NBODY6/7 problem-solving

(a) Looping without results

Activate DO 22 in intgrt.omp.f

Recompile and restart

Smoking gun: STEP(I) & STEPR(I)

Note counters NSTEPU & NSTEPI

Start bisecting with diagnostic flags

Isolate final subroutine & bisect

Set internal diagnostics and inspect

Indentify nature of problem

(b) Large energy error: SSE or GPU

Check restart reproduction

Consult dir Docs for strange fort.x

Activate SHRINK diagnostics in gpucor.f

Equivalent procedure in nbint.f

Track smoking gun STEP(I)/STEPR(I)

Change output interval to determine validity

Consult man6.pdf/Docs for possible clues

Reduce time-steps by modified ETAI/ETAR

Energy check: CALL ADJUST directly

(c) General problems

Difficult initial conditions

Neighbour criterion: NNBMAX vs NMAX

Load balance: NNB $\simeq$ NNBMAX/5, #40

Previous history: what is different?

Energy error: massive wide binaries

Increasing TCOMP: small STEP(I) in hierarchy

Commensurate output times: choice of SMAX

Time-step reduction: some bugs reproduced

Perturbation trap: switch #10 to GAMMA > 1

(d) A challenge

Eccentric BH binary: e $= 0.9999$, $a = 3*10^{-4}$

Kozai-Lidov oscillation vs de/dt damping

STEP(I1) below limit near pericentre

Hermite PN block-step integration fails

Switch to ARC by initialization procedure

Difficult condition: distant perturber

Direct exit after one NBODY6 block-step

Enforced ARC termination & KS initialization

(e) Black Holes

Few-body dynamics: strong interactions

PN decision-making: Einstein shift

Tidal disruption event: mass loss & accretion

Energy budget: ejection of remnant

GR coalescence: large correction terms

ARC collision: exit for astrophysics

Roche-lobe overflow: BH + star $\Rightarrow$??

Post-Newtonian cross terms: C. Will 2014

(f) Recent developments

External perturbation: two-body criterion

Strong perturbers: single/binary INJECT

Alternative: jump to CHAIN on $\gamma > 1$

Tidal circularization: inert binary $a < 10^{-3} R_{cl}$

Activation of inert binary: unique identity

Improved criteria: initialization & termination

Parallel KS: thread-safe version

(g) ARC termination tools

External perturbation: GPERT

Inverse KS distances: RINV(K), K=1,N-1)

Sorted distances: ISORT(K), K=1,N)

Particle identity: INAME(K),K=1,N)

Coordinates & velocities: XCH & VCH in 1D

Decision-making: singles versus binaries

Chain selection: X–X————————X

X–X————-X–X

Removal: IESC, JESC from ISORT & INAME