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A fast high-order solver for the Grad-Shafranov equation ANDRAS PATAKI, ANTOINE CERFON, NYU CIMS, JEFFREY FREIDBERG, MIT PSFC, LESLIE GREENGARD, NYU CIMS — We present a new fast solver to calculate highly accurate fixed-boundary plasma equilibria in toroidally axisymmetric geometries. By combining conformal mapping methods with Fourier and integral equation methods in the unit disk, we show that high-order accuracy can be achieved for the solution of the Grad-Shafranov equation and its first and second derivatives. Smooth arbitrary plasma cross-sections as well as arbitrary pressure and poloidal current profiles can be given as inputs to the solver. Equilibria with large Shafranov shifts and steep pressure pedestals are computed without difficulty. Spectral convergence is demonstrated by comparing the numerical solution with a known exact analytic solution. For ITER-like and NSTX-like equilibria, we typically achieve 10+ digit accuracy for the solution and its derivatives in under a minute on a single CPU core on a 512 by 512 grid.

Antoine Cerfon
NYU CIMS

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