Coarsening exponents from a coarsening-length kinetics: Applications to Cahn-Hilliard and Bales-Gooding dynamics

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After a temperature quench to below transition, order parameter (OP) domains get coarser with time, with an increasing coarsening length L(t) ~ t^*a* [so the inverse length or *coarsening curvature* falls as g(t) = 1/L(t) ~1/ t^*a*]. Two-point OP-OP correlations exhibit *dynamical scaling*, C(R,t) = G(R/ L(t)) = G(g(t) R). The exponent *a*, in sequential time windows, can take on different universal values.

For temperature quenches below a first-order structural transition, we numerically study the evolution of the *strain* order parameter, governed by a 'Bales-Gooding' or under-damped, momentum-conserving dynamics [1]. We find that dynamical scaling is obeyed, with exponents like *a* =2/3 and 1/2 for early and late times, independent of spatial dimension *d*. To understand this, a nonlinear *curvature kinetics* for g(t) is approximately derived from the Bales-Gooding correlation dynamics, with time-window power-law solutions g(t) ~ 1/ t^*a* , and exponents matching the numerics [2].

Applying this approach to the well-known Cahn-Hilliard number-conserving dynamics and a second-order transition, predicts that *a* = 1/4 and 1/3 for early and late times, for scalar OP; while *a* = 1/4 for all times, for all vector OP; and for all *d* [2]. This is in agreement with the literature, suggesting the curvature kinetics approach might be useful in understanding exponents of other coarsening dynamics.

[1} GS Bales and RJ Gooding , PRL **67**, 3412 (1991); T Lookman, SR Shenoy, KO Rasmussen, A Saxena and AR Bishop, PRB **67**, 024114 (2003).

[2] N Shankaraiah, AK Dubey, S Puri and SR Shenoy, PRB **94**, 224101 (2016).