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The full abstract with figures can be found here:

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The text of the abstract is reproduced below:

HALO : A GPU code for calculating the non-linear evolution of fast particle driven eigenmodes in Tokamaks

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HALO (HAGIS-LOCUST) is a recently developed code for predicting the non-linear evolution of MHD eigenmodes driven unstable by fast particle populations in tokamaks. HALO is built on top of the LOCUST fast particle tracking code which exploits modern GPU technology to rapidly track the full gyromotion of millions of particles in realistic tokamak geometries. LOCUST has been used extensively to model heat loads on first wall components in various reactors, including components under the divertor dome on ITER [1]. Fig. 1 shows a LOCUST calculation of the heat load on in-vessel components due to residual gas-stripping in the MAST-U Double Beam Box. HALO leverages the high performance of LOCUST to calculate the non-linear response of a set of prescribed eigenmode fields to a given fast particle population. The code can deploy either guiding centre or gyro-orbit tracking and particles can be tracked outside the separatrix.

HALO exploits a perturbative approach, assuming that the eigenmode shapes are constant as the modes evolve. This is applicable to a large number of physically relevant scenarios, most notably TAEs. HALO tracks particles via solution of the Lorentz force law, calculates the work done by the particle population on the wave fields and then solves a complex ODE for each mode to determine the evolution of its amplitude and phase. HALO, like HAGIS, also exploits a delta-F scheme for noise reduction.

HALO has been validated using a near cylindrical geometry case with a single TAE and has been observed to conserve the invariant K=E-(omega/n)P to an accuracy of 1 part in 10**5. Growth rate comparisons with HAGIS show excellent agreement when HALO is run in 'drift order'mode as well as a disparity consistent with theory when full orbit effects are included. HALO also successfully reproduces the chirping behaviour expected when ad-hoc mode damping is included (Figure 3).

HALO is now starting to be used for realistic studies of TAE losses on JET in preparation for DTE2. Development work is ongoing and is currently focussed on further parallelisation of the code with MPI and coupling the code with MISHKA3 to allow studies with ion cyclotron modes as well as low frequency modes. Another key research goal is the incorporation of collisional effects which are presently absent.

[1] High fidelity simulations of fast ion power flux driven by 3D field perturbations on ITER, R. Akers et al., 26th IAEA Fusion Energy Conference - IAEA CN-234

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