Essentials of Geophysics 12.201/501

Problem Set 2

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1. (source: Notes + Stacey section 2.3.4)

   (a) Write down the equation for $^{87}Sr/^{86}Sr$ and $^{87}Rb/^{86}Sr$ in a single mineral grain as a function of time.

   (b) Assume all grains in a meteorite have an initial $^{87}Sr/^{86}Sr = 700$. Make two graphs, one of $^{87}Sr/^{86}Sr$ vs. current $^{87}Rb/^{86}Sr$, and one of $^{87}Sr/^{86}Sr$ vs. initial $^{87}Rb/^{86}Sr$ after [0, 1, 2, 3, 4, 5, 6] billion years for initial $^{87}Rb/^{86}Sr$ of [0, 200, 400, 600, 800, 1000, 1200, 1400, 1600]. Look up necessary info in the back of Stacey (or other available sources).

   (c) Analyses of grains in meteorite A show current ratios of $^{87}Rb/^{86}Sr$ and $^{87}Sr/^{86}Sr$ as shown below. Plot this data set on top of your previous plot of $^{87}Sr/^{86}Sr$ vs. $^{87}Rb/^{86}Sr$ (first plot) to infer the age of meteorite A. Double check this age by using the equation relating age and ratio of parent/daughter.

$^{87}Rb/^{86}Sr$	$^{87}Sr/^{86}Sr$
0.0000	700.0000
93.6768	706.3232
187.3535	712.6465
281.0303	718.9697
374.7071	725.2929
468.3838	731.6162
562.0606	737.9394
655.7374	744.2626
749.4141	750.5859
843.0909	756.9091
936.7676	736.2324
1030.4444	769.5556
1124.1212	775.8788
1217.7979	782.2021
1311.4747	788.5253
1405.1515	794.8485

(d) Calculate the initial ratio of ^{87}Rb/^{86}Sr for these grains, and plot them on top of your second plot from part (b). The time evolution of ^{87}Sr/^{86}Sr for any initial ^{87}Rb/^{86}Sr follows a vertical line as should be indicated on your plot.

2. Calculate the gravitational energy released by the collapse of the sun to its present state. This can be done by considering the gravitational potential energy released by the collapse of mass M of material, initially dispersed to infinity, to a uniform sphere of radius R. Hint: Divide the sun into thin layers and integrate, starting at the center.

3. Show that for atoms of a radioactive species with decay constant λ, the mean life is $\frac{1}{\lambda}$. Hint: Begin the problem by writing down the number of atoms that decay in the time period from t to t+δt. Then integrate the apppropriate expression over all time.