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*Abstract: Singular SDEs with critical distributional drifts: sharp solvability and blow ups*

This is a joint work with Damir Kinzebulatov. We establish weak well-posedness and construct strong Markov family of solutions for SDEs with some discontinuous diffusion coefficients and general critical distributional drifts satisfying minimal assumptions, i.e. we only require well-posedness of Cauchy problem for the Kolmogorov backward equation in  $L^2$ . By a result of Mazya and Verbitsky, these are precisely those drifts that can be represented as the sum of a form-bounded drift (containing e.g. Hardy or Morrey class drifts) and a divergence-free distributional drift in the  $BMO^{-1}$  space of Koch and Tataru.

We test our results for SDEs against particle systems with strong attracting interactions of Keller-Segel type immersed in a flow with velocity field in  $BMO^{-1}$ . Importantly, in dimensions  $d \geq 3$ , we cover most of the interval of admissible strength of attraction between the particles going almost up to the blow up thresholds.