Motivation for Workshop 1:

The discovery of gravity waves has presented a fascinating issue: are massive black hole (BH) binaries common? How did they form? If you are interested in exactly what was discovered, I have put the announcement papers on LMS under the tab 'Tutorial Resources': *ligo-detection.pdf* and *ligo-bh.pdf*

In this workshop, we will explore ideas around the birth of stars. And then of course, how did they evolve. In the process you will understand calculations applying the ideas we have learned in lectures.

Activities:

Order-of-magnitude estimate 1: are there more grains of sand on the beaches of Earth or more stars in the Milky Way?

Now we will start by thinking about the populations of stars.

The likely model for the formation of stars is the collapse of a gas cloud under gravity – we will start by exploring the Jean's Mass.

The formation of stars starts with a gas cloud, that is more dense than its surroundings. The gas cloud will fragment due to some unknown process forming stars of different masses. Usually we use a power law to describe the distribution of masses of the stars that are formed. That function is called the *initial mass function (IMF)*.

Some of the key questions are:

(1) Is the IMF ubiquitous, in all places and at all times?

(2) What physical processes are responsible for the shape of the IMF?

Research task 1: What is the lowest mass for a star? What Physics determines this mass? Will compact objects form below this mass – and if so what are they? Can we observe them?

Calculation 1: What is the most massive star that can form? State the physics that you have used to derive this estimate. How could a star form that might avoid this limit?

Calculation 2: Suppose the gas cloud of 10^3 M_{sun} collapses under gravity and forms stars. Under simple assumptions, what is the largest star that will form? You may assume the Salpeter IMF which has the form: $dN/dm \propto m^{-2.35}$.

Calculation 3: Once a gas cloud reaches an overdensity of $\sim$1, it will collapse in free fall. Determine the time scale of collapse of a gas cloud of mass M. Work out how this scales. What will stop our gas cloud collapsing into a black hole?

This is page 1 of the workshop; next page follows on Tuesday!