Background

Research Goals

Experimental Set Up

Data Analysis

Conclusions
Cosmology and Microwave Radiation

COBE Cosmic Microwave Background

Spitzer "First Light"

Hubble Deep Field

Microwaves

Infrared

Visible

BIG BANG

0 yrs

400,000 yrs

400 million yrs

13.7 billion yrs

Timeline of the Universe

Spitzer Space Telescope • IRAC

NASA / JPL-Caltech / A. Kashlinsky (Goddard Space Flight Center)
Why can’t we see microwaves?

Electromagnetic Spectrum – Absorption Percentage vs. Wavelength
Why do molecules absorb different wavelengths differently?

Rotational Mode
• Molecules rotate when they absorb radiation

Vibrational Modes
• Occurs at higher energy
• Can combine rotational with different vibrational modes

Asymmetrical Stretching
Scissoring
Symmetrical Stretching

Symmetrical Stretching  Scissoring  Asymmetrical Stretching
Where does water vapor fit in?

- Liquid phase condenses, scattering visible and infrared
- Gas phase absorbs and emits in infrared and microwave spectra
- Fluctuates spatially and temporally
Research Goals

• Understand the emission/absorption of water vapor
• Monitor water vapor in the infrared
• Determine if there is a correlation between microwave and infrared
• Remove water vapor interference from microwave data
Infrared and Visible Cameras

- Monitor water vapor near 10 microns in infrared
- Use the visible camera as a basis for comparison

FLIR Photon 320 Infrared Camera
ABS Visible Light Camera
Error Elimination

- Co-mounding system
- Flat field correction – data normalization
- Data collected from various elevations
Deployment of Infrared/Visible cameras at White Mountain
Infrared vs. Visible

Visible Image  Infrared Image
Flat field corrections

Unfiltered Image

Flat-fielded Image
Low/High Pass Filtering

Low Frequency Image

High Frequency Image
Videos

- **Original**: original_movie_2009_07_27_20_00_55
- **Low Frequency**: low_freq_movie_2009_07_22_20_00_55
Conclusions

We have:

- Mounted visual and infrared cameras
- Created routines to analyze data
- Started the data collection process
- Data of interest is in low frequency region
Future research

Infrared Image

Microwave Image
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