Comparison of recent experimental STM data with single-impurity and many-impurity Bogoliubov-de Gennes calculations strongly suggests that out-of-plane dopant atoms in cuprates modulate the pair interaction on the atomic scale. This type of pairing disorder is crucial to understanding the nanoscale electronic structure inhomogeneity observed in the BSCCO 2212 system, and can reproduce observed correlations between the positions of impurity atoms and various aspects of the local density of states such as the gap magnitude and the height and weight of the coherence peaks. In addition, off-diagonal scattering of this type is shown to account for some heretofore unexplained aspects of Fourier Transform STM on these systems.

Fig. 1. Left: 90x90 Bogoliubov-de Gennes calculation of LDOS in d-wave superconductor with 7.5% out-of-plane O defects modeled by local enhancements of pair potential g with range 0.5a. Note highly particle-hole symmetric modulation of coherence peak positions, unlike results obtained with conventional Coulomb potential.

This type of analysis suggests (a) that the famous nanoscale inhomogeneity observed in many cuprates is a consequence of dopant disorder; and (b) the validity of a new approach to determining the pair interaction in these materials, by attempting to understand changes in local electronic structure and correlating them with measured changes in the superconducting gap.

References