Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Prediction of scalar gradient distributions under stretching and random aggregation processes: application to mixing in turbulent and porous media flows TANGUY LE BORGNE, University of Rennes 1, France, PETER HUCK, Aix Marseille University, France, MARCO DENTZ, CSIC Barcelona, Spain, EMMANUEL VILLERMAUX, Aix Marseille University, France — Scalar gradients play a key role in controlling mixing and reaction processes in natural and industrial flow systems. The stretching action of flow fields naturally organizes scalar fields into lamellar structures, whose elongation and aggregation determine the evolution of concentration distributions. In this context, the prediction of scalar gradient distributions requires quantifying the spatial correlation of concentration fields. For general stretching and aggregation processes, we derive theoretical predictions of the temporal evolution of the concentration increment PDFs over any spatial increments. This framework is shown to provide accurate predictions of concentration gradient distributions for a range of flow systems, including turbulent and porous media flows. In particular, the theory links intermittent scalar field properties to their random additive nature and consequent spatial organization. We argue that the analysis of the distribution of concentration increments over different spatial increments may be considered as a deconstruction of the basic lamella assemblage, revealing the elementary structures building concentration distributions in heterogeneous flows.

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Date submitted: 31 Jul 2014 Electronic form version 1.4