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Fluctuating Cu-O-Cu Bond model of high temperature superconductivity in cuprates D.M. NEWNS, C.C. TSUEI, IBM T.J. Watson Research Center — Twenty years of research have yet to produce a consensus on the origin of high temperature superconductivity (HTS). However, several generic characteristics of cuprate superconductors have emerged as the essential ingredients of and/or constraints on any viable microscopic model of HTS. Besides a T_c of order 100 K, they include a d-wave superconducting (SC) gap with Fermi liquid nodal excitations, a pseudogap with d-symmetry and the characteristic temperature scale T^*, an anomalous doping-dependent oxygen isotope shift, nanometer-scale gap inhomogeneity, etc.. The isotope shift implies a key role for oxygen vibrations, but conventional BCS single-phonon coupling is essentially forbidden by symmetry and by the on-site Coulomb interaction U. Hence the present work invokes nonlinear coupling of planar oxygen vibrations to the Cu-Cu hopping integral t. A dominant Fluctuating Bond field emerges involving oxygen vibrational square amplitudes - and associated Cu-Cu t's - in a pattern of quadrupolar symmetry around a given Cu site. Such fluctuations in Cu-Cu bonds mediate d-wave pairing, leading to a d-wave SC gap, and an explanation of the anomalous isotope shift. A quadrupolar CDW generates a d-wave pseudogap related to T^*. Other salient features of HTS are also explained by our model. This work is to appear in Nature Physics.

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