Phase diagram of the one dimensional Hubbard-Holstein Model at $1/2$ and $1/4$ filling$^{1}$ RAHUL HARDIKAR, TORSTEN CLAY, Mississippi State University — We present a detailed study of the phase diagram of the Hubbard Holstein model at $1/2$ filling and $1/4$ filling, including finite-frequency quantum phonons within the numerically exact Stochastic Series Expansion quantum Monte Carlo method. In one dimension at $1/2$ filling, the electron-phonon (e-ph) coupling gives a Peierls charge density wave, while Hubbard onsite $U$ promotes antiferromagnetic correlations and a Mott insulating state. Our previous study revealed a third Intermediate phase when the electron-electron and e-ph interaction are closely balanced. We show here from direct calculations of charge and spin susceptibilities that (i) as the e-ph coupling strength is increased first a spin gap transition and then the Peierls transition occurs, (ii) transitions between Mott/Intermediate and Intermediate/Peierls states are of the Kosterlitz-Thouless type, (iii) for large $U$, the two transitions merge into a single first order transition. Our data is consistent with a renormalization of the Luttinger Liquid exponent $K_{\rho}$, which gives a slightly larger intermediate region as determined from susceptibilities than in previous calculations of $K_{\rho}$. At $1/4$ filling we find a very similar phase diagram.

$^{1}$Supported by the American Chemical Society (Petroleum Research Fund) and DOE

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Date submitted: 17 Nov 2006

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