Homework 4

Lulu Zhang 1701110221

A kilonova as the electromagnetic counterpart to a gravitational-wave source

a. This indicates that neutron-star mergers produce gravitational waves, radioactively powered kilonova, and are a nucleosynthetic source of the r-process elements.

b. This paper reports the observations and physical modelling of a rapidly fading electromagnetic transient(formally registered with an IAU name of AT2017gfo) in the galaxy NGC 4993, which is spatially coincident with GW170817 and a weak, short γ-ray burst, and has physical parameters that broadly match the theoretical predictions of blue kilonovae from neutron-star mergers. The primary work in this paper is to gather multi-colour photometry and analyse the physical properties of the source by kilonova models.

Firstly, The paper verified that AT2017gfo should be the electromagnetic counterpart of GW170817 by both its spatial coincidence and the statistical properties of astronomical observation.

Then, with the multi-colour photometry data, the paper calculated the bolometric lightcurve and total luminosity with appropriate assumption and compared the absolute magnitude of all band to several kilonova models calculated for NS-NS mergers predicted before the discovery of GW170817. Through the compare, they found that lanthanide-rich models that with high opacity do reproduce the near infra-red luminosity at 7 - 14 days but the observed early emission which is hot and blue is not reproduced in merger models, and the model using a lower opacity can produce a 'blue kilonova', appropriate for light r-process elements (a blend of elements with $90 < A < 140$).

With further explore of the 'blue kilonova' scenario, the paper found that the data can be explained with a low mass of ejecta having opacity consistent with a blend of elements in the $90 < A < 140$ mass range powered by r-process radioactive decays. And another important thing is that the following analysis of optical and NIR spectra support above idea as well.

However, for model with high opacity is able to fit the later data points well, they said that cannot rule out a second component consisting of the heavy lanthanides and actinides contributes to the infra-red flux after 3 days. But as a whole, things can be sure are that AT2017gfo should be the electromagnetic counterpart of GW170817 and the nucleosynthetic origin of the r-process elements can be in neutron star mergers.