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Finite size scaling study of a two parameter percolation model: Constant and correlated growth

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***Highlights (for review)**

The present manuscript represents a new percolation model of enhanced parameter space with simultaneous growth of multiple clusters. In this model, two tunable parameters are the initial seed concentration ρ and the cluster growth parameter $\mathtt{g}$. Two different growth probabilities, uniform time independent constant growth probability and cluster size dependent dynamic growth probability for the cluster growth lead to constant growth and correlated growth models respectively. It is found that for each ρ there exists a critical growth probability $\mathtt{g}_{c}$ at which a percolation transition occurs. The influence of the partial hindrance or steric repulsion in the growth of a cluster due to the presence of other clusters in the constant growth process is found to be inadequate to change the values of the critical exponents from that of the OP. On the other hand, in the correlated growth model suppression of the growth of larger clusters seems to have a weak effect on the critical properties. The values of the critical exponents found to deviate from those of the OP in the dilute limit of $\rho(<0.2)$ and the model is found to belong in new universality classes. However, such an effect is not found to be strong enough to change the order of transition apart from the fact that the cluster size distribution develops curvature and the order parameter distribution broadens in the limit $\rho\to 0$. The FSS theory proposed here is found to be well satisfied by the critical exponents obtained in these models. The broadening of the order parameter distribution in the correlated growth model in the dilute limit of ρ indicates a possibility of obtaining a bimodal distribution of the order parameter under stronger suppression of the growth of the larger clusters corresponding to a first-order transition. A tricritical point as well may exists in the enhanced parameter space.