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Selecting suitable smoothing factors for First-Order Reversal Curve distributions

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The recent development of First-Order Reversal Curve (FORC) diagrams has allowed the detailed investigation of coercivity spectra, interactions, and domain states of fine particle magnetic systems. However, calculation of a FORC distribution from the measured magnetisation data using a second order trend surface fitted in a piecewise manner can be a time consuming task and it is not yet clear what criteria are suitable for selecting the level of smoothing that should be applied to the data.

To provide a quantitative measure of the deviation of a smoothed FORC diagram from the measured magnetisation data we present a simple method that allows reconstruction of the smoothed FORCs and an assessment of the signal-to-noise ratio of the data. A methodology based on the spatial autocorrelation of the residuals obtained from the fitting procedure is employed to determine the level of smoothing which can be performed before the smoothing process distorts the representation of the FORC distribution. In numerical tests this method appears to be highly effective in selecting smoothing levels that remove a substantial proportion of the noise contribution from the data without unduly affecting the form of the FORC distribution. Examples of the method will be shown for a number of natural materials demonstrating the strong effect smoothing can have on the FORC distributions of certain samples. Finally, a statistical criterion will be introduced that provides an objective determination of the optimum smoothing factor for a given FORC data set.