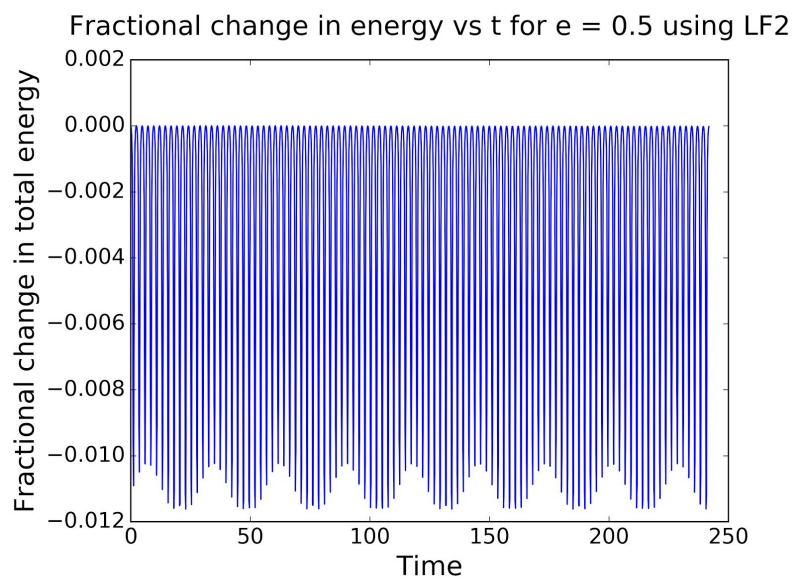
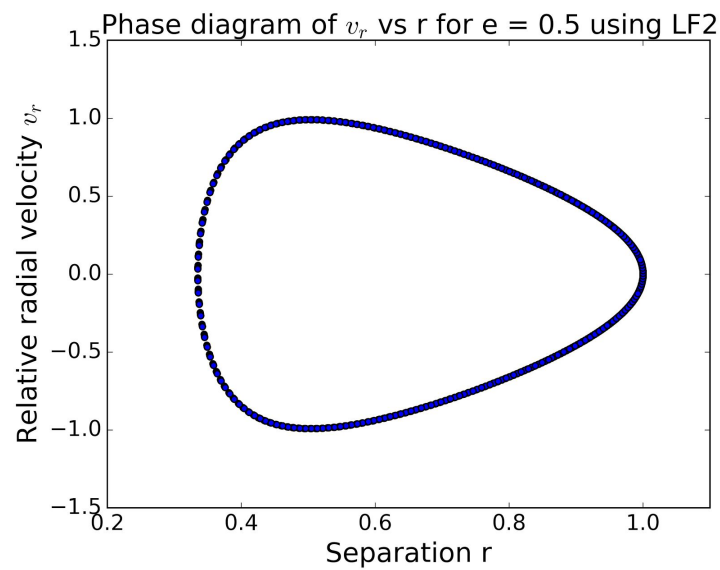
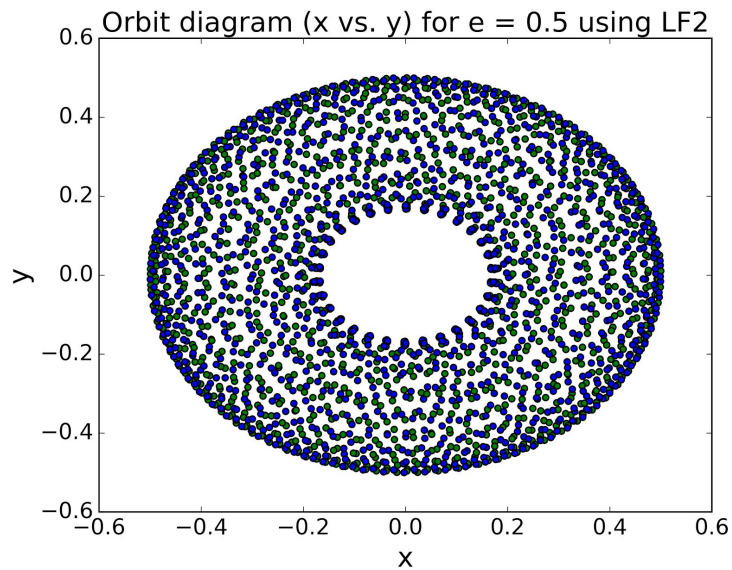


ASTR615 - Computational Astrophysics, Homework #4

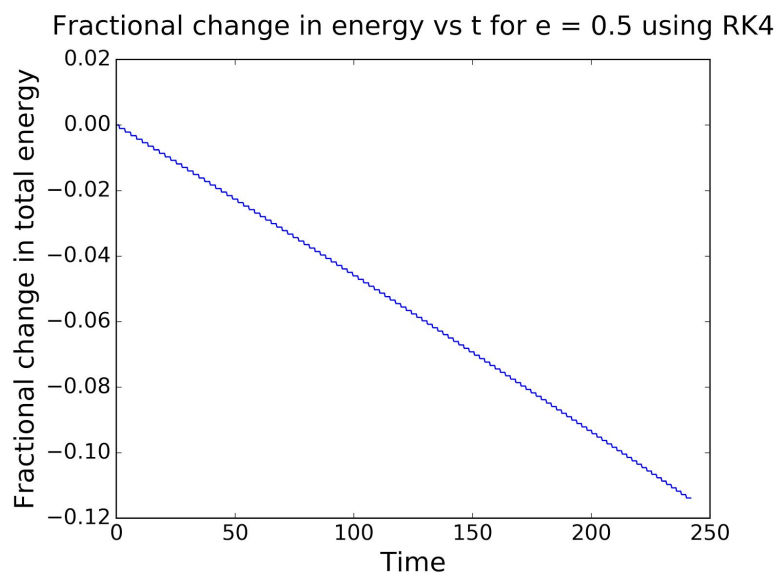
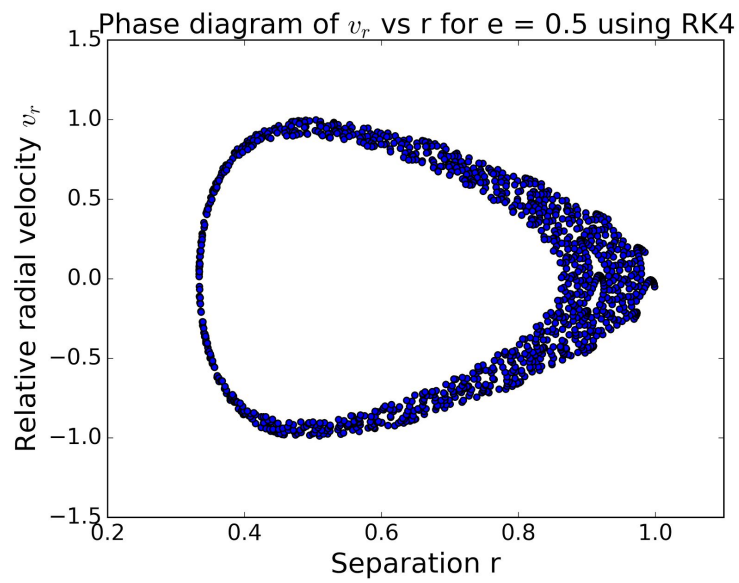
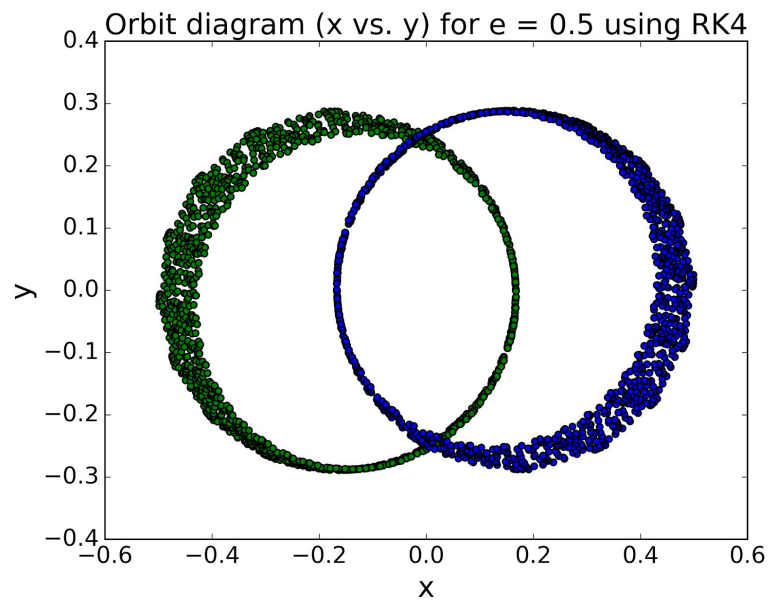
Group 4: ChongChong He and Mohammed Khalil

Problem 1

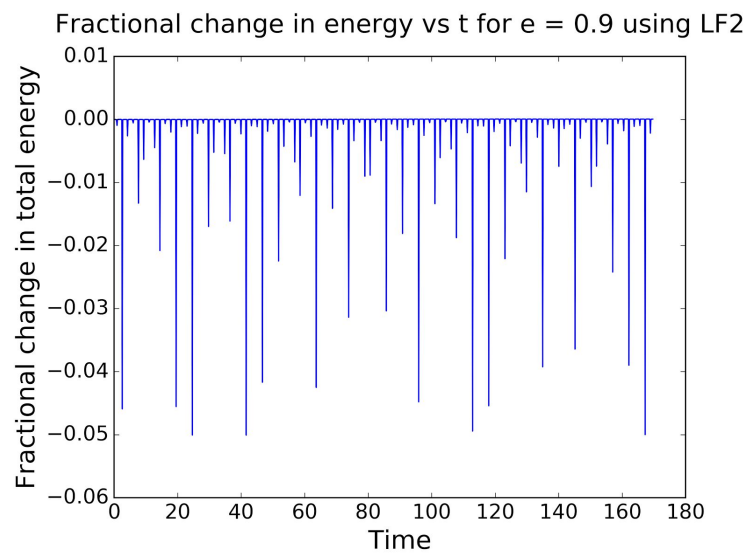
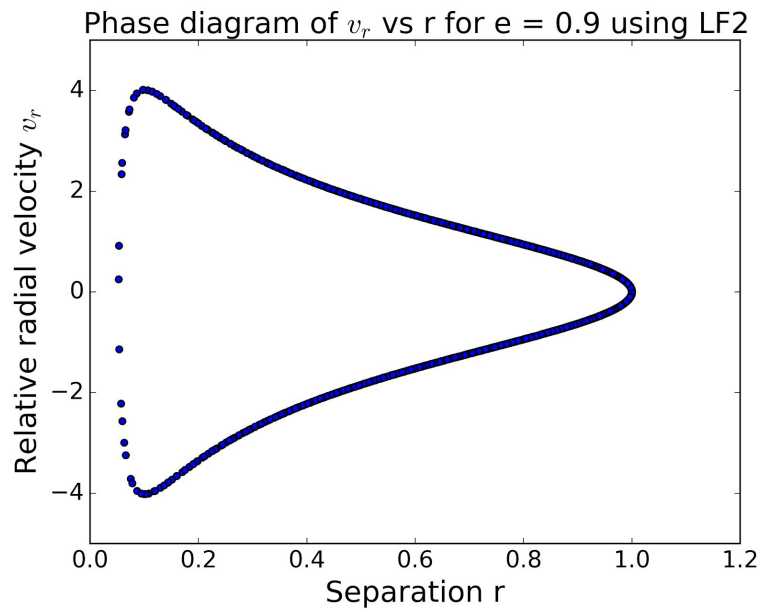
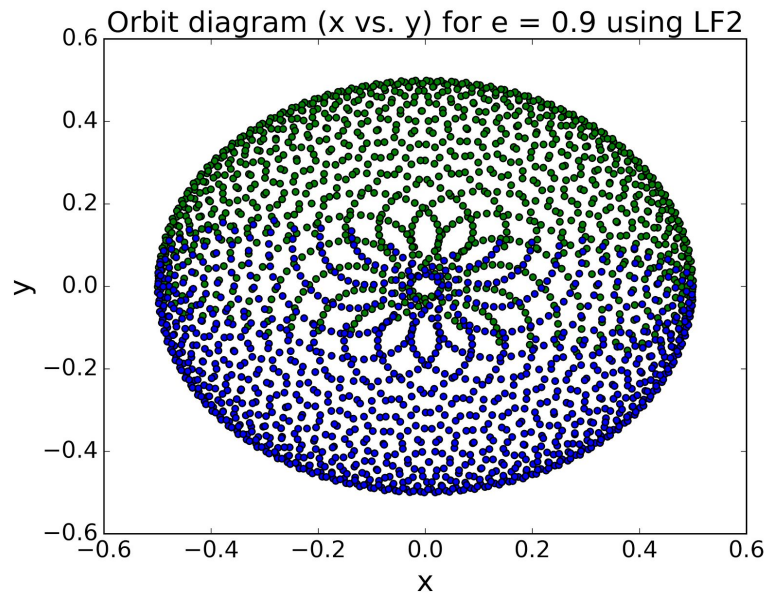
2nd order Leapfrog, $e = 0.5$



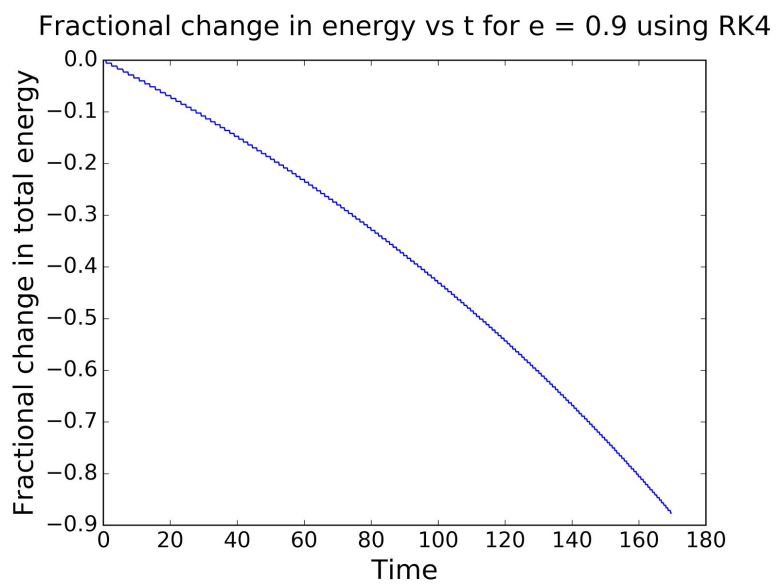
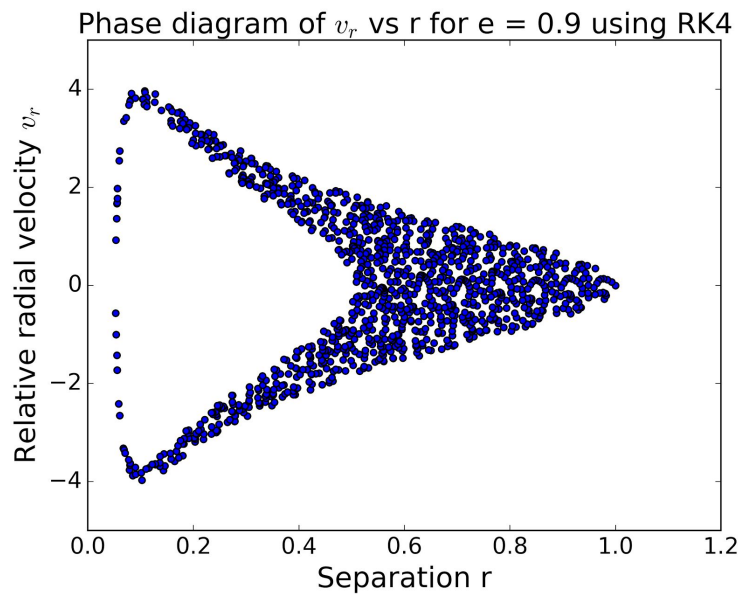
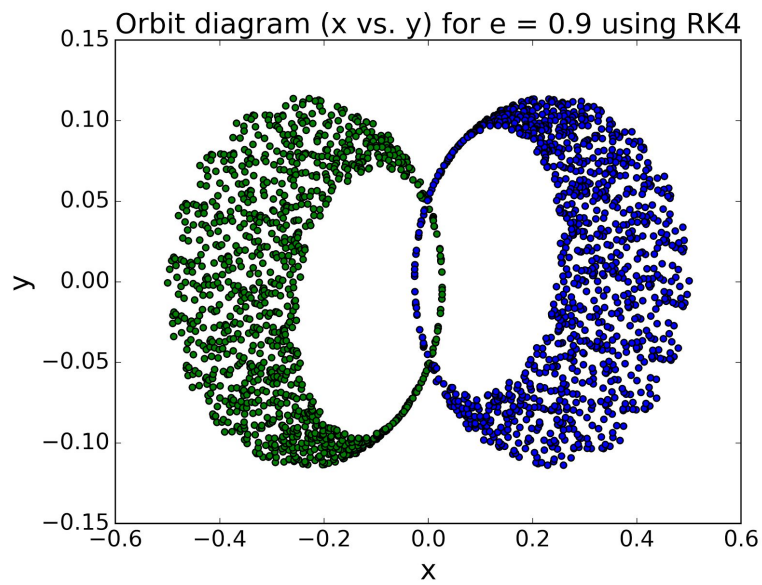
4th order Runge-Kutta, $e = 0.5$



2nd order Leapfrog, $e = 0.9$



4th order Runge-Kutta, $e = 0.9$



Comments:

- Leapfrog is better at conserving energy. For $e = 0.9$, the energy error in RK4 reaches 90% after 100 periods. While in LF2, the fractional change in energy oscillates with a maximum error of 5%.
- This is also clear from the phase diagram; LF2 repeats almost exactly the same cycle, while RK4 produces larger errors since the separation decreases continuously as the system loses energy.
- However, LF2 leads to larger phase error than RK4. After 100 periods, the phase error is almost $\pi/2$ (at the given time steps), while the phase remains the same in RK4.
- Therefore, leapfrog is more practical for N-body simulations with long simulation time, while Runge-Kutta is more accurate for small simulation time.