PHYS 600: Homework 5

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Problem 1 Growth of Matter Perturbations—Matter and Radiation

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Problem 2 Spherical Collapse

The equation of motion for a single shell enclosing a mass of M during spherical collapse is

$$\begin{aligned}
\frac{\mathrm{d}^2 r}{\mathrm{d}t^2} &= -\frac{GM}{r} \\
\implies \frac{1}{2}\left(\frac{\mathrm{d}r}{\mathrm{d}t}\right)^2 - \frac{GM}{r} &= E \\
\frac{1}{2}\left(\frac{\mathrm{d}r}{\mathrm{d}\theta}\frac{1}{\mathrm{d}t/\,\mathrm{d}\theta}\right)^2 - \frac{GM}{r} &= E \\
\frac{1}{2}\left(\frac{A\sin\theta}{B(1-\cos\theta)}\right)^2 - \frac{GM}{A(1-\cos\theta)} &= E \\
\frac{GM}{2A}\left(\frac{\sin\theta}{1-\cos\theta}\right)^2 - \frac{2|E|}{1-\cos\theta} &= E \\
\frac{GM}{2A}\frac{1-\cos^2\theta}{(1-\cos\theta)^2} - \frac{2|E|}{1-\cos\theta} &= E \\
\frac{1+\cos\theta}{1-\cos\theta}|E| - \frac{2|E|}{1-\cos\theta} &= E
\end{aligned}$$

$$\frac{-|E| + |E|\cos\theta}{1 - \cos\theta} = E$$
$$-|E| = E$$

We have shown that this is a parametric solution for $E < 0$, as desired.

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Problem 3 Equality Scale

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Problem 4 A Study in Simulations

Orienting Yourself : The Linear Power Spectrum description

Non-linear Power Spectrum and Structure Growth description

Computing the Growth Function description

Halo Mass Function description

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A Python code