Project Title: The Birth and Death of Stars

***The understanding of how stars function to create elements and how they live and die is one of the greatest achievements of modern astronomy. The Sun is a typical star but some of the more extreme outcomes of evolution occur for massive stars. In no more than 750 words, address the following questions about star birth and death:***

1. ***What is the source or cause of the Sun’s light, and how do all the elements in the periodic table get produced?***

The fusion process taking place within the central volume bounded by a quarter of the Sun’s radius creates an immense amount of energy . From there, this energy in the form of Gamma rays performs a random walk process outwards through the remaining volume of the Sun. During this outward trek, these Gamma rays collide frequently with plasma particles there (typically electrons). These collisions slowly degrade the temperature and energy of these particles until they become photons with light in the visible spectrum. This radius where energy becomes light in the viisible spectrum is called the photosphere and is what we preceive as the surface of the sun although its really just a transition in opacity.

The source of the Sun’s light is derived from a mechanism called the proton-photon chain; a three step nuclear process whereby protons combine in stages to form deuterium, helium-3, and then helium-4. At each stage in the process particles are released along with radiation. In the final step, two protons are released to partake in future reactions, thereby recycling them. In this three step fusion chain, the star is building heavier elements from lighter elements. This process is not entirely efficient though so roughly one part in a hundred of the mass-energy in the nuclei being fused is released as radiant energy (e.g. sunlight).

This fusion chain is a form of nucleosynthesis being performed by our Sun. For example another type of fusion collision such as triple collision can result in the formation of carbon nuclei. Nucleosynthesis of heavier elements is also possible but the heavier the element, the greater pressure and temperature required. This is part of the reason that hydogen and helium are incredibly prevalent in our universe but at atomic number climbs, prevalence decays exponentially.

1. ***What is the general process by which a large diffuse cloud of gas turns into a star and surrounding planets?***

The general process by which a large diffuse cloud of gas turns into a star and surrounding planets is induced star formation. It begins with a shockwave emerging from that supernnova event will compress the edge of a nearby gas cloud, and that can induce a gravitational collapse. This collapse and compression of material in the cloud forms a young star. The relatively small amount of residual material in the cloud that did not contribute to the star forms rocky planets and gas giants.

1. ***Name of the two end states of stars much more massive than the Sun and describe their physical properties?***

After the completion of a star’s main sequence, a star reconfigures into a preliminary end state called a Red Giant. In this state, the star starts a new energy source, releasing a large envelope, and experiences a collapsing core. In the case of our Sun, billions of years from now as the main sequence draws to an end, it’s expected that it’s Red Giant state will have an envelope large enough to encompass the orbit of Mars (thus also encompassing Earth and ending the habitability of Earth in the process).

After the Red Giant state, the star enters an unstable phase ejecting most of its mass into space as a planetary nebula. The remaining core material shrinks. With no new fusion process possible, the core gradually cools into its final state: a White Dwarf.

Supernova blackhole