Line profiles in red giants of NGC 6752

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Abstract:

This paper will encompass the research work that took place during the summer REU program at McDonald Observatory. The research done was on the atmosphere of red giants by looking and the analyzing of the core line shifts.

Introduction:

The raw data of NGC 6752 was gathered from the VLT (Very Large Telescope) located in Chile. The data came to me as massive tables that held wavelength, flux, and aperture. For each of the given stars, the spectrum was from an echelle spectrograph that first broke the data to the red half and the blue half. With the red half, the spectrum is broken up into 15 apertures; the blue, into 23 apertures. There was some overlapping of wavelengths when going from one aperture to the next so that there were no gaps in the information. This overlapping of information will come into play in a little bit.

So, with these tables of measured wavelength, flux, and aperture, I was able to 'transform' this three column table to a ten column table through an idl program given to me by Carlos Allende Prieto with some minor adjustments. The columns created were the following:

Measured wavelength, error on that wavelength, Solar wavelength, error on the Solar wavelength, the Ion of the line, Excitation potential, log (gf) (the oscillator strength), equivalent width, the minimum point of the flux, and aperture

Once the table above is completed, the issue of the repeat lines needed to be addressed. So, by using the following equation, I was able to properly handle the situation.

$$U' = (\Sigma(xi/\sigma 2) / \Sigma(1/\sigma 2))$$

With this equation, I was able to weight the information so that no data was thrown out or 'cook' the data in any way.

The next step was to find rotational velocities for each of the stars. Through the following equation the velocities for each identified line were found.

$$V = ((\text{ Measured wavelength - Solar wavelength})/ (\text{Solar wavelength})) * c$$

With the error calculated by:

$$\sigma v2 = (\partial V / \partial m)2 \ \ \sigma m2 + (\partial V / \partial s)2 \ \sigma s2 + (\partial V / \partial c) \ \sigma c2$$

By using iraf, I plotted the velocity verses equivalent widths ended up with two different results, positive slopes and negative slopes as shown in figure 1 and 2. The positively sloping graph is what is more expected when studying red giants, for that means that the star's atmosphere is expanding. With the negatively sloping graph (see figure 2), it more than likely means that the atmosphere is contracting, which may mean that that particular star is going through a period of pulsation. This result is very exciting, for little is known about the exact details of pulsation within red giants.

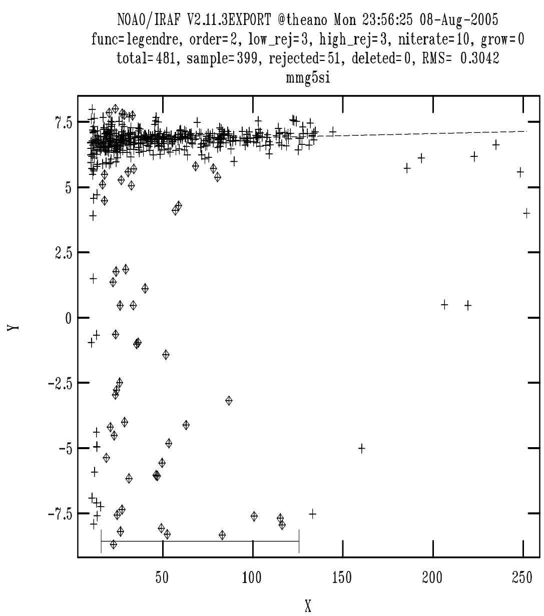

Figure 1 is an example of a resulting positively slope graph from the star mmg5, showing velocity vs. equivalent width.

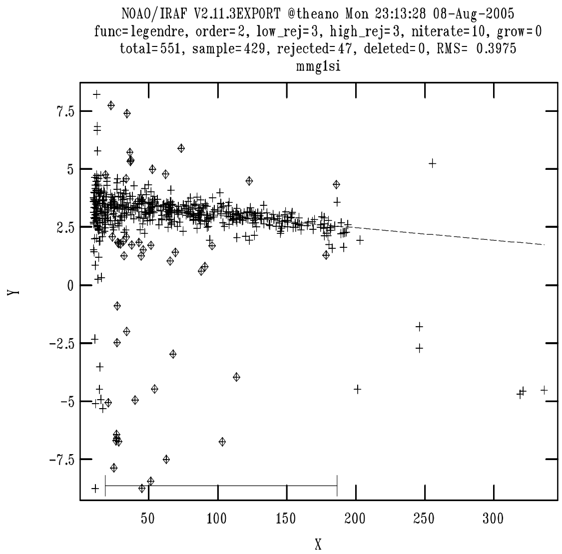

Figure 2 is an example of one of the negatively sloping graphs. This shows star mmg1's velocity vs. equivalent widths

For each of the stars, two similar plots (like those above) were found and the slope of the fit line was recorded. Making sure that the two fit-line-slopes agreed with the red and blue parts of the spectrum (for the individual stars) before averaging the values was very important to be able to notice any discrepancies. Similar measures where used in comparing the excitation potential to rotational velocity.

In Yong et al. 2003, NGC6752 was studied for different reasons. By combining their work along with mine, I was able to create the table shown on the subsequent page. I did graph the both equivalent width and excitation potential the other columns to see if there was any noticeable relationships. There are definitely correlations between the stage of the red giants and the slope relation of equivalent width/velocity.

The field of red giants has barely been touched, with an insight into one aspect of red giant a wide range of questions and possibilities.

Source:
Yong, Grundahl, Lambert, Nissen, and Shetrone. 2003 A& A 402, 985-1001

Name	Teff (K)	log g (cm s^-2)	ξ (km s^-1)	Macro (km s^-1)	Al	Red slope	Blue slope	Avg Slope	EP Red	EP Blue	EP Avg
mg0	3928	0.26	2.7	5	5.91	2.52E-03	3.64E-03	3.08E-03	-7.90E-04	-9.98E-04	-8.94E-04
mg1	3900	0.24	2.7	4.75	5.65	-5.08E-03	-6.19E-03	-5.63E-03	1.62E-03	2.04E-03	1.83E-03
mg2	3894	0.33	2.5	6	5.6	3.02E-03	2.17E-03	2.60E-03	-1.42E-03	-9.20E-04	-1.17E-03
mg3	4050	0.5	2.2	5.5	5.6	1.21E-03	2.26E-03	1.73E-03	-2.72E-04	-6.96E-04	-4.84E-04
mg4	4065	0.53	2.2	5.5	5.73	-8.31E-04	-1.06E-03	-9.44E-04	3.43E-04	9.44E-05	2.19E-04
mg5	4100	0.68	2.1	5	5.57	1.93E-03	1.89E-03	1.91E-03	-4.83E-04	-5.74E-04	-5.29E-04
mg6	4154	0.8	2.1	4.5	5.4	4.95E-04	1.52E-03	1.01E-03	-5.59E-04	-3.06E-04	-4.33E-04
mg8	4250	0.91	2	5	5.57	3.78E-04	3.77E-03	2.07E-03	3.29E-04	-1.42E-04	9.34E-05
mg9	4288	0.9	1.9	5	5.6	-4.44E-04	2.28E-04	-1.08E-04	-1.04E-04	6.33E-05	-2.05E-05
mg10	4264	0.94	1.8	4.75	5.61	-8.73E-04	1.70E-03	4.11E-04	-1.59E-04	-2.22E-04	-1.90E-04
mg12	4286	1.02	1.8	5.25	4.92	-1.12E-03	7.36E-04	-1.91E-04	-1.06E-04	-4.24E-04	-2.65E-04
mg15	4354	1.11	1.9	5.25	5.55	-1.88E-03	-3.85E-04	-1.13E-03	-3.60E-04	1.84E-04	-8.82E-05
mg18	4398	1.2	1.8	4.75	5.42	-3.24E-04	6.93E-04	1.84E-04	1.84E-04	-2.35E-04	-2.59E-05
mg21	4429	1.2	1.8	5.25	6.01	-7.19E-04	9.27E-04	1.04E-04	-2.35E-04	-2.35E-04	-2.35E-04
mg22	4436	1.31	1.8	5	5.82	-1.84E-03	1.49E-03	-1.75E-04	-4.43E-04	-6.42E-04	-5.42E-04
mg24	4511	1.33	1.9	5	4.95	-3.43E-04	1.38E-03	5.18E-04	-1.74E-04	-5.96E-04	-3.85E-04
mg25	4489	0.5	1.7	5.25	5.34	1.93E-04	1.76E-03	9.77E-04	-3.96E-06	-4.02E-04	-2.03E-04
hd141531	4273	0.8	1.9	5.5	4.74	-1.41E-03	3.54E-04	-5.30E-04	-3.51E-04	-1.83E-04	-2.67E-04
hd103036*	4200	0.1	3.1	7.25	5.08	-1.11E-03	-1.11E-03	-1.11E-03	1.42E-04	1.42E-04	1.42E-04