Fluctuations, mean-field $T_c$ and energy gaps in cuprate superconductors  

JEFFERY TALLON, Industrial Research Ltd, JAMES STOREY, Victoria University of Wellington, JOHN LORAM, Cambridge University — We have carried out an analysis of Gaussian fluctuations about $T_c$ in the specific heat of (Y,Ca)Ba$_2$Cu$_3$O$_{7-x}$ and Bi$_2$Sr$_2$CaCu$_2$O$_{8+δ}$. The analysis employs a full ARPES derived dispersion, including the pseudogap. This enables us to calculate the doping dependence of the mean-field transition temperatures, $T_{c}^{mf}$, in the absence of fluctuations. The values lie well above $T_c$ especially for lower doping where $T_{c}^{mf}$ is trending towards 180K. As a result, while the observed $T_c$ follows the well-known parabolic doping dependence, the values of $T_{c}^{mf}$ decrease monotonically with doping along with the superconducting gap parameter, $\Delta_0$, such that $2\Delta_0/k_BT_c = 5$. Using this result we offer explanations for a number of anomalous observations. The line $T_{c}^{mf}(p)$ should not however be confused with the $T^*(p)$ line which is associated with the pseudogap and falls abruptly to zero at critical doping ($p_{crit}=0.19$ holes/Cu).