

**KD6040**

**Individual Physics Project**

**FINAL REPORT**

**BSc (Hons) Physics**

**MPhys (Hons) Physics**

**BSc (Hons) Physics with Astrophysics**

**MPhys (Hons) Physics with Astrophysics**

**2020/2021**

**The Formation and Evolution of Blue Super Giant Stars (BSGs)**

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Date of Submission

**Declaration**

I hereby declare that the work contained in this document is all my own work. I also confirm that when this work uses ideas and opinions from the work of others, these are credited in full by citing the corresponding references.

Name:

Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Contents

[ABSTRACT 3](#_Toc67736515)

[1. INTRODUCTION (General introduction to BSGs) 3](#_Toc67736516)

[**1.1** **Properties of BSGs** 3](#_Toc67736517)

[**1.2** **Formation of BSGs** 3](#_Toc67736518)

[**1.3** **Processes of BSGs** 3](#_Toc67736519)

[**1.4 Evolutionary paths of BSGs** 3](#_Toc67736520)

[2. AIMS AND OBJECTIVES 4](#_Toc67736521)

[3. METHODOLOGY and RESULTS AND DISCUSSION 4](#_Toc67736522)

[**3.1** 4](#_Toc67736523)

[**3.2** 5](#_Toc67736524)

[**3.3** 5](#_Toc67736525)

[**3.4** 5](#_Toc67736526)

[4. CONCLUSIONS 5](#_Toc67736527)

[5. REFERENCES 5](#_Toc67736528)

[6. LAY SUMMARY 5](#_Toc67736529)

# ABSTRACT

Provide a summary of your project that addresses the following points:

* The definition and current state-of-the-art of the topic of your project.
* The main aim of your project.
* The main results of your project.
* The main conclusions of your projects.
* Any implications or future work that can be derived from your project.

(Length of this section: between 250-300 words)

Points to mention:

* Are Mass loss values of BSGs significant
* Are the evolutionary paths coverall constructive or destructive

# INTRODUCTION (General introduction to BSGs)

## **Properties of BSGs**

Stars are vital celestial bodies that have helped the universe evolve the way it has through its lifetime of around 13.7 billion years. Some stars can support life on orbiting planets such as the Sun, whereas other stars can create the materials necessary for the formation of planets and the evolution of galaxies and the universe. Such stars are known as high-mass or early type stars and such an example of this are blue supergiant stars (BSGs). Stars are classified by several methods, but the most common way is by spectral class. This method considers a star’s temperature and luminosity when classifying it into one of the spectral classes: O, B, A, F, G, K and M, with O type being the largest and most massive and M type being the smallest and least massive [1].

O type stars have the highest values of temperature and radius for stars and these values decrease with each following spectral class until M type stars which have the lowest values of mass, temperature and luminosity. As a result the majority of BSGs are classified as O type and a selection are classified as B type stars. Some examples of BSGs are given in table 1 along with their masses, temperatures and other properties. It is theorized that these early type stars provided light in the form of high energy photons that ionized the hydrogen that the early universe composed of. This is known as the epoch of reionization and occurred several hundred million years after the Big Bang [2]

BSGs being classified as either O type or B type means that they must have minimum surface temperature values of 11,000K, minimum solar radius of 14Rʘ, where 1Rʘ indicates the radius of the Sun which is 6.960x105 Km, minimum solar mass of 10Mʘ, where 1Mʘ­ is 1.98x1030Kg, and minimum luminosity of 20,000Lʘ, where 1Lʘ is 3.84x1026W m-2 [3].

Another classification scheme used to differentiate stars is via their luminosity or total brightness, this is known as the Yerkes luminosity class and uses roman numerals in which I indicates the most luminous stars and VII indicates the dimmest stars. BSGs are most often classified as class I due to their extraordinary high luminosity values.

Table 1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Star Name** | **Star Mass (Mʘ)** | **Star temperature (K)** | **Star Luminosity (Lʘ)** | **Star radius (Rʘ)** | **Spectral class** |
| Naos - Zeta Puppis | 56.1 | 40,000 | 813,000 | 14 - 26 | O4 If(n)p |
| Alnitak Aa | 33 | 29,500 | 250,000 | 20 | O9.5 Iab |
| Alnitak Ab | 14 | 29,000 | 32,000 | 7.3 | B1 IV |
| Alnilam | 40 | 27,500 | 537,000 | 32.4 | B0 Ia |
| Saiph | 15.5 | 26,500 | 56,881 | 22.2 | B0.5 Ia |
| Omicron2 Canis Majoris | 21.4 | 15,500 | 220,000 | 65 | B3 Ia |
| Aludra | 19.19 | 15,000 | 105,442 | 56.3 | B5 Ia |
| Rigel A | 21 | 12,100 | 120,000 | 78.9 | B8 Ia |

## **Formation of BSGs**

## **Processes of BSGs**

Introduce the topic of your project, supported by a critical review of previous relevant work reported in the literature. Your review should be followed by a discussion of the opportunities for work that you have identified, and these should lead to a clear motivation of your project.

(Indicative length of this section: 8 pages)

Topics to mention:

* What are BSGs (defining properties, size, mass, temp, etc.) 1.1
* History of BSGs (when was the first discovered, how long have they been being research for) 1.1
* How properties of high mass stars are determined (mass, temperature, luminosity) and minimum properties of BSGs 1.1
* Examples of BSGs (use table and give values of examples of BSGs)
* Formation (comparisons to solar like stars, stages of formation) 1.2
* HR diagram (magnitude, luminosity and temperature values) 1.1
* Stellar winds and mass loss 1.3
* Nuclear fusion and the CNO cycle (energy comparison, triple alpha process)1.3
* Deaths stages and how they evolve 1.4

# 2. AIMS AND OBJECTIVES

The main aim of this project is to research and understand the fundamental formation of blue supergiant stars and how these stars evolve into, through and past their main sequence phase into more impactful celestial phenomena such as supernovas and black holes. The objectives to achieve this aim are:

1. To study and analyse the conditions that lead to the formation of a blue supergiant star by researching the pre nebula of existing blue supergiant stars
2. To investigate the potential evolutionary path and how the death of a blue supergiant star can affect the surrounding universe either by a supernova, black hole or other factors
3. To compare the stellar composition, structure, magnetism (and features such as stellar flares and stellar spots) and processes such as nuclear fusion of blue supergiant stars to solar-like stars

# 3. METHODOLOGY and RESULTS AND DISCUSSION

Describe the methodology used in the project. This must include a summary of any background concepts related to physics, any relevant background theory, a description of experimental techniques and computational methods, or a combination of these elements.

Provide a narrative comment, supported by figures, diagrams, tables, or any other relevant evidence, that supports the completion of your objectives. Provide a critical discussion of your results, drawing from relevant concepts in physics. Avoid using an anecdotal or chronological style in your narrative; instead, focus on a logical presentation of your work in relation to your project’s aims and objectives.

(Indicative length of this section: 15 pages)

## **3.1**

## **3.2**

## **3.3**

## **3.4**

Topics to mention:

* Formation (competing theories, in depth description of stages)3.1
* Star magnetic processes (do BSGs experience flares and stellar spots?) 3.2
* Nuclear fusion (late fusion, fusion shells and the creation of heavy elements) 3.2
* Stellar winds and mass loss (compare measured form sources and calculated using equation) 3.2
* Binary systems (mass transfer between companion stars) 3.3
* Death stages (constructive and destructive effects on the ISM) 3.4
* BSG becoming a binary companion 3.3

# 4. CONCLUSIONS

Provide a narrative comment of the conclusions drawn from your work, including:

* A summary of the work carried out in your project.
* A statement of the deductions drawn from your results.
* A discussion of any limitations that might affect these deductions.
* A discussion of the implications of your results.
* A statement of any future work that might derive from your work.

(Indicative length of this section: 2 pages

# 5. REFERENCES

List the references in numerical order of appearance in the text. As guidance, you should include at least 30 references to either books or peer-reviewed papers (not to online resources).

[1] Enchantedlearning.com. 2018. Star Classification - Zoom Astronomy. {Accessed 27 March. 21}

[2] Bloomfield, S., 2018. Big Bang cosmology epochs, P17-20 {Accessed 27 March. 21}

[3] Antolin, P., 2020. Introduction to the Sun {Accessed 27 Mar. 21}

# 6. LAY SUMMARY

Provide a lay summary of your project. Your summary must address the following aspects:

* The definition and importance of the topic of your project.
* The context of your project.
* The main results and conclusions of your work.
* The potential impact or significance of your work.

Your lay summary must be written in a style amenable to a non-specialist audience and should have a word count between 900-1000 words.