Minutes of the Pre-Sherwood '03 NIMROD Team Meeting

Saturday, April 26, 1:00-6:00 PM
Aransas Room, 3rd Level, Omni Bayfront Hotel

Welcome and Overview (5 min)
I. Code development
I.A. Kinetic capabilities
I.A.1. CEL formulation and implementation status, Eric Held (30 min)

- Eric has relabeled the approach to "Integral Closure" instead of "CEL" to be more descriptive.
- Our USU contingent has implemented the closures for $q_{\|e}$, $q_{\|i}$, $\Pi_{\|e}$, and $\Pi_{\|i}$ based on the $\mathbf{v}_{\|}\cdot\nabla$-based ordering. This is more appropriate for $q_{\|e}$ than for the others (for example, the $\Pi_{\|e}$ closure will need a more accurate drift ordering to produce perturbed bootstrap current effects), but the completed development work will be needed for the more relevant orderings to come, anyway. The crew has learned that although the ion heat flow is smaller than the electron heat flow, the ion parallel heat flux computation does not truncate more rapidly than the electron heat flux computation.
- The present finite mod-B analytic computations do include collisional trapped effects that survive bounce averaging.
- Parallelization over the Fourier/toroidal direction is still needed.
- Eric has been rerunning Tom's last 86144 simulations at larger mesh resolution. The resolved cases show much more structure in parallel heat flux in the vicinity of the islands. The perturbations now appear as expected for exciting NTM growth, but none has been observed so far.
- The 86144 cases are being used to compare anisotropic heat conduction with the heat flow from the integral closure, which emphasizes the importance of the latter.

I.A.2. Minority ion formulation review and benchmark progress, Charlson Kim (30 min)

- Charlson has passed his defense, so congrats to Dr. Kim.
- Charlson briefly covered the formulation of the hot particle addition to single fluid MHD. There are several assumptions made along the way, and we will be able to go through the details in his dissertation.
- Double-counting of contributions to the trace of the hot particle stress tensor has been corrected.
- For the fishbone benchmark, the growth rate and oscillation frequency appear to be correct; however, computations are pretty noisy. The noise is under investigation.
- So far, computations scale okay up to 64 processors.

I.B. Fluid capabilities
I.B.1. Map and equilibrium field representation, Carl Sovinec (10 min)

- CS reported on changes to the mapping and equilibrium fields (using Lagrange polynomials instead of bicubic splines). The difficulty with overshoot in packed grids was explained. Lagrange polynomials can also produce overshoot if one packs side and interior nodes. The recommendation is to pack vertices and then distribute side and interior nodes evenly with curvature as needed.

I.B.2. AZTEC coupling, Carl Sovinec (5 min)

- The revised AZTEC coupling works, giving us the ability to solve nonsymmetric matrices. The native nimrod solver with global line Jacobi is still faster on the symmetric matrices of our typical production problems.

I.B.3. Implicit equilibrium flow advection formulation and test results, Carl Sovinec (15 min)

- A cylindrical tokamak with sheared poloidal equilibrium flow near the poloidal sound speed (similar to ET computations of the past but not yet in a torus) has been demonstrated to be stable with the existing predictor/corrector scheme. The increased semi-implicit coefficient recommended by Roberto Lionello is essential (along with near centering of the wave-like terms during prediction). [Dylan also reported 'no problem' with toroidal flow in 86166.]
- CS has analyzed and implemented an unsplit, centered, implicit advection scheme for equilibrium flow. It avoids a numerical stability restriction on time step, and a demo large Δt computation ($\Delta t > \tau_A$) was shown. However, the perturbed si matrix is now very ugly, and AZTEC would not provide a solution at the original mesh resolution, and the solver tolerance had to be relaxed to a large degree. Discussion with AZTEC-folk may help.
- Two versions of split equilibrium advection (one with an implicit solve, and the other with subcycled advection) have been implemented. Von Neumann says the scheme is stable, but NIMROD does not. More investigation is needed, since this split scheme may prove to be more economical.

I.B.4. Harned&Mikic-like Hall si operator formulation and status, Hao Tian/Carl Sovinec (10 min)

- Formulation of a fourth-order operator was discussed. Hao is in the process of implementing it, but it's still in the coding stage.

I.B.5. Spectral element code status, Alan Glasser (30 min)

- Alan reported on progress with his SEL code. Developments for efficient static condensation improve the solve time by a factor of 1000.
- Work on the variational mesh alignment strategy requiring singular value decomposition was described.

Break

I.C. General development issues

I.C.1. Preprocessor changes, Scott Kruger (15 min)

- The mapping/equilibrium modified code package is nearly complete with the exception of using inverse equilibria for fluxgrid.
- Disruption case now runs at S=6.e6.
- One should use 'uniform' as the standard grid type.
- The disruption cases suggest that free boundary computations work, but the 86166 case still has problems. There appears to be an instability near the separatrix. Scott and Dylan are trying to sort out what equilibrium gradients may be responsible.
- Scott is considering smoothing the equilibrium fields. Objections were voiced.

I.C.2. CVS repository contents, Scott Kruger (10 min)

- Mapmod changes are available to the team and should be used to exercise the code.
- An SAIC summer intern is working on scripts for automatically documenting input.f changes.

I.C.3. Future plans, Scott Kruger (15 min)

- Figure out how to get DIII-D free boundary simulations to work robustly.
- Finish development of inverse solvers in mapmod version.
- Release NIMROD 3.2.
- Complete the resistive wall implementation.

I.D. SCIDAC

I.D.1. Review of development commitments for existing support (45 min)

- Particles

    - Most of the implementation is sorted out.
    - There is some concern about the level of noise, but this may be due to different representations of field and particle spatial support (to be corrected).
    - A time-averaged P_hot may be effective and appropriate.
- Integral closures
    - Benchmarking is a difficulty (because USU is breaking new ground!)
    - There are computational performance concerns, but efficient scaling to >1000 processors has been demonstrated.
    - We need to advertise this unique capability!!!
- Fluid advance
    - Advection is getting exercised and improved.
    - Nonsymmetric solves are being used.
    - New developments for the Hall term are underway.
- Resistive wall
    - This is a near-term project.
    - A helpful revision to the coupling matrices will be trivial (according to Scott K.)
    - The secular n=0 part will be handled in-house, minimizing what is needed from Morrell Chance.
    - Resistive wall calculations are being planned.

I.D.2. Strategy and planning for recompete (45 min)

- Rostom thought that the RFP for the recompete would be mid-Spring '04 at the earliest. However, Curt later said that it could be as early as December '03.
- CS asked about how to ensure that existing grants will run their full 3 years (and will keep reminding politely).
- Different views on the re-compete were expressed, but it is way too early to make any definite plans. All doors are open at this point.

Sunday, April 27, 8:30-12:30
Aransas Room, 3rd Level, Omni Bayfront Hotel

II. Applications
II.A. Kinetic calculations
II.A.1. RFP heat flux, John James (15 min)

- John reported on his cylindrical RFP studies that are being developed to do a heat flux comparison with experiment.
- Help was provided regarding performance issues.

II.A.2. Slab heat flux studies, Michael Addae-Kagyah (15 min)

- Michael is comparing heat flux from the integral closure with that from anisotropic conduction.
- The new investigation focuses on adding a secondary island to make a stochastic region.

II.B. Alternates
II.B.1. Spheromak transients, Giovanni Cone (15 min)
II.B.3. LLNL spheromak sims from Bruce Cohen (5 min)

- CS showed a couple of Bruce's slides. T profile now compares with SSPX, but it is the result of scaling coefficients.
- Ron is getting heavily involved. He indicated that he may have attended at least part of the team meeting if he had known about it sooner.

II.B.4. PPCD in RFPs, Jim Reynolds (15 min)

- Jim is investigating profile evolution during PPCD via modified-spectrum runs and new E diagnostics.

- Dan B. suggested plotting q vs. un-normalized poloidal flux to distinguish diffusive effects.

II.B.5. Magnetic nozzle application, Alfonso Tarditi (15 min)

- Alfonso has solved a difficulty with inflow bc's by putting a large source reservoir region within his computational domain.

II.C. Tokamaks

II.C.1. CDX-U, Scott Kruger (20 min)

- CDX-U case appears to run well. n=1 mode changes from m=1 to m=2 during crash.
- A large amount of CPU time was used. CS suggested comparing with fewer modes, less mesh, and an n-dependent viscosity as a form of hyperviscosity.
- During CEMM, we learned that Josh did not run the same q profile and had skipped most of the growth period.

II.C.2. DIII-D, Scott Kruger and/or Dylan Brennan (30 min)

- 87009 is making good progress—leading to new collaboration with Dennis Whyte.
- Rostom wants to stay informed of all progress in big tokamak simulations!!
- Dylan outlined different experimental results that he is trying to sort out theoretically and computationally:
    - sawtooth directly seeds NTM that is linearly stable
    - n-th sawtooth seeds an NTM while classical destabilization plays a role
    - spontaneous NTM without seed
- Dylan is adding toroidal rotation in his tearing computations.

II.C.3. Big Splash calculations, progress, needs, Scott Kruger to lead (45 min)

- There was discussion of the equilibrium search and the conclusion to use 86144 profiles as the best approach.
- Scott laid-out the plan:
    - MHD+aniso conduction, free bc, converged high S: Dalton
    - MHD+aniso conduction, free bc, converged high S+shear flow: Dylan
    - MHD+aniso conduction, free bc, converged high S+neoclassical effects: Scott
    - MHD+ free bc, converged high S+neoclassical effects, and integral closures: Eric
- Integral closures may be the best bet for using large computer resources to do new physics.
- Particle developments will contribute as availability allows.

Added: Johann Carlson from Tech-X spoke about new data transfer work and their interested in working with NIMROD.

Break

III. View from Germantown, Rostom Dagazian (30 min)

- Rostom noted integral closure and flow developments.
- Curt thought that any new funds associated with ITER would be in FY 2006.
    - For Big Splash, he suggested trying to project whether the physics of contemporary tokamaks will hold in the larger device.

IV. Script tutorial, Scott Kruger (40 min)

- No time

V. Initial summer meeting plans

- It may be Utah in early August to help the final push for BS.

Adjourn