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**Imaging studies of hole-electron asymmetry observed  
in a lightly-doped high- $T_c$  superconductor  $\text{Ca}_{2-x}\text{Na}_x\text{CuO}_2\text{Cl}_2$**

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We have reported spectroscopic imaging on the electronic state inter-  
vening between the Mott insulator and the  $d$ -wave superconductor [1].  
The electronic state with  $|E| < 100$  meV shows complex spatial modu-  
lations with  $4a_0 \times 4a_0$  ( $a_0$ : in-plane lattice constant) correlations. More-  
over, the tunneling spectra show characteristic hole-electron asymmetry,  
which is thought to be related to the approach of the Mott insulator [2].  
Here we report on new studies of imaging the 'Mottness' through map-  
ping the asymmetry in tunneling spectra associated with high energies  
 $|E| > 100$  meV. Spectroscopic mapping of the asymmetry reveals strong  
 $4a_0 \times 4a_0$  periodic modulation up to several hundreds meV. However  
the  $4a_0/3 \times 4a_0/3$  component, which appears in the Fourier transform  
of the checkerboard pattern observed at  $|E| < 100$  meV, is negligible.  
This spatial modulation of the 'Mottness' may indicate that hole den-  
sity is modulated with the  $4a_0 \times 4a_0$  periodicity. This would imply that  
the  $4a_0/3 \times 4a_0/3$  periodicity observed at lower energies may arise from  
umklapp scattering due to the hole density modulation. [1] T. Hanaguri  
*et al.*, Nature 430, 1001 (2004). [2] P. W. Anderson and N. P. Ong,  
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Prefer Oral Session  
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