

AST353 (Spring 2016)

## ASTROPHYSICS

### Group Project 2: Gravitational Waves from the First Stars

15-min presentation/discussion: Thu/Fri, May 5-6, 2016

Written report due: Friday, May 6, 2016

(worth 15/100)

You should work on all components of this project in close collaboration with your team (Groups A – I). Your group is expected to get stuck occasionally, at which point you should not hesitate to ask the TA or the professor for help.

I will test your understanding in a short (15-min) meeting with the individual groups. In the beginning (first 10 mins), you will give a brief presentation (powerpoint, say), explaining the basics of gravitational waves, and describing the answer to the numerical challenge. I will then follow-up with questions.

#### 1. Brief Intro: Gravitational Waves

Do some background reading on gravitational waves, and the *Laser Interferometer Gravitational-Wave Observatory* (LIGO). Prepare a brief presentation on what you have learned.

#### 2. Gravitational Waves from Population III Black Holes

LIGO has recently detected the gravitational wave signature of a merging black hole (BH) binary. This is the famous event GW 150914. It is currently hotly debated where this BH binary came from.

Assume that GW 150914 originated in a BH binary system that was left behind when a massive Population III binary system died at a redshift  $z = 20$ .

Calculate the initial BH binary separation,  $a_{\text{init}}$ , (in units of solar radii) if this source indeed were the origin of what LIGO saw.