Exercises lecture one

1. PART ONE: In the context of linearised theory over flat space-time, solve the wave equation in TT gauge (in vacuum). For a plane wave propagating in the z-direction (wave-vector $\mathbf{k} \parallel \boldsymbol{z}$), find the metric line element ds^2.

   PART TWO: Using the equation

$$\ddot{\xi}_a(t) = \frac{1}{2}\ddot{h}^{TT}_{ij}(t)\xi_a(t)$$

With

$$\xi_a(z=0,t) = (x_0 + \delta x(t), y_0 + \delta y(t))$$

(x_0, y_0) Initial positions of the masses

$(\delta x, \delta y)$ Displacement of the masses

Find the effect of a wave with only plus polarisation on a circle of test masses situated on the plane z=0.

NOTE! Remain at linear order in the perturbation

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2. (OPTIONAL)

Think about the difference between the linearised theory of GW with matter, expanded about Minkowski, and cosmological perturbation theory (energy momentum tensor? Bardeen equation vs. GW propagation equation?)