Analysis of Atmospheric Differential Refraction on OSIRIS Infrared Spectra

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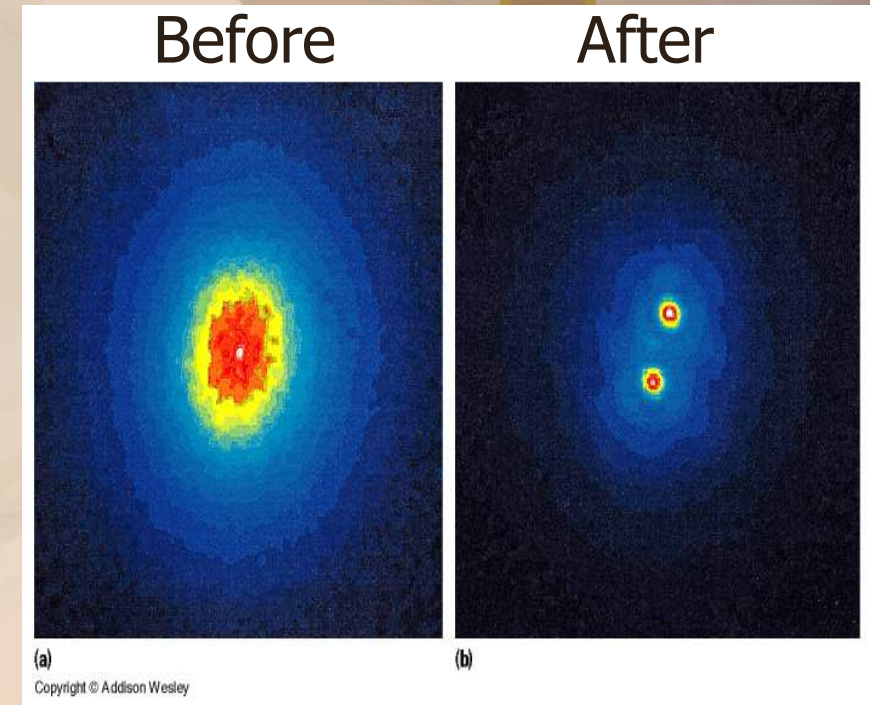
Photo:**http://**www.stecf.org**/~**rfosbury/home/photography/Keck/1996/MK_sunset_2.gif

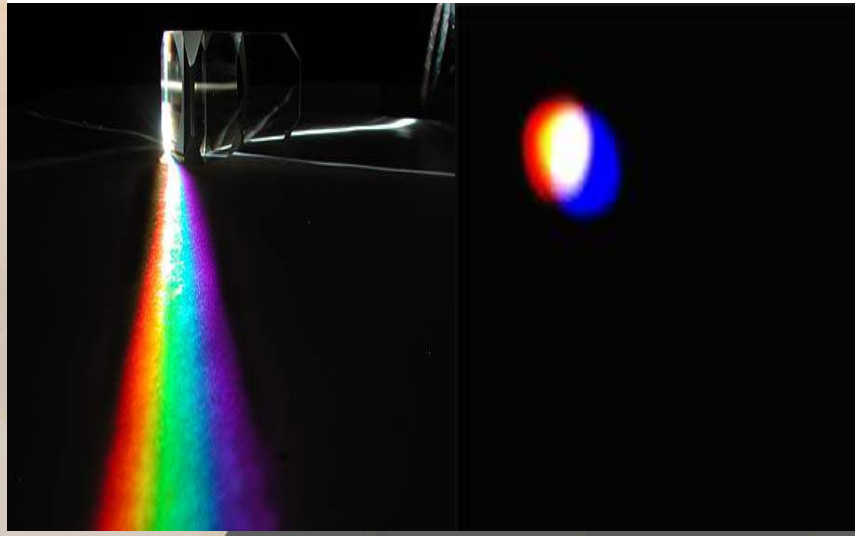
OVERVIEW

- The Problem
- Goal
- Analysis
- Results
- Conclusion

The Problem: ADR

- Keck II Adaptive Optics(AO) works well in correcting for the turbulence in the Earth's atmosphere.
- AO does not correct for Atmospheric Differential Refraction (ADR).
- ADR is the refraction of starlight by the atmosphere.



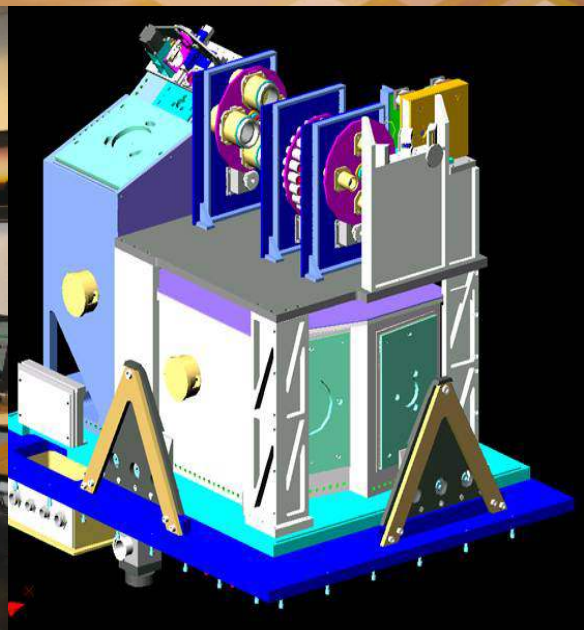


http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=36585, www-nutev.phyast.pitt.edu, http://www.rit.edu/~andpph/photofile-c/prism-DSCN4982.jpg

What is OSIRIS?

- The OH-Suppressing Infra-Red Imaging Spectrograph (OSIRIS)
- OSIRIS may take up to 3000 spectra and act as a CCD Imager simultaneously.
- First light was achieved February 22 2005!

Keck II

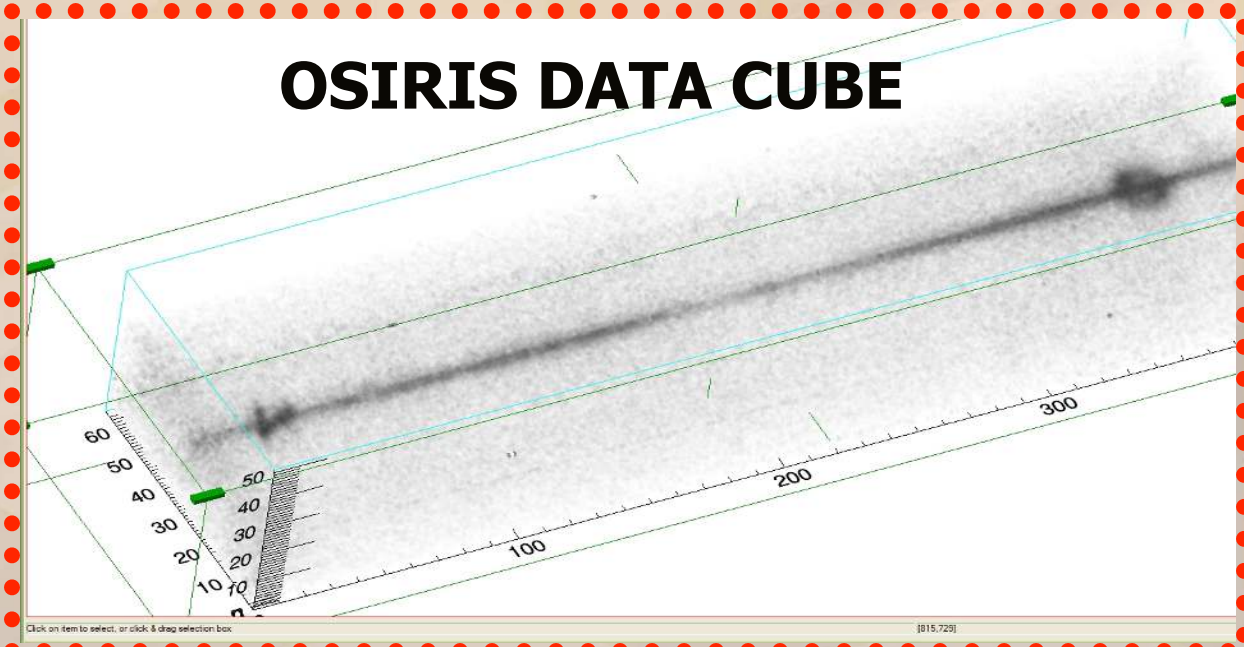


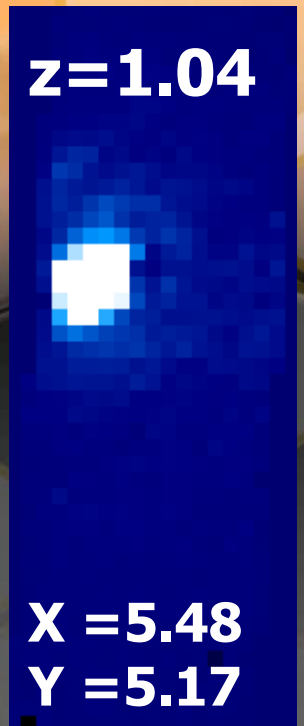
Meeting OSIRIS for the first time

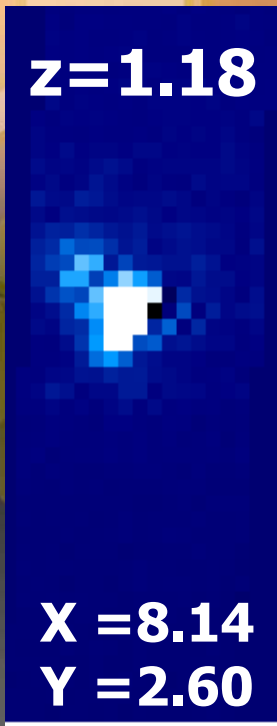
- In week two
  - Randy Campbell, mentor
  - UCLA Professor James Larkin , OSIRIS Principle Investigator
- On Mauna Kea we did some troubleshooting on OSIRIS.

The Problem: ADR on OSIRIS Spectra

- The OSIRIS spectra is combined to form a 3-D “data cubes”.
- There is a spectrum for each pixel.
- ADR shift causes incomplete spectra.







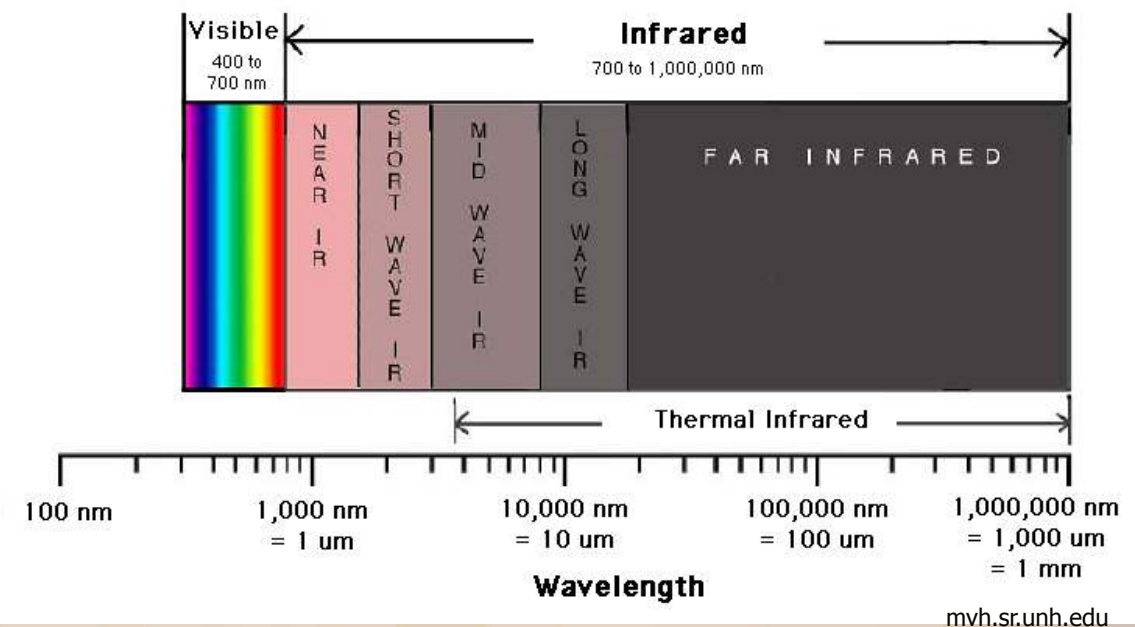
Goal of Analysis

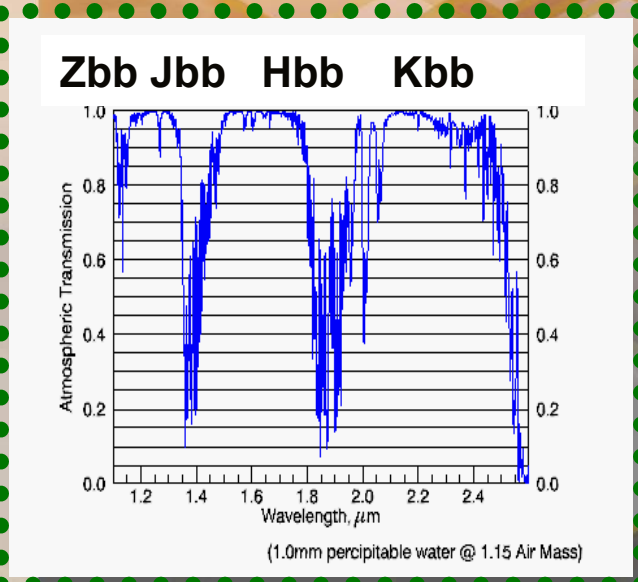
- **To predict the shift of stars through an OSIRIS data cube.**

Analysis Methods

- **PART I : MEASURED SHIFT**

- **The atmosphere allows only certain bands of near-infrared wavelengths (1.1 – 5 microns) to enter the 10m Keck mirror.**

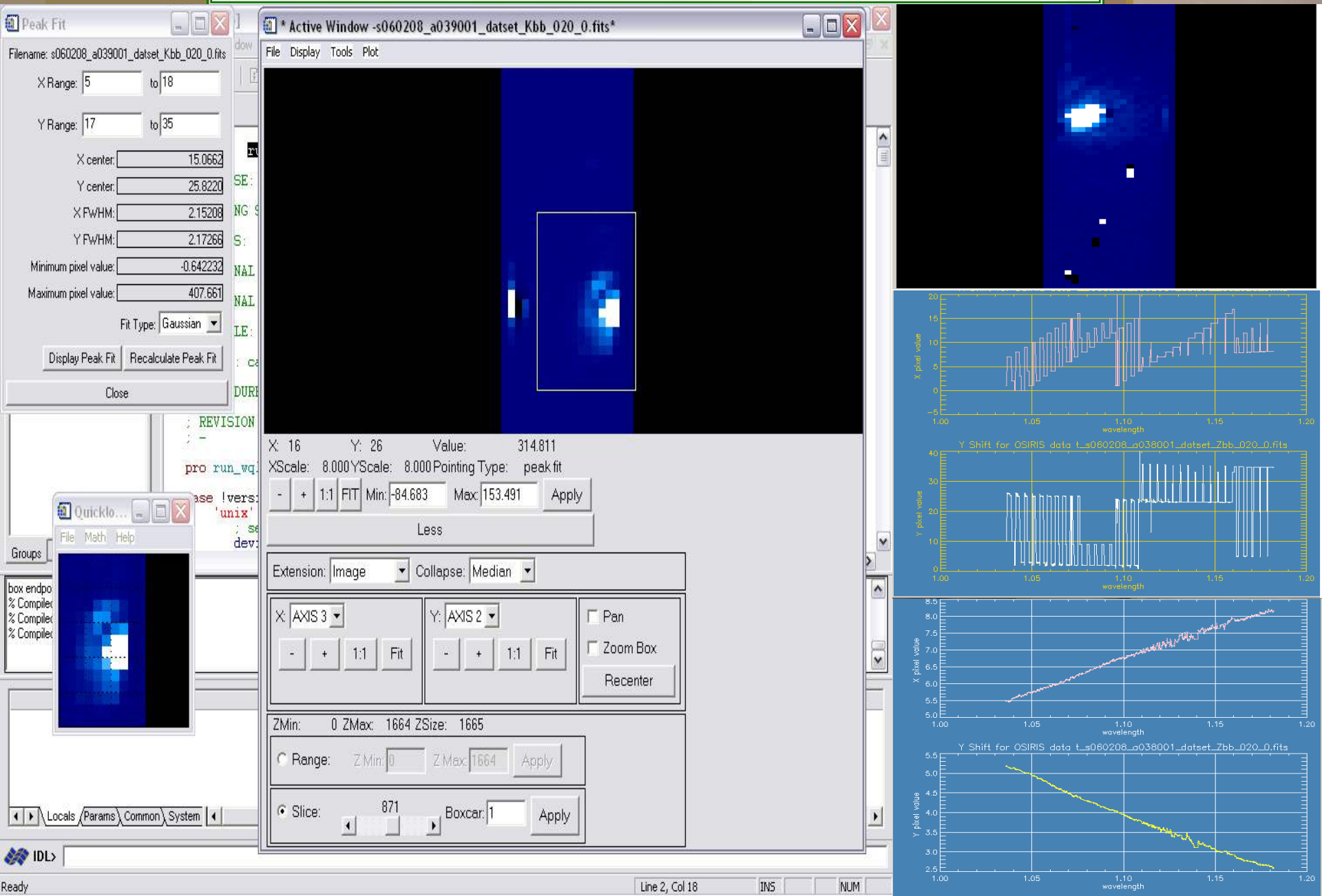




- **OSIRIS uses filters at these wavelengths to isolate the spectral data.**

http://tycho.bgsu.edu/~laird/cp_images/keck.jpg Plot from Keck website

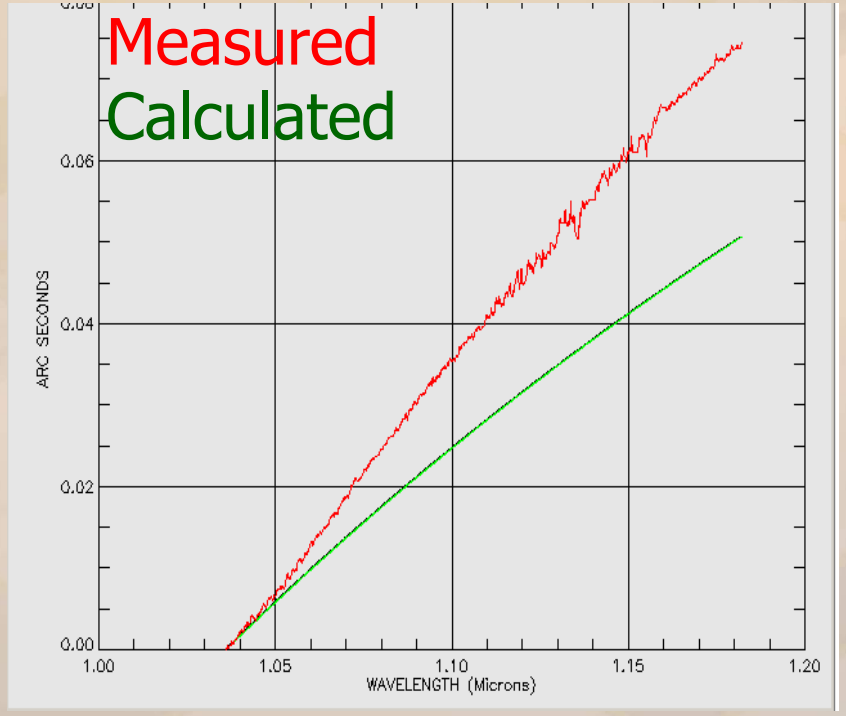
Analysis Methods



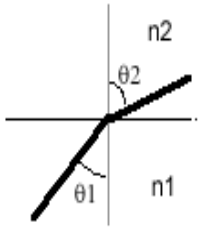
Analysis Methods

- **PART II : CALCULATED SHIFT**
- **Fillipenko 1982 & Roe 2002**
- **Edlen 1953**
- **Snell's Law & the atmosphere**

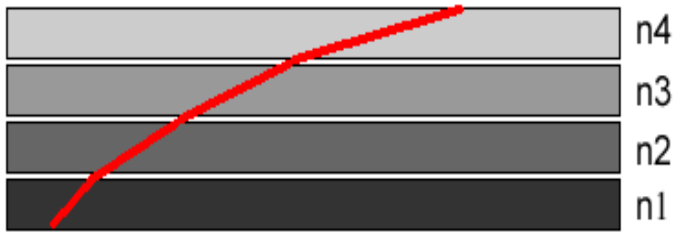
$$(n(\lambda)_{15,760} - 1)10^6 = 64.328 + \frac{29498.1}{146 - (1/\lambda)^2} + \frac{255.4}{41 - (1/\lambda)^2}$$



Snell's Law



$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{n_2}{n_1}$$



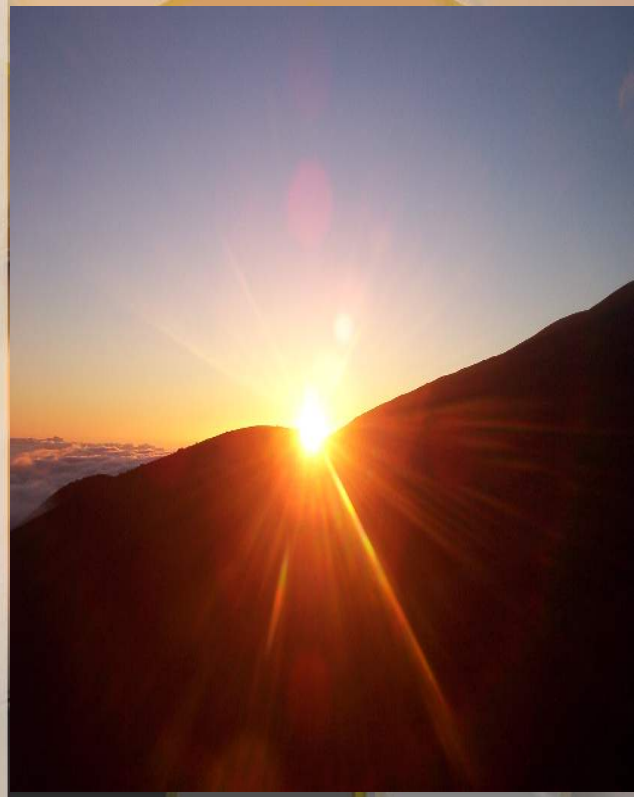
$n_1 > n_2 > n_3 > n_4$

Analysis Methods

- **We were able to find one last equation,**

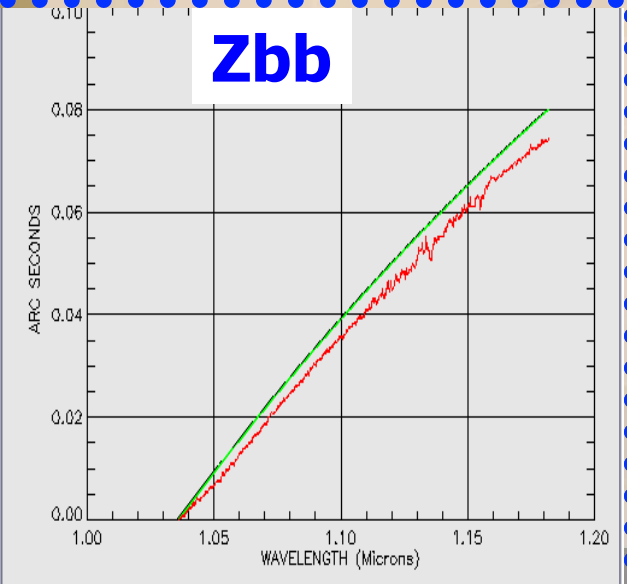
Peck & Reeder (1972)

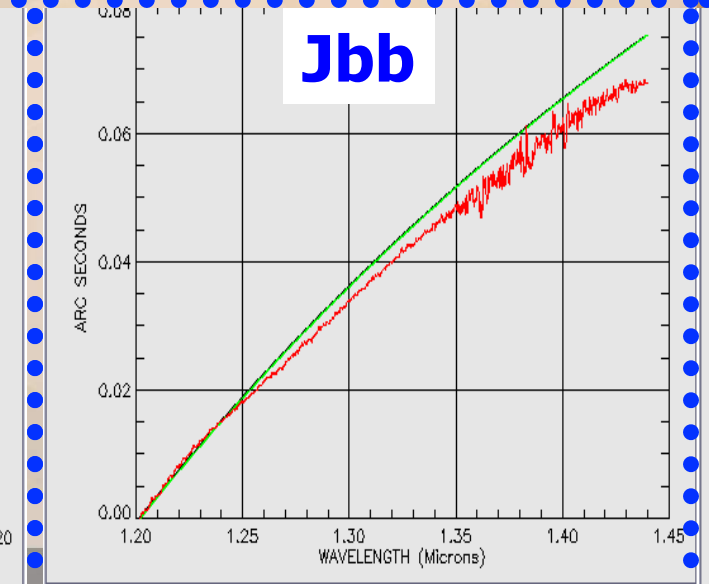
$$(n-1)\times 10^8 = 8342.13 + \frac{2\,406\,030}{130-\sigma^2} + \frac{15\,997}{38.9-\sigma^2}$$

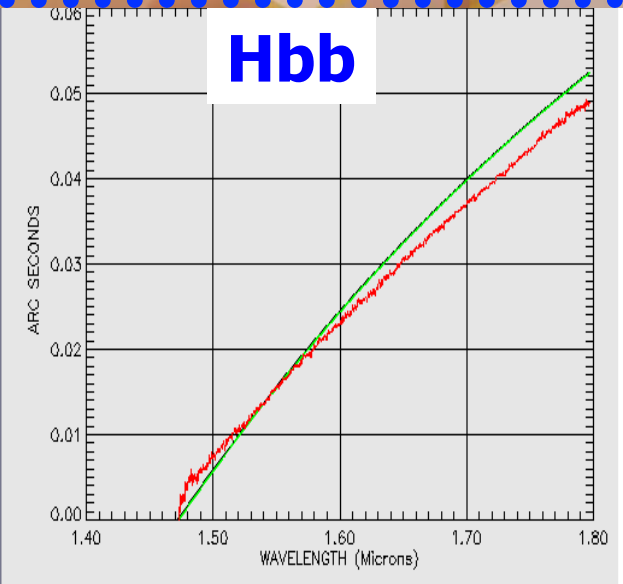


RESULTS

NIR Window microns	Pixel Spectra Array	Start Cent. (X,Y)	End Cent. (X,Y)	M Shift arcsec	C Shift arcsec	Diff. milli-arcsec
Zbb λ (1.04-1.18)	64x19 x1218	(5.48, 5.17)	(8.14, 2.60)	.0740	.0800	**6.00**
Jbb λ (1.20-1.44)	64x19 x1587	(4.37, 5.51)	(6.75, 3.07)	.0679	.0753	**7.38**
Hbb λ (1.47-1.80)	64x19 x1620	(4.48, 4.01)	(6.31, 2.39)	.0488	.0523	**3.47**



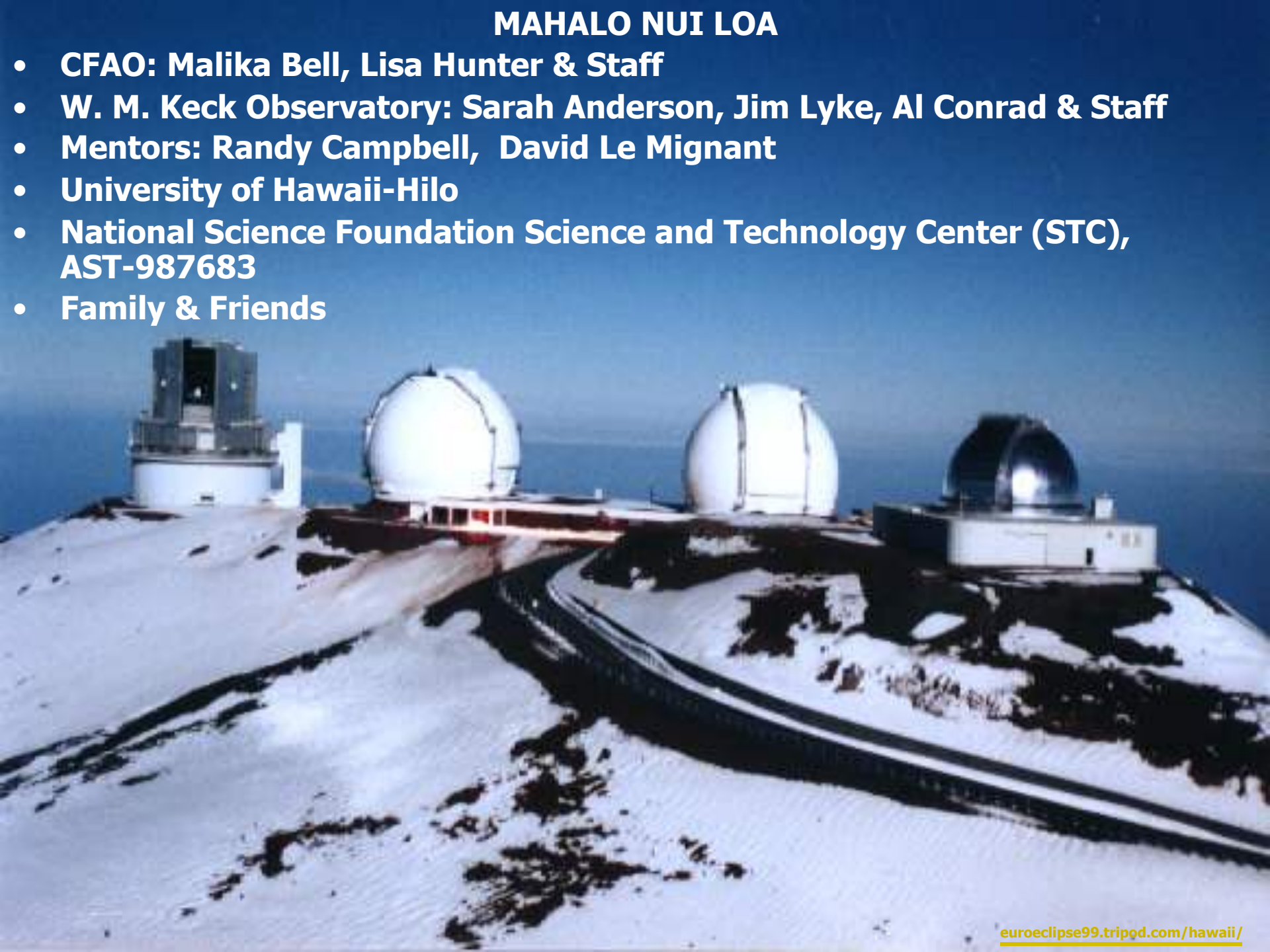




Conclusion

- This was an awesome project
- Reduce the separation even more
- Apply the analysis
- Future collaboration

http://www.noao.edu/image_gallery/images/d5/dumba.jpghttp://www.solstation.com/stars/earth.jpg

MAHALO NUI LOA

- CFAO: Malika Bell, Lisa Hunter & Staff
- W. M. Keck Observatory: Sarah Anderson, Jim Lyke, Al Conrad & Staff
- Mentors: Randy Campbell, David Le Mignant
- University of Hawaii-Hilo
- National Science Foundation Science and Technology Center (STC), AST-987683
- Family & Friends