Laboratory and Computational Physics 2

Options: There will be two options for you over the final 4 weeks of semester.

Option 1: Independent project
        You will choose a project (or propose your own) to develop over the last weeks. You can work on it by yourself, or with a small group. More details on the independent project can be found below.

Option 2: Continue with 1-week projects.
        You can also choose to continue with a series of shorter, slightly more structured projects, similar to the ones you've been doing over the last weeks. These will not include the python tutorials after the current week 7 lab.

Immediate action item: Please contact Colin Entwisle by the end of this week (Friday May 8 at noon) to let him know which option you wish to take. We plan to reorganise groups to align with the options. You can enter your decision in this doodle poll:
https://doodle.com/poll/engqayfe3ch855sn

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Independent project

Project timeline:
1) Before your first lab:
    A) Choose your partners if you decide to work in a group (1-3 people)
    B) Look over the list of projects (or think of your own)
2) In the first 3hour session:
    A) Talk with your demonstrator if you are proposing your own idea for a project.
    B) Define the questions you'd like to answer and write down your plan to do so. Submit a flowchart or outline at the end of the first day.
    C) Discuss the project and your plan with your demonstrator.
3) Sessions 2-6: Work on the plan. Your demonstrator should provide some feedback on your initial outline by session 3.
4) Session 7: Review and sanity check the results you've gotten.
5) Session 8: Write up your results and what you've learned, likely supported by plots and other outputs from your code.

Submission:
Submit your code and report. If done in a group, please also include a short statement of contribution from each group member (ie what parts each person worked on).

Project ideas:
1) Light sails and lasers have been proposed as a way to get to the stars (most recently by Starshot Breakthrough initiative). There are of course a number of engineering challenges. Light spreads out (and thus the power of your laser drops with distance); your light sail needs to be light but also deal with high accelerations; you can reduce the acceleration (but then the journey takes longer); the lasers could fry satellites; and so on. Model some of these issues, and comment on the feasibility of the approach and what you think will be the hardest issues.

2) Epidemiology. Build your own coronavirus model.
3) Modelling traffic jams. You look at drivers driving in a (large) circle, presuming they are following each other trying to maintain distance (possibly measured in time to travel) with some finite response time. Look at what happens when someone hits the brakes, and how it depends on the traffic density. You might also look at what fraction of the cars would need to be computer-controlled to avoid a traffic jam.
4) Deflecting a dinosaur killing asteroid: Let's say we detect an asteroid or comet with a high probability of hitting the Earth. Look at and model options for deflecting it or destroying it.
5) Where might life be found in the Galaxy? Where should we look for evidence of intelligence? The center of the Milky Way has more stars (and presumably potentially habitable planets), but more stars also increases the odds of a near-by supernovae (and complex life certainly takes time to evolve). Try building a model to see where to look.
6) You looked at the 2-body problem earlier. What happens if you add atmosphere to the equation? How long does it take an orbit to decay as a function of elevation? Are there any other physical effects that have a significant effect?
7) Another variation on the 2-body problem: If two satellites collide, what distribution of orbits might the pieces end up in? What fraction will reach higher elevations than the initial collision? Do you think we should be concerned about satellite collisions and debris orbiting the EARTH for the long-term viability of satellites?
8) Extend a project from an earlier week
9) Choose your own project.