Aging Through Hierarchical Coalescence in the East Model

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We rigorously analyze the low temperature non-equilibrium dynamics of the East model, a special example of a one dimensional oriented kinetically constrained particle model, when the initial distribution is different from the reversible one and for times much smaller than the global relaxation time. This setting has been intensively studied in the physics literature to analyze the slow dynamics which follows a sudden quench from the liquid to the glass phase. In the limit of zero temperature (i.e. a vanishing density of vacancies) and for initial distributions such that the vacancies form a renewal process, we prove that the density of vacancies, the persistence function and the two-time autocorrelation function behave as staircase functions with several plateaux. Furthermore the two-time autocorrelation function displays an aging behavior. We also provide a sharp description of the statistics of the domain length as a function of time, a domain being the interval between two consecutive vacancies. When the initial renewal process has finite mean, our results confirm (and generalize) previous findings of the physicists for the restricted case of a product Bernoulli measure. However we show that a different behavior appears when the initial domain distribution is in the attraction domain of a α-stable law. All the above results actually follow from a more general result which says that the low temperature dynamics of the East model is very well described by that of a certain hierarchical coalescence process, a probabilistic object which plays an important role in several models of non-equilibrium coarsening dynamics of one-dimensional systems.