國立清華大學
NATIONAL TSING HUA UNIVERSITY

10920ASTR660000
Computational Astrophysics
計算天文物理

Release date: 2020.03.18
Due in class: 2020.03.25
(submit it in google classroom)

Problem Set 3

Reading Assignments

1. Read Google's Introduction to Python (https://developers.google.com/edu/python/introduction).
2. Read the Style Guide for Python Code (https://www.python.org/dev/peps/pep-0008/)
3. Read the pyplot tutorial (https://matplotlib.org/tutorials/introductory/pyplot.html)
4. *(Optional)* Learn Astropy (http://learn.astropy.org/tutorials.html)
5. *(Optional)* The tight layout guide (https://matplotlib.org/tutorials/intermediate/tight_layout_guide.html#sphx-glr-tutorials-intermediate-tight-layout-guide-py)
6. *(Optional)* Customizing matplotlib (https://matplotlib.org/3.2.0/tutorials/introductory/customizing.html).

Written Assignments

(Warm-up)

1. Linear Algebra: Calculate the inverse and the determinant of the following matrix: [25pts]

$$A = \begin{bmatrix} 2 & 0 & -1 \\ 5 & 1 & 0 \\ 0 & 1 & 3 \end{bmatrix} \tag{1}$$

2. Special Relativity: Find the matrix for the Lorentz transformation consisting of a boost v_x in the x-direction followed by a boost v_y in the y-direction in the space-time coordinates (x, y, z, t). Show that the boosts performed in the reverse order would give a different transformation. We will need this matrix in the next lecture. [25pts]

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Programming Assignments

1. Python Exercise: (a) Redo the binary stars code that we used in the previous lecture but rewrite it with `python`. Set $\Delta t = 0.01$ yr and $t_{max} = 10$ yrs. (b) Compare the performance of your python code with your fortran codes. Can you use `numpy` or `scipy` to improve the performance? (c) *(Bonus, 10 pts)* use Object Oriented Programming to structure your code. [25+10pts]

2. Following problem 1, Use `imshow` in `matplotlib` to draw the absolute value of gravitational potential at $t = 0$ in log scale and plot five equipotential contours. Please adjust color ranges and the contour levels to make sure that your plot is meaningful. Do not use the default colormap in `matplotlib`. [25pts]

3. *(Optional)* Use `ffmpeg` to make a movie of your binary stars' trajectories on top of their gravitational potential. [10pts]