Calculation of transport coefficient profiles in modulation experiments as an inverse problem

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The calculation of transport profiles from experimental measurements belongs in the category of inverse problems which are known to come with issues of ill-conditioning or singularity. A reformulation of the calculation, the matricial approach, is proposed for periodically modulated perturbative experiments, within the context of the standard advection-diffusion model. We show that this algorithm allows computing transport coefficients from the trivial inversion of a 2×2 matrix, function of the measured signal. This is done by a controllable smoothing of the experimental data, instead of the ad hoc regularization of the profile of transport coefficients operated by transport codes. This sheds light on the accuracy of calculations with transport codes, and provides a path for a more precise assessment of the profiles and of the related uncertainty. Error bars can thus be added to the computed coefficients, depending only upon measurement errors, and not also to additional arbitrary assumptions, such as the choice of the class of trial profiles for the same coefficients. In particular, we show that estimating transport coefficients can fail at specific radii. This is related to the vanishing of the determinant of the same matrix, and physically, it amounts to a lack of sufficient information from the experiment to resolve simultaneously both coefficients.