Project Stellar Motion using MATLAB

Abstract

The motion of the star away or towards the sun is known as radial velocity. When the same motion is perpendicular to the sun, it is known as tangential velocity. To measure the accurate velocities of the stars, its radial and tangential velocities uses the Pythagorean Theorem to calculate overall motion.

The radial velocity of a star can be measured by the Doppler effect that its motion produces in its spectrum, and is more or less instantly determined by measuring the wavelengths of absorption lines in its spectrum, which can be accomplished regardless of its distance from the Sun, providing that it is bright enough to observe its spectrum in the first place. The only way that its distance affects the measurement is that the further away it is the fainter it appears, so the longer it takes to collect enough light to observe its spectrum.

To measure the tangential velocity, however, we must wait for the star's apparent position in the sky to change due to the proper motion produced by its tangential velocity. If the star has a large tangential velocity and is relatively close to the Sun, it may have a large proper motion. Barnard's Star, a red dwarf which happens to be a high-velocity star and is also the second closest star to the Sun

(counting the Alpha Centauri system as a single object), has a proper motion of more than ten seconds of arc per year, so its tangential velocity can be measured in just a few months.

In this stellar motion project, we will use the software called MATLAB to examine the spectrum of HD94028. HD94028 is faint star from the constellation of Leo, whose diffraction grating results will guide towards the motion.

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1. Introduction

Legitimate Motions. Legitimate Motion is the obvious rakish movement of a star over the sky regarding increasingly far off stars. This is the projection onto the sky of the star's actual movements through space with respect to the Sun.

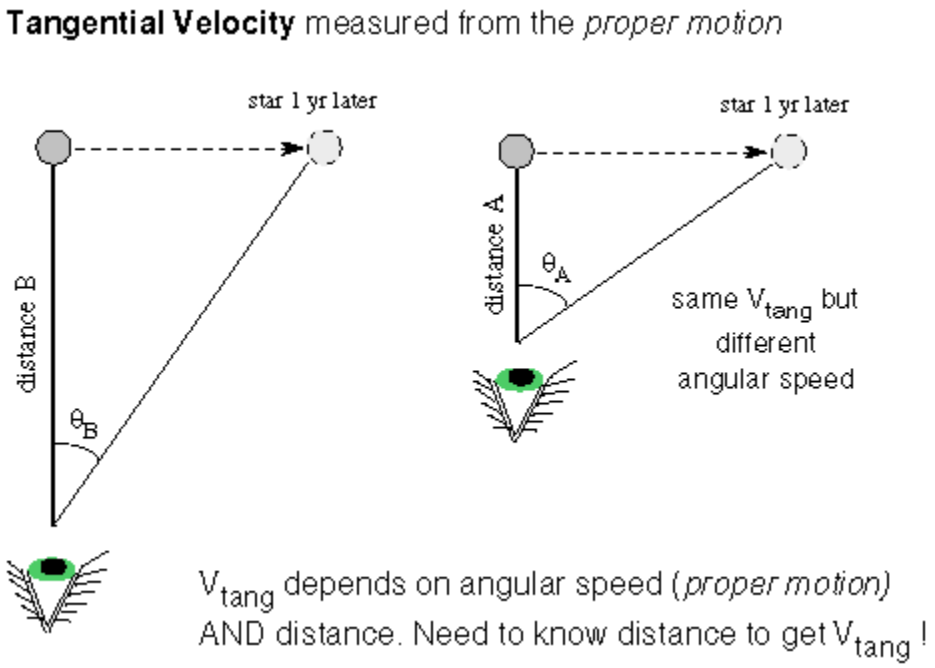
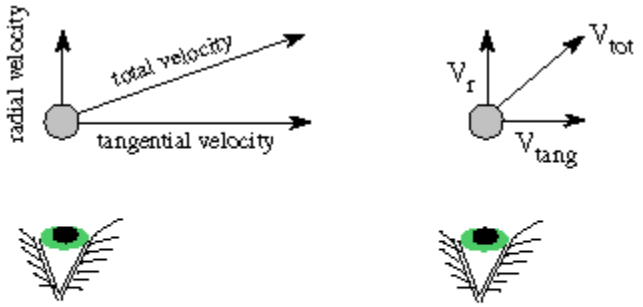


Fig 1: Tangential Velocity

To get the digressive/tangential speed, you have to initially quantify the rakish speed of the star over the sky (d/dt). This is what number of degrees on the sky the star moves in a given measure of time and is known as the best possible movement by space experts.



Two stars with the same **radial velocity** (line-of-sight) but very different **tangential velocities** and, therefore, very different **total velocities**. The radial velocity is measured from the doppler effect. The tangential velocity is derived from the angular speed and star's distance.

Fig 2: Radial Velocity

Appropriate movement, in space science, the evident movement of a star over the heavenly circle at right points to the onlooker's viewable pathway; any outspread movement (toward or far from the Sun) is excluded. ... … conceivable just when the two its legitimate movement and outspread speed can be estimated.

2. Spectrum of HD94028

When the sunlight strikes the star it produces a spectrum in which the information of the diffraction grating gives a clue about the star properties.

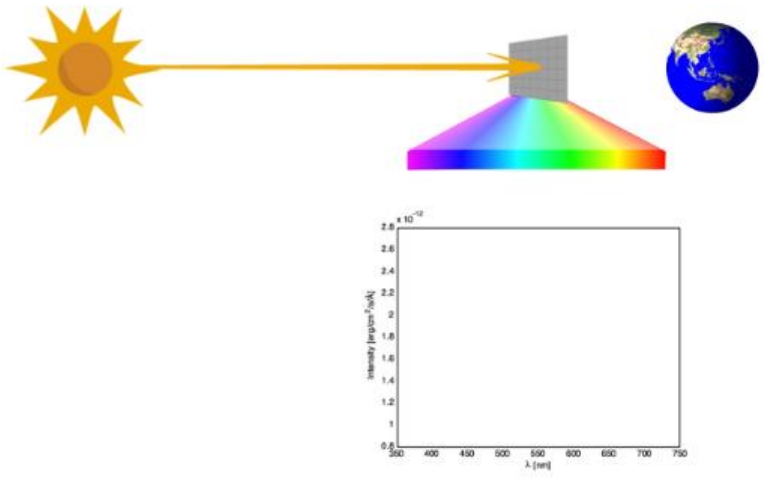


Fig 3: Sunlight striking the star to produce diffraction grating

With the help of this spectrum, we can able to get the spectrum graph of HD94028. The graph has several spikes which denotes the color radiation. The more the spike is, the less is the radiation.

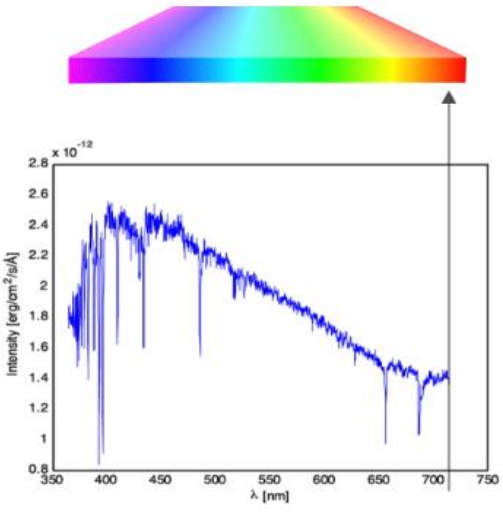


Fig 4: Spectrum of HD94028

HD94028 is part of constellation of Leo. Like HD94028, many stars which forms constellations like Leo can be examined with the help of their spectrum. The basic need for this work is proper information and elements involved in the spectrum and the amount of mixing of chemicals from the outer space.

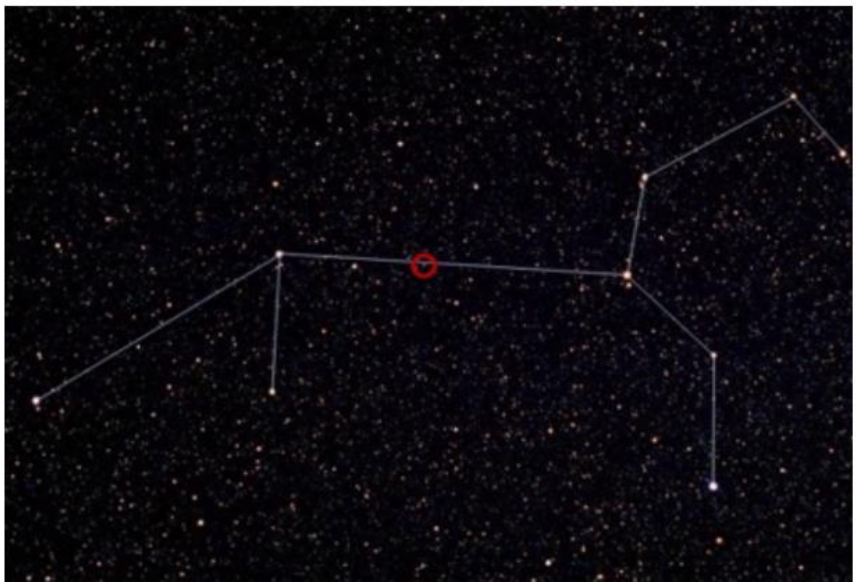


Fig 5: Leo constellation

The deep spike as discussed earlier, denotes the amount of hydrogen mixed in that particular area. Here we can see the spike is around red color region of the sunlight spectrum. The red color regions spike gives a clue that at the particular point of spectrum the hydrogen is absorbing light of only 656.3 nm.

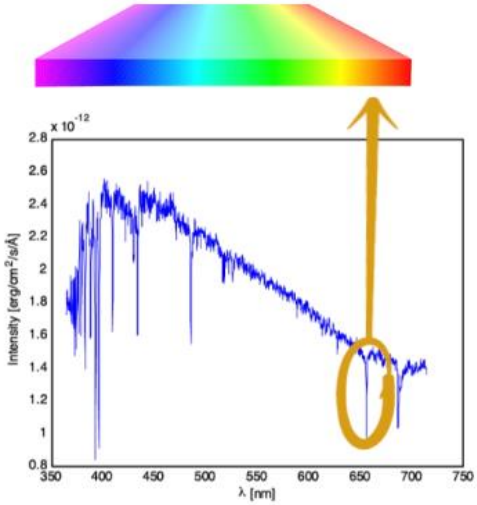


Fig 6: Spike occurred in the spectrum

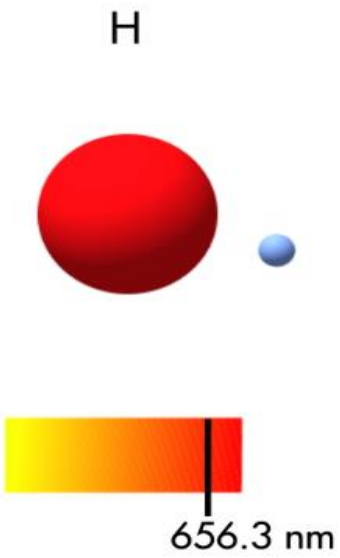


Fig 7: The absorption of light by Hydrogen atom

3. Project Description

After getting the spectrum of HD94028, the next step is to determine the exact characteristics of the spike which occurred in the red color region also known as hydrogen alpha.

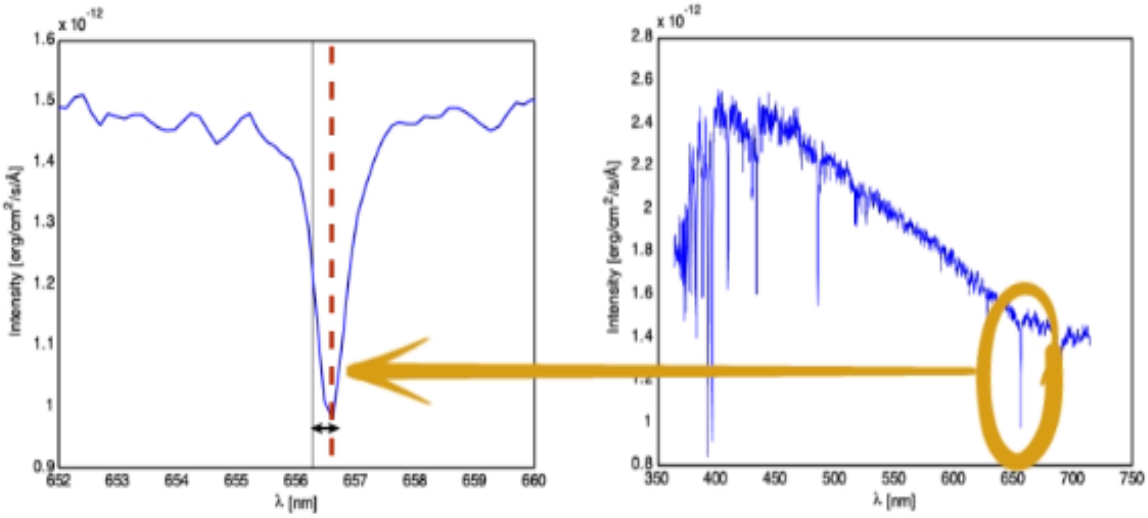


Fig 8: Difference between spike: Original and Spectrum

To display this spike in MATLAB, we insert several information about the spectrum so the accurate image comes to the display.

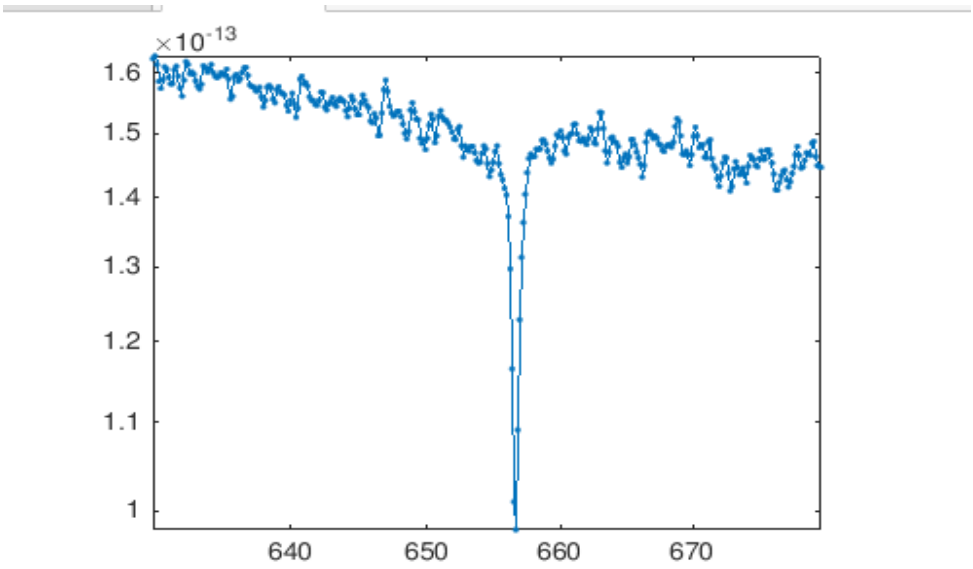


Fig 9: Spectrum obtained in MATLAB

Now this spectrum needs to clarify about the wavelength of hydrogen, loss data and the value at which the spike occurs. This further demonstration is done in the development part of the project.

4. Development Process

The following code displays the spectrum of HD94028:

```
load starData;
nObs= size(spectra, 1);
lambdaStart= 630.02;
lambdaDelta= 0.14;
lambdaEnd= lambdaStart + (nObs-
1)*lammdaDelta;
lambda=(lambdaStart:lambdaDelta:lambdaEnd);
s=spectra(:,6);
loglog(lambda, s, '-');
[sHa, idx]= min(s);
sHa= 9.8010e-14 (result)
idx=191 (result)
lambdaHa=lambda(idx);
lambdaHa=656.62 (result)
```

After obtaining the value of lambdaHa, we are now supposed to determine the wavelength of hydrogen-alpha line.

```
hold on;
```

```
loglog(lambdaHa, sHa, 'rs', 'MarkerSize',
8)
hold off
z=lambdaHa/656.28-1;
speed=z*299792.458;
```

5. Conclusions

From the above code, we conclude that:

- MATLAB has generated a virtual spectrum of HD94028 to clarify the hydrogen alpha wavelength.
- After creating the spectrum of HD94028, it has also changed the coordinate details to capture the spectrum of HD10032.
- Theoretically, the hydrogen absorption is around red color of white color spectrum which gives the value of 656 nm. The MATLAB experiment gives the value of about 656.62 nm, which is a slight accurate value.

6. References

- https://cseligman.com/text/stars/stellarmotion.htm
- https://www.astronomynotes.com/starprop/s8.htm
- http://www.astronomy.ohio-state.edu/~pogge/Ast162/Unit1/motions.html
- https://in.mathworks.com/
- http://userpages.irap.omp.eu/~jleborgne/stelib_web2005/asfiles/HD94028_moy.txt