# Measuring Emissions from the Solar Chromosphere

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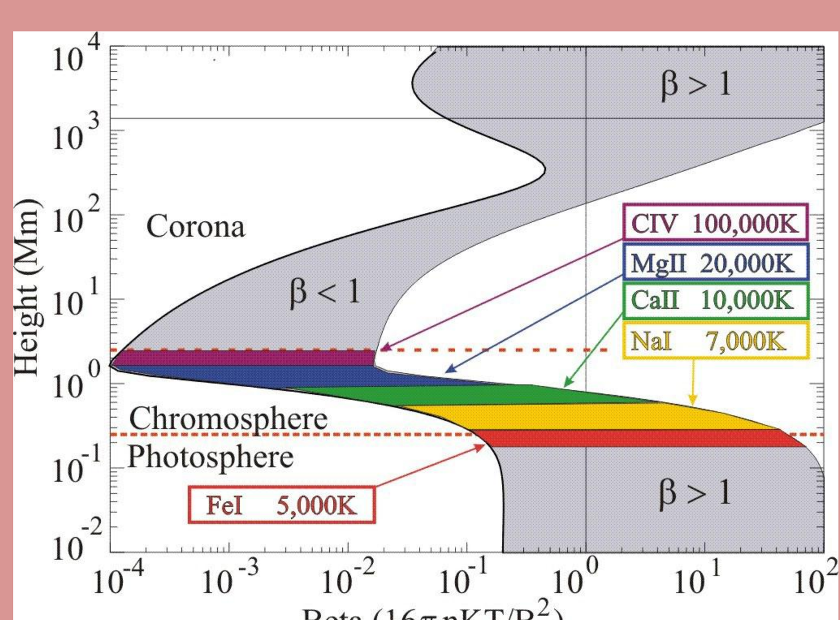
## Abstract

Accurate measurements of solar emissions are crucial in understanding the behavior of magnetic fields in areas of the solar atmosphere above the photosphere. We have used a custom built Carbon lamp as well an Extreme Ultraviolet source to calibrate detectors which will be sent to space to measure various types of emissions. If successful, the data collected will allow researchers to gain a better understanding of how solar activities such as flares and coronal mass ejections occur, and enable them to issue real-time alerts when these phenomenon occur.

## Introduction/Background

- Measurements and characterizations of the magnetic fields in the solar photosphere (where solar dynamics are dominated by gas pressure) have been successful.
- However, in areas where solar dynamics are dominated by magnetic fields, such as in the chromosphere and the transition region between the chromosphere and the corona, direct measurements of the magnetic fields are difficult.
- Indirect measurements are possible using several ions which are produced in these regions.

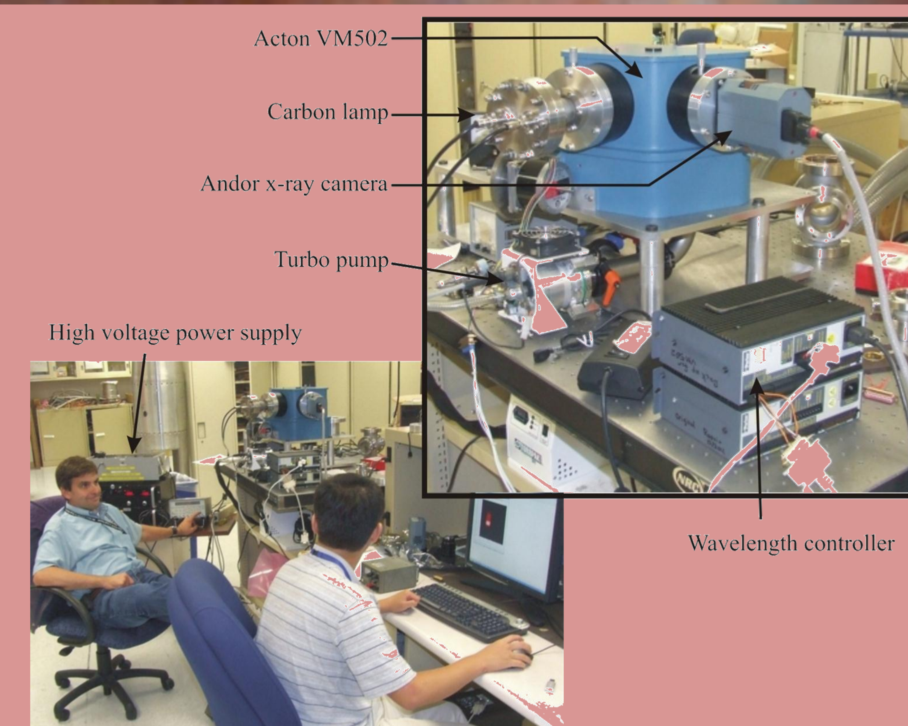



*Original by G.A Gary*

Ratio of gas pressure to magnetic pressure (β) for several regions of the solar atmosphere, as well as ions produced at various temperatures.

- A carbon lamp was constructed to produce CIV (Carbon 4) and a X-ray camera was used to record its spectral line emissions over a range of wavelengths.
- CIV emits at a wavelength of 155nm. A strong, bright spectral line at that wavelength would indicate that the carbon lamp is working as desired.
- The carbon lamp will be used to calibrate CIV detectors on the SUMI (Solar Ultraviolet Magnetograph Investigation) sounding rocket.

## Methodology

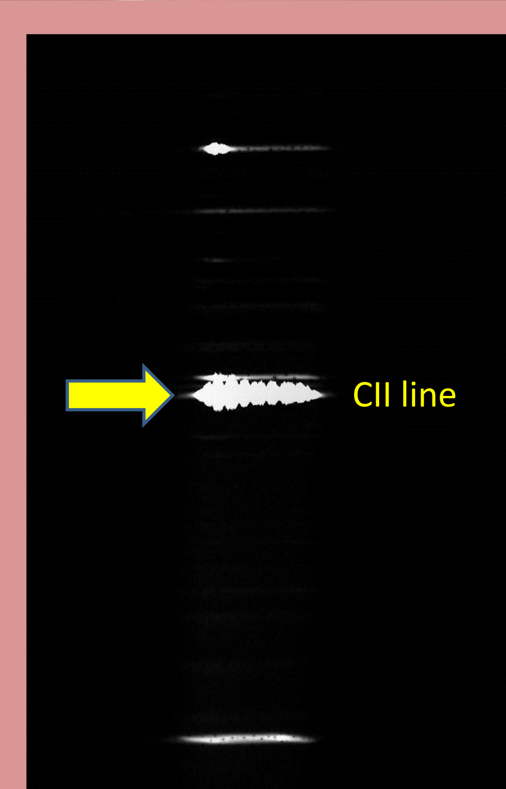



Carbon lamp test set up

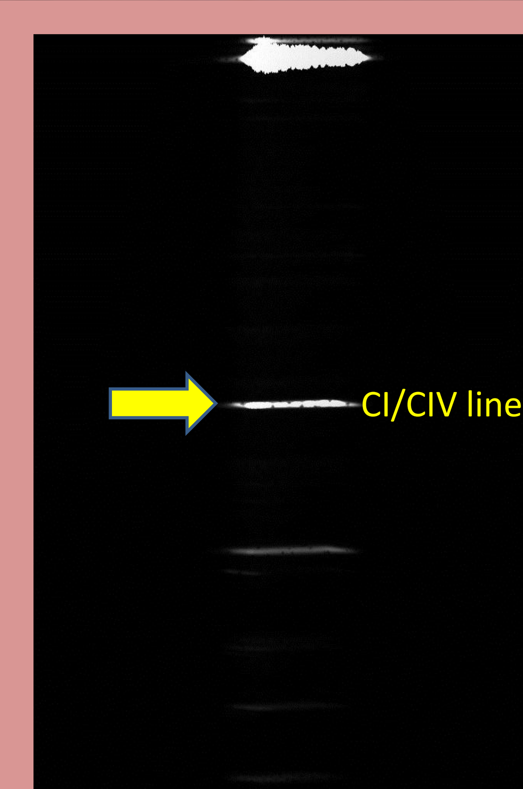
- The carbon lamp and the X-ray camera were connected to the Acton VM502 monochromator. A vacuum pump was used to reduce the pressure inside the monochromator to less than $10^{-3}$ torr.
- A Labview program was used to adjust the wavelength controller.
- Several other lamps were used to calibrate the monochromator using known spectral lines.

| Lamps Used | Wavelength Ranges (nm) |
|---|---|
| 1. Carbon | 120-170 |
| 2. Mercury | 170-340 |
| 3. Deuterium | 120-180/260-300 |
| 4. Platinum-Neon | 130-180/260-310 |

## Results




Carbon lamp at 133nm



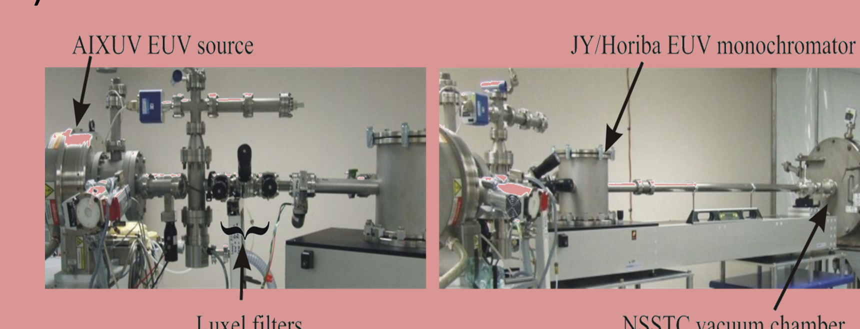

Carbon lamp at 156nm

## Conclusion

- The carbon lamp produced excellent results at 133nm, which is the emission wavelength of CII.
- However, the results at 155nm/156nm are very ambiguous.
- CIV emits at a wavelength of 155nm, but CI emits at 156nm.
- The data gathered so far cannot be used to resolve the CI/CIV spectral line.
- The carbon lamp does produce carbon ions, but at this time it is impossible to conclusively state whether the lamp produces CI, CIV, or some combination of both.

## Future Work

- Replace the existing interface between the carbon lamp and the monochromator with a custom built interface to improve image focus.
- Move the X-ray camera into the extreme ultraviolet (EUV) set up to calibrate detectors for the Hi-C (High resolution Coronal imager).




EUV experimental set up

## Acknowledgements

- Jonathan Cirtain, MSFC- ZP13
- Edward A. West , MSFC-ZP13
- James J. Richeson, MSFC-ZP11
- NASA Academy Program

## References

[1] E. West, K. Kobayashi, J. Cirtain, A. Gary, J. Davis and J. Reader, "Toroidal Variable-Line-Space Gratings: The Good, the Bad and the Ugly," SPIE: Optical System Alignment, Tolerancing and Verification III, **7433**, 17 (2009)