Real Space Formulation for AORSA3D

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The spectral code AORSAD3D is a valuable tool in understanding the energy conversion process of electromagnetic plasma waves in a hot plasma in fully three dimensional stellarator configurations. The spectral formulation leads to the solution of large, dense, complex linear systems. A problem using 34 by 34 by 64 Fourier modes produces system size of 221,952 (three complex equations for each mode) that requires 788Gbytes of memory. AORSA3D took over 358 min on 1936 power3 processors on the new Seaborg at NERSC.

We have implemented a new formulation in AORSA3D that transforms the linear system from the Fourier basis to a representation in the real configuration space. This alternate representation exposes new opportunities in reducing the overall number of equations used. In one example the number was reduced to 39,394, over a factor of five. The new reduced system requires about 26 Gytes of memory and completes in about 13.4 min, with a 100 fold speedup in linear solver and 27 fold speedup in overall runtime. The reduced system is small enough to be solved on a single 32-way power4 node instead of using 1936 power3 processors.

The efficiency gained from the real space formulation of AORSA3D allows higher resolution and more design analysis for the Quasi-Poloidal Stellarator (QPS) to be considered.