Computational Astrophysics HW5

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I. EXERCISE 1

(1) The Sun:
with $T \approx 10^7 K$, $n \approx 10^{26} cm^{-3}$, the mean free path $\lambda_{sun} \approx 10^{-6} cm$, compared to the size of system $L \approx 6.96 \times 10^{10} cm$, the result shows that it can be described as a fluid.

(2) Solar wind:
with $T \approx 10^5 K$, $n \approx 10^1 cm^{-3}$, the mean free path $\lambda_{solarwind} \approx 10^{15} cm$, compared to the size of system $L \approx 1.5 \times 10^{15} cm$, the result shows that it can not be described as a fluid.
(By searching the net, I find that solar wind may travel a distance circa 100 AU, still not satisfy the relation $\lambda \ll L$)

(3)Warm ionized interstellar medium:
with $T \approx 10^4 K$, $n \approx 10^1 cm^{-3}$, the mean free path $\lambda_{WIM} \approx 10^{13} cm$, compared to the size of system $L \approx 3.0 \times 10^{19} cm$, the result shows that it can be described as a fluid.
(Scale of WIM is about 1000 pc, from wikipedia.)

(4) Intracluster medium within galaxy clusters:
with $T \approx 3 \times 10^7 K$, $n \approx 10^{-3} cm^{-3}$, the mean free path $\lambda_{IM} \approx 9 \times 10^{23} cm$, compared to the size of system $L \approx 10^{25} cm$, the result shows that it can not be described as a fluid.
(Scale of galaxy cluster is about 1 to 5 pc, from wikipedia.)

II. EXERCISE 2

(1) The trajectories of the two time step $dt = 0.00001$ year and $dt = 0.01$ year shown in following figure:

(2) By using RK4 method, and let $dt = 0.01$year, we can see the result(FIG. 5.) is well

improved in contrast to Euler method.

III. EXERCISE 3

By solving analytically we can get $\theta \approx 33^\circ$ and the velocity of y direction $v_y \approx 8.52 m/s$, by using shooting and bisection method, we can derive the value of $v_y \approx 8.517$, result shown in FIG.6.

IV. EXERCISE 4

Use *numpy.linalg.solve* to solve the linear equation, and plot the result with 2 different h, $h = 0.05$ and $h = 0.005$, result shown in FIG. 7,8

V. CODE LINK

Exercise1

Exercise2-1 Exercise2-2

Exercise3

Exercise4