CHAPTER 1

INTRODUCTION

1.1 Research Background

Red giants are unique. They are larger and brighter than the main sequence star. Red giants have been studied theoretically in order to investigate the evolutionary sequence (Sandage & Schwarzschild 1955; Hoyle & Schwarzschild 1952).

Red giants are evolved from main sequence stars with masses in the range from about 0.3 solar masses to somewhere between 4 and 6 solar masses (Laughlin et al. 1997). Most of the stars with mass larger than 0.25 $M_{\odot}$ have the possibility to evolve into a red giant (Whitworth 1989).

In general, the luminosity of red giants is extremely high due to their enormous radii. However, it still depends on their mass, structural density, inner and outer temperature and chemical composition (Whitworth 1989). Hence, due to the luminosity of the stars, M-type red giant stars are believed to be part of the extreme Population I type in galactic structure (Lee 1970). Even though this population always related to hot and young stars but due to the size and the luminosity of red giants, and to the fact that they are relatively short-live, they are found to be concentrated in the spiral arm section in disk of the galaxy.

Red giants are correlated with the later stage of stellar evolution. This fact relates to the existence of heavier element on the stars. M-type red giants, especially supergiants and hypergiants, are candidates for being a supernova (Hayashi & Cameron 1962; Hayashi, Hoshi & Sugimoto 1962; Sugimoto et al. 1968; Stothers & Chin 1969).

M-type stars are cool stars even though some of red giants are part of them. Thus, the lower temperature allows stars to form molecule and one of the molecule associated with M-type is TiO (Christy 1929). TiO spectral bands can be seen strong in M stars, usually dominating their visible spectrum. In particular, TiO spectral bands are very obvious for M5 to M9 (Lee et al. 1947).

1.2 Research Focus

The research will be focus on the spectrum pattern of various M-type red giants stars along the subclasses for M0 onwards to see the existence of TiO molecular band and emphasizing on the pattern of Hα I λ6562 and two prominent photospheric lines which are Fe I λ6546 and Ca I λ6572 (Eaton 1995) from the same range of the stars.

1.3 Research Questions and Objectives

The research concerns on several puzzle that can be link with the M-type red giants and astronomical spectroscopy technique. Hence, these questions leads to the objective which is to observe the red giants specifically in M-type class by using astronomical spectroscopy technique and to investigate their spectral characteristics.

- TiO always associated with M-type stars. How dominance and what are the patterns of TiO molecular bands for different M type red giant spectrums?
- Since Hα abundance always being associated with stars, what is the variation of Hα for various red giants within the M class? Does H-α value reduce when the red giant goes into the later subclass?

- How is the existence of heavier elements (heavier than H, He) in the spectrum of M type? What is the numerical pattern for M-type stars for elements Fe (I) and Ca (I) which are dominant as photospheric lines?

1.4 Research Limitations

Optical astronomy is dependent on the vision ability of the optical instrument used in the astronomical observation. Since the optical range of observation can be somehow compared with the human eyes, there are limitations.

Weather is one of the main factors to limit the observation. Malaysia is an equatorial climate country with the variation of hot and humid all year long with average rainfall of 250 centimeters per year. The wet season limits the observation session since the cloud covers the whole sky while the rain have a potential damage to the optical system and the electrical instruments such as the CCD camera. The high humidity and the cold temperature sometimes affect the inner part of the optical system such as telescope and spectrograph by the existence of water droplets which also affecting the observation by giving a foggy image.

M-type red giant stars are among the dim type stars with exclusion of several stars that are luminous such as Betelgeuse and Antares. The others are almost hard to be seen by naked eye especially in urban area with much light pollution. The optical aid, which is the telescope, does help the observation in order to take the image of the stars. However, when light of the stars were dispersed by the grating to give the spectrum, the brightness is reduced and to capture the image of that spectrum is sometimes excruciating due to the long exposure time which sometimes takes about 2 hours non-stop. But, due to the weather pattern in Malaysia which clouds are always expected at

any time, a good data for that long duration is almost impossible. This will be discussed later in Chapter 5.

1.5 Hypotheses

The M class stars are distributed into 10 subclasses which are from M0 to M9. This distribution is based on the effective temperature of the stellar surface. Hence, from the spectra obtain among these stars; we expect to observe the decrease pattern of H-alpha strength and the increase pattern for Ca I and Fe I. We also expect to find the existence of TiO molecular band which is associated to M-type red giant stars for most of the observed stars.

1.6 Chapter Outline

The aim of the work for this dissertation was to use astronomical spectroscopy technique to investigate and observe the spectral pattern and characteristics of red giants in M-type class. There are several reasons for specifically studying the red giants. From a theoretical perspective, this type of stars is already going to the end of their evolutionary track and some of the even predicted to end sooner or later or even assumed as already ends. It is out of curiosity to learn the spectral characteristics and chemical compositions of these late type stars.

The outline of this dissertation follows the sequence of chapters. This work consists of six chapters all together, which is organized as follows:

As an introduction, Chapter 1 provides a very brief description of the research background, problem statements or research questions, limitation and research methodology.

Chapter 2 contains the background theory of this study and the literature review that can be associated with this work. The chapter starts with the basic concept of astronomical spectroscopy. Later, the chapter also discusses the stellar classification base and its relationship with stellar evolution. The chapter will lay emphasis on the M-type as it is the main focus of this work. Then, red giants will be discussed briefly with the relation of stellar late phase and its theoretical structure.

Chapter 3 contains a description of the instruments used in this work. Also discussed is the experimental set-up used in observation session run at Langkawi National Observatory with other experimental equipments associated which are the camera detector and spectrograph. Brief discussion on the software used during the observation and the analysis process will be covered as well. The chapter also presents the observation procedures, steps on image reduction process and wavelength calibration.

Chapter 4 presents the method of data analysis and the results after the calibration process and the analysis. In this chapter, the spectrum will be studied thoroughly and will be compared with every observed red giant star in order to see a pattern or identify similarities among this same type stars. Also, some measurement will be conducted in this chapter to see the spectral strength in some chemical composition such as Hα.

Chapter 5 discusses the output from the analysis and to reason with reference of previous theories and studies. This chapter also discusses every possibility that produces the output.

Finally, Chapter 6 contains the summary of the research, conclusions and suggestion for future research directed from this work.