2015

The Magnetic Field of Theta1 Orionis C

Nicholas Fatta
Florida Institute of Technology

Recommended Citation
Fatta, Nicholas, "The Magnetic Field of Theta1 Orionis C" (2015). *Aerospace, Physics, and Space Science Student Publications*. 23.
https://repository.fit.edu/apss_student/23

The Magnetic Field of Theta^1 Orionis C

Nicholas Fatta, Faculty Advisor: Dr. Veronique Petit

Department of Physics and Space Sciences, Florida Institute of Technology

Introduction

θ^1 Orionis C is an O type star found in the Orion Nebula. An O type star on the main sequence is 15 to 90 times more massive than the sun, and has a surface temperature between 30,000 and 50,000 K. These massive stars were not thought to have magnetic fields until one was discovered around θ^1 Orionis C. Since then, it has been found that 10% of massive stars have magnetic fields. The magnetic field of a star can be measured by observing the Zeeman splitting in the spectral lines, or observing the circular polarization induced in the spectral line due to the Zeeman effect.

Magnetic fields In stars

Almost all low-mass stars host a dynamo generated magnetic field, while high-mass stars rarely have a magnetic field. These fossil magnetic fields are also different in their properties. High-mass stars have a fairly simple large-scale topology and show no intrinsic variability even over the time span of a decade.

Zeeman Effect

The easiest way to detect a magnetic field is through observing the Zeeman effect, which is the splitting of spectral lines due to a magnetic field. The magnetic field interacts with the magnetic dipole moment associated with the orbital and spin angular momentum. The problem with this method is the splitting is very small and so it is generally hard to detect if the magnet field is weak or if the spectral lines are broadened by other mechanisms. An example of this can be seen in figure 1.

Circular Polarization

Another method to detect the magnetic field of a star is by observing the circular polarization of the light. Circular polarization happens as light travels through a magnetic medium such as ionized gas. This medium acts similar to birefringent material. This technique is applied to measurements from θ^1 Orionis C in figure 2.

Phase of the Star

The phase number is a measure of where on the stars rotation the data is being taken. The phase ranges between 0 and 1 with 0 being 0° and 1 being 360°. Thus, a phase of 0.5 would mean the star rotated 180° from the first reading. The phase shows how uniform the magnetic field is across the surface. This also helps to determine if more data needs to be collected in the future. Each line in the figures below represent a different phase. The phase is shown by the number on the left of the line.

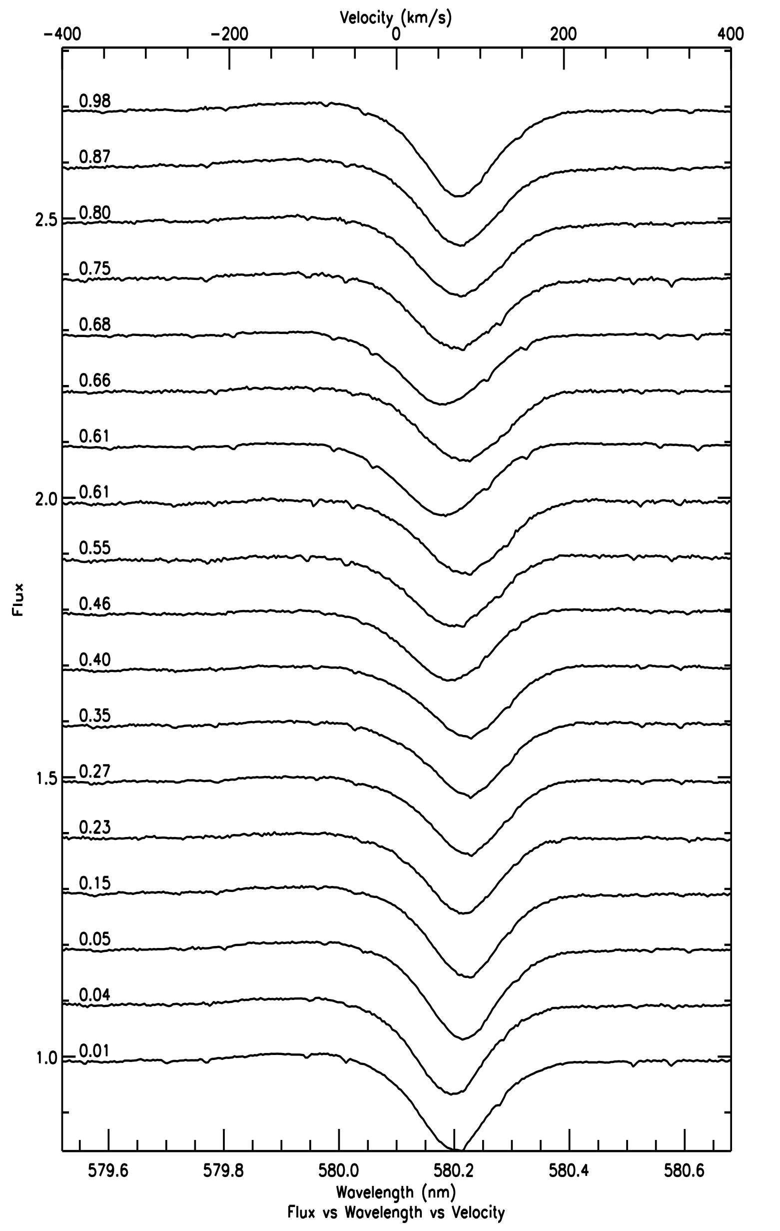

Figure 1. Flux vs wavelength at 580.1 nm. The shift in the graph is due to the Doppler effect. This graph illustrates the Zeeman splitting of the spectral lines when the spectral lines are broadened by other mechanisms. Each line is a different phase.

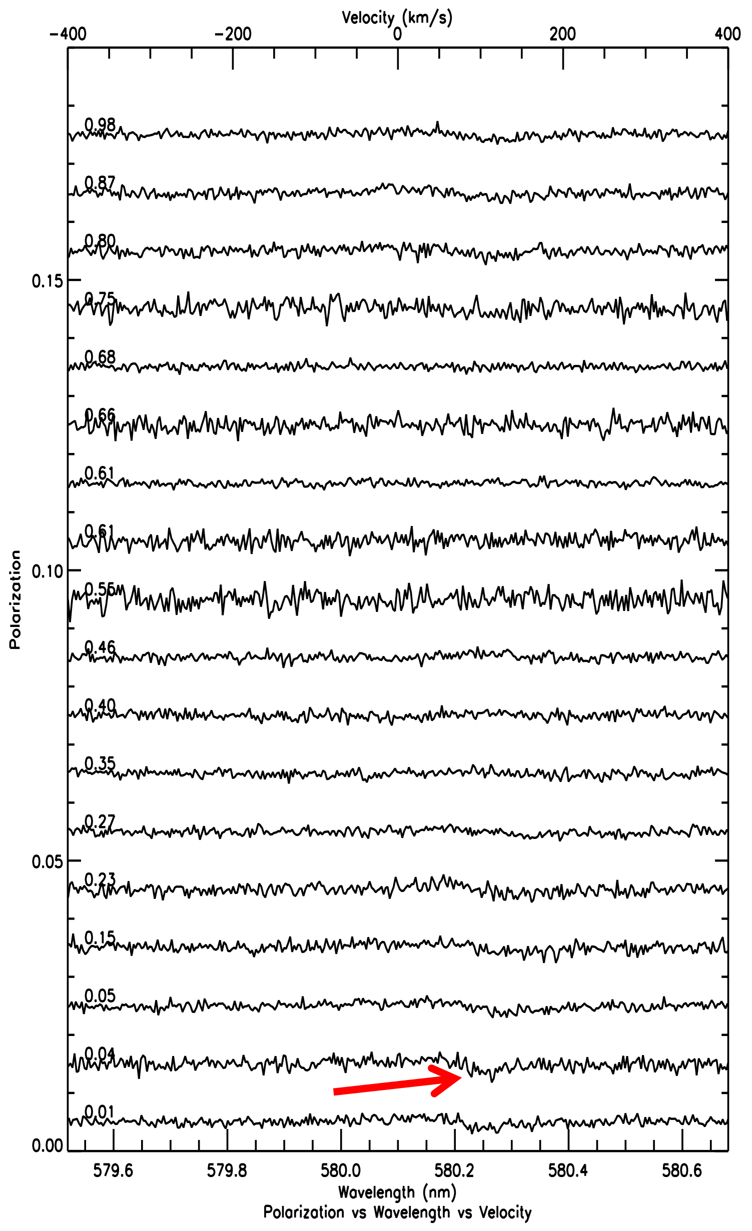

Figure 2. Circular polarization vs wavelength at 580.1nm. The steps at about 580.2 nm is caused by a magnetic field. Each line is a different phase represented by the number to the left.

Doppler Effect

The velocity in figures 1 and 2 was calculated by using the Doppler effect. The Doppler effect is the shift in wavelength when an object is moving. This shift can reveal if an object is moving towards or away from the reference point, as well as its speed. The velocity is calculated by using the following equation:

$$v = \frac{(\lambda_d - \lambda_n)}{\lambda_n} * c$$

Where v is velocity, λ_d is detected wavelength, λ_n is expected wavelength, c is the speed of light.

The velocity measured is the rotational velocity of the star.

Results

By using Idl to create figures 1 and 2 you can see two different methods used in identifying a magnetic field. As seen in figure 1 the Zeeman splitting is not obvious. In the case of splitting, the peeks would split into pieces. In figure 2, the step shown by the arrow indicates the star hosts a magnetic field. The lack of splitting in figure 1 is due in part to the technology available in observing the stars.

Conclusion

Although a magnetic field could not be detected by observing the Zeeman splitting, the circular polarization shows the existence of a magnetic field around θ^1. As I continue this research, the next step is to do a comparison against NGC1624-2 which is the most magnetic massive star known to date. Hopefully, this can give a better understanding as to why certain massive stars have magnetic fields.

Acknowledgements

I would like to thank Dr. Petit for the support and allowing me to do this under her guidance, along with Florida Institute of Technology and Northrop Grumman for making this possible.

NORTHROP GRUMMAN

Engineering & Science
Student Design Showcase
at Florida Institute of Technology