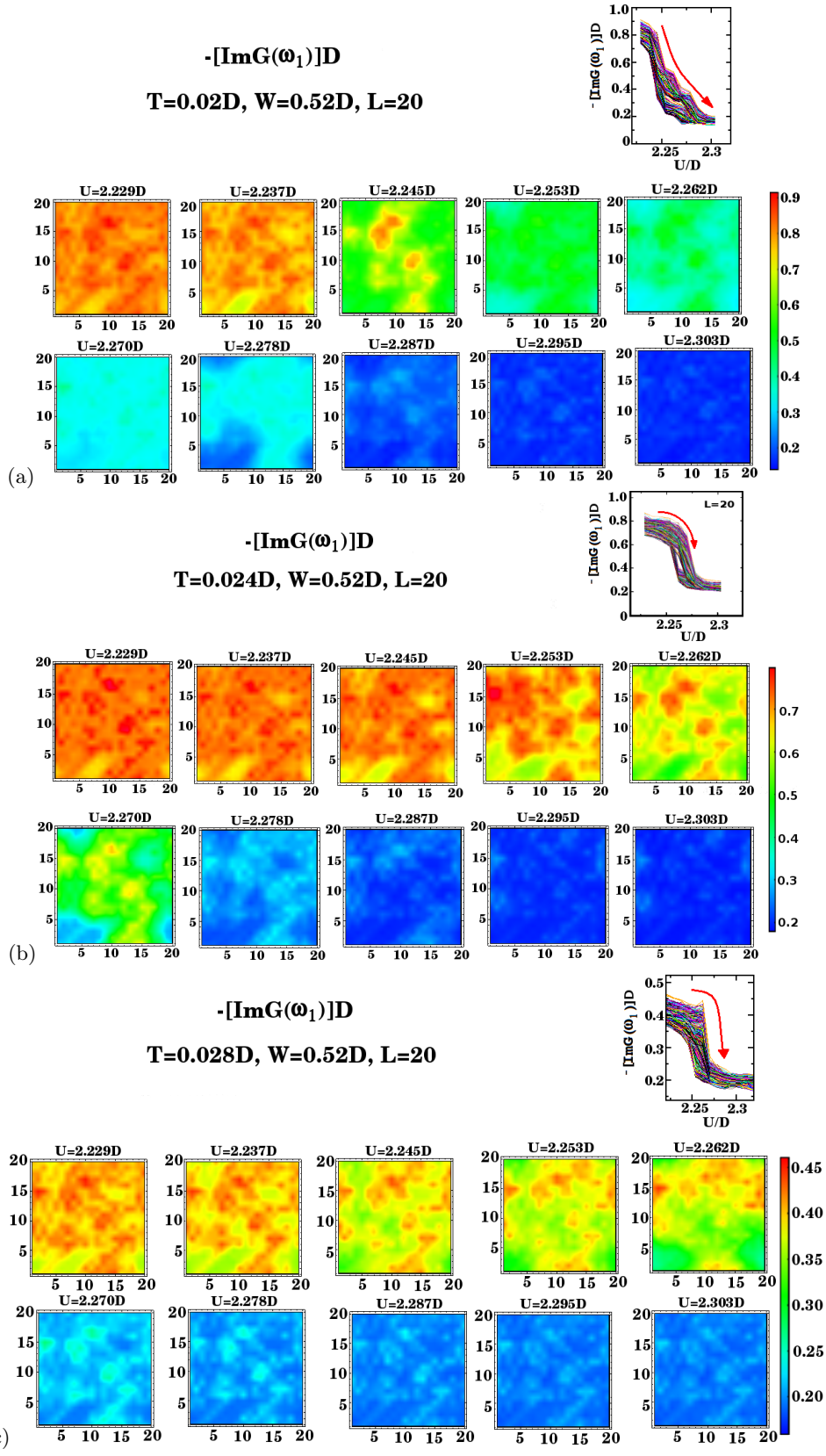

Figure 1. Imaginary part of the Green's function at the first Matsubara frequency $\mathrm{Im}G_i(\omega_1)$ for each site of the square lattice for (a) $T = 0.020D$, (b) $T = 0.024D$, and (c) $T = 0.028D$ scanning U values from the metal to the insulator. In each panel, the upper insets show the bundle of hysteresis loops.

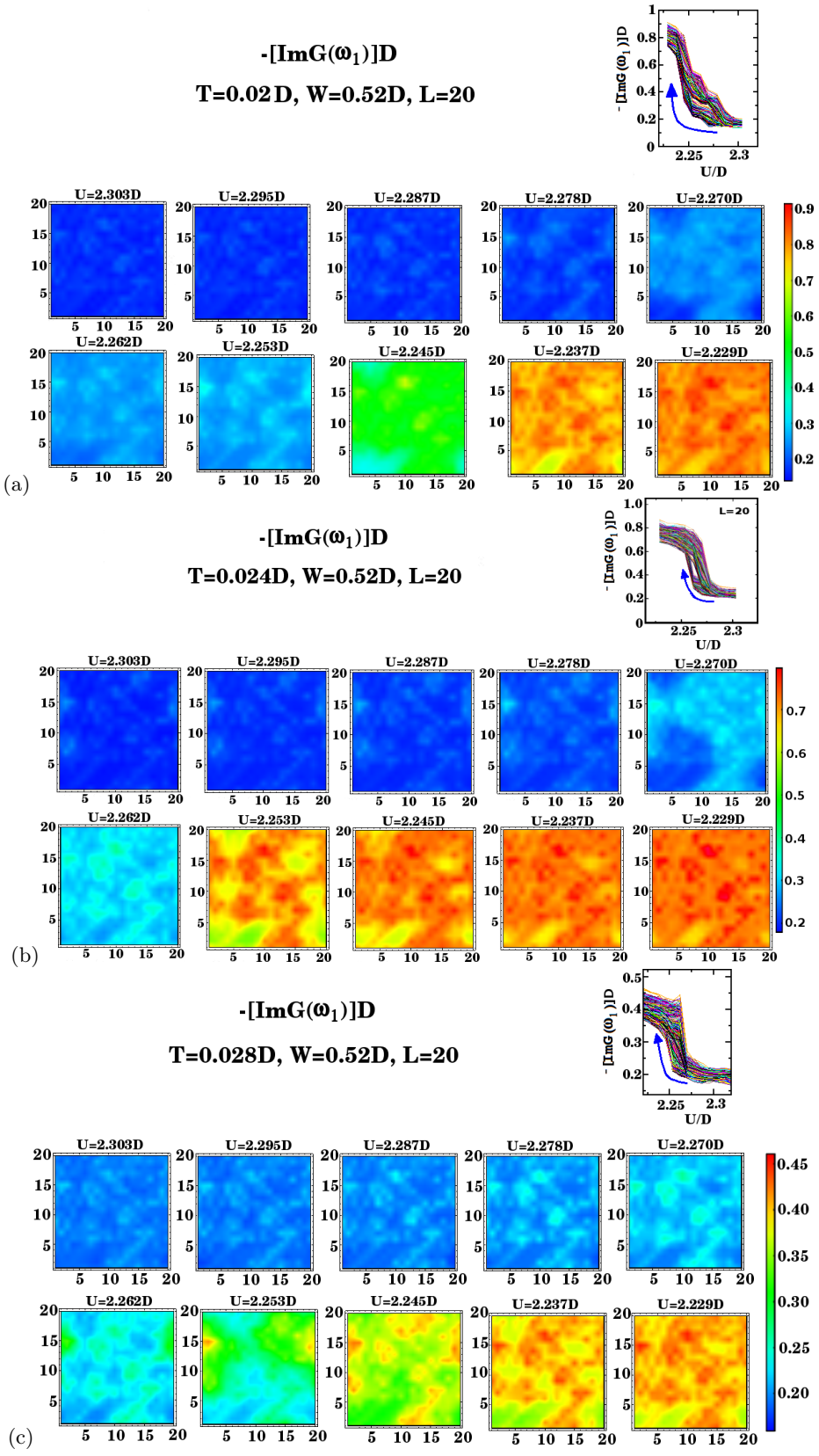

Figure 2. Imaginary part of the Green's function at the first Matsubara frequency $\mathrm{Im}G_i(\omega_1)$ for each site of the square lattice for (a) $T = 0.020D$, (b) $T = 0.024D$, and (c) $T = 0.028D$ scanning U values from the insulator to the metal. In each panel, the upper insets show the bundle of hysteresis loops.

II. FINITE-SIZE EFFECTS

Now we show in Fig. 3 the spatial pattern of $\mathrm{Im}G_i(i\omega_1)$ for $U = 2.27D$ and different temperatures, in the upper branch of the hysteresis loop (metal to insulator). Note how, as the lattice size increases, metallic "bubbles" persist at the same positions, but at the same time insulating "bubbles" gradually appear. In the thermodynamic limit we expect the proliferation of metallic and insulating regions and the complete smearing of the transition.

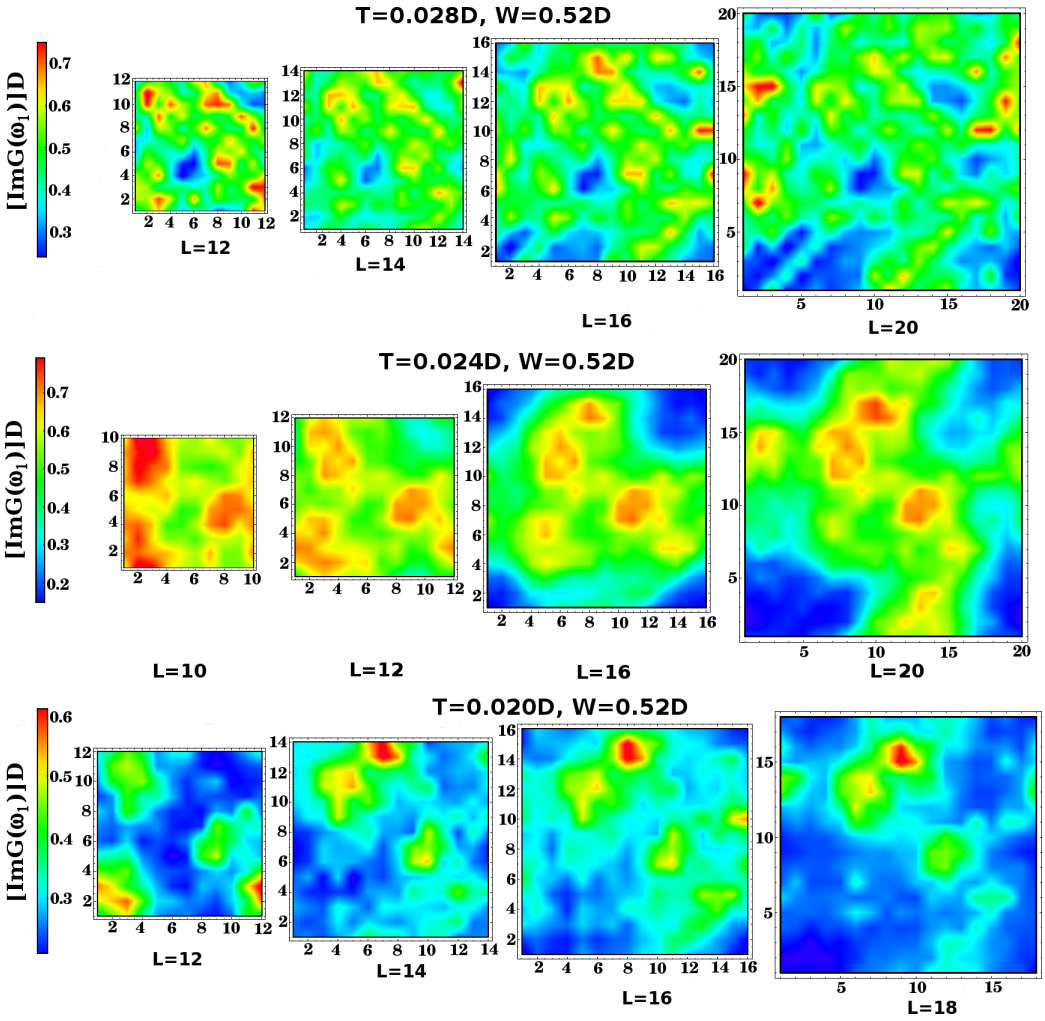

Figure 3. Spatial pattern of $\mathrm{Im}G_i(i\omega_1)$ for different lattice sizes and temperatures with $U = 2.27D$ in the upper branch of the hysteresis loop. Metallic and insulating bubbles coexist and proliferate as the lattice increases.

III. TRANSPORT IN THE LATTICE

Finally, we show the spatial pattern of the current for different temperatures and $W = 0.52D$ in the vicinity of the Mott transition The red color represents regions of larger currents and the blue color corresponds to smaller ones. We note that the current is not uniform in the system and has spatial fluctuations. However, its variations are mild and the overall values decrease with increasing U.

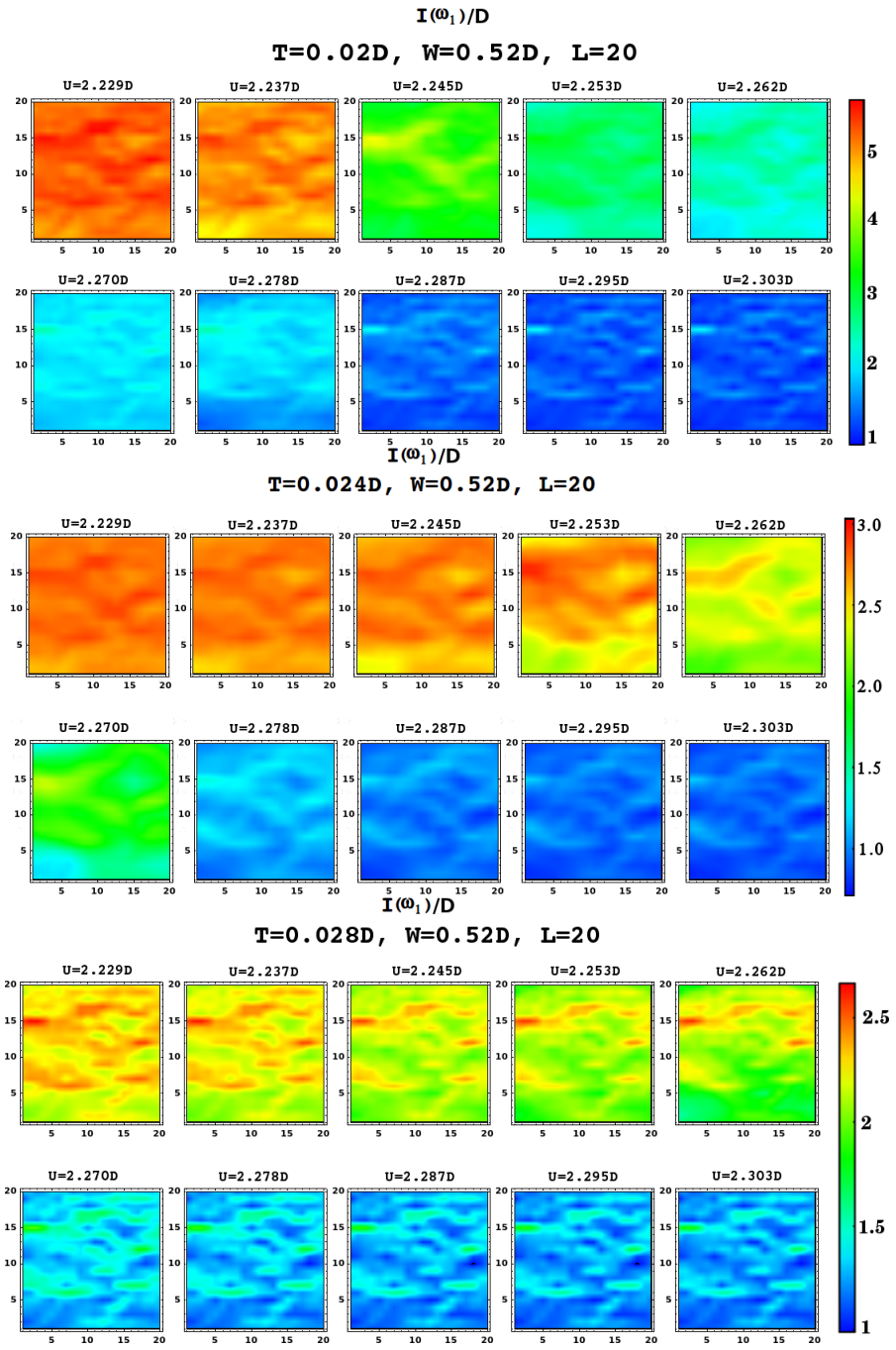

Figure 4. Spatial pattern of the current across the Mott transition for temperatures $T = 0.020D$, $T = 0.024D$, and $T = 0.028D$.

IV. LARGER DISORDER STRENGTH

Finally, we show similar data but for a larger value of disorder strength $W = 0.75D$, both for a steadily increasing value of U (from metal to insulator, Fig. 5) and for decreasing U values (from insulator to metal, Fig. 6). A first obvious feature is the shift of the finite-size transition to higher U-values. Also apparent is the decrease of the typical bubble size with the larger disorder strength, consistent with the Imry-Ma picture.

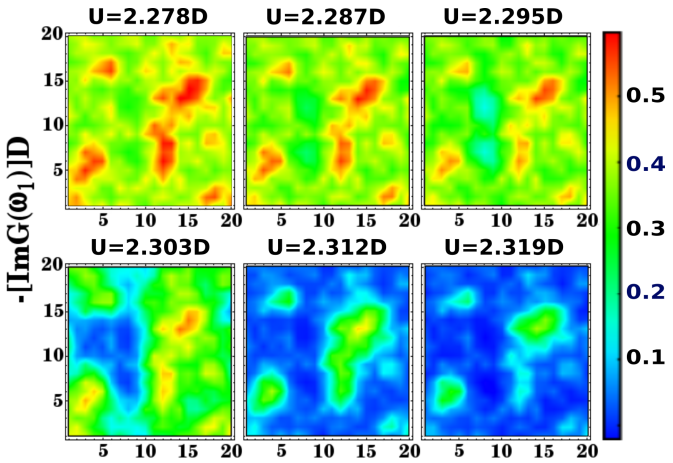

Figure 5. Imaginary part of the local Green's function at the first Matsubara frequency $\mathrm{Im}G_i(\omega_1)$ for each site of the square lattice for $T = 0.024D$, scanning U values from the metal to the insulator. The disorder strength was fixed at $W = 0.75D$ and $L = 20$.

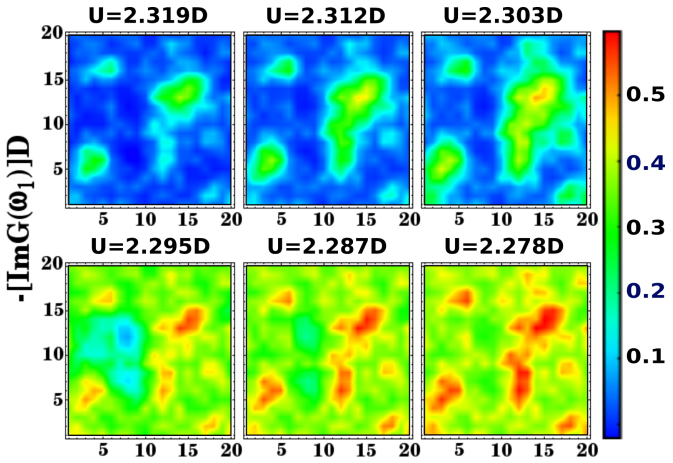

Figure 6. Imaginary part of the local Green's function at the first Matsubara frequency $\mathrm{Im}G_i(\omega_1)$ for each site of the square lattice for $T = 0.024D$, scanning U values from the insulator to the metal. The disorder strength was fixed at $W = 0.75D$ and $L = 20$.