Astronomy 288C

Special Projects in Astronomy:
Balloon and Ground Measurements
Why a Balloon launch

• Balloons get above 99.7% of the atmosphere
• Balloons get above 99.98% of the water vapor
• Balloon cost is ~1% of space launch
• Students can get into balloon program
• Balloon program is ~5 yr vs 15 yrs for space
Challenges of Balloon Flight

• Temperature
• Pressure
• Power
• Communication
• Recovery
Temperature

• Ground -5 to 45 C depending on location
• Temperature at 125000 ft ~-40 C
• Strongly dependant on day/night
• Little conduction/convection cooling
Pressure

• Low pressure for disk heads
• High voltage breakdown
• No liquid state for water, nitrogen
Power

- Night: Batteries limited power, limited energy
- Solar cells toward sun
Communication

- Line of sight limited to ~300 mi
- Limited by power
- TDRIS
Recovery

• Remote locations: West Texas
• Desert of Australia
• Greenland
• Central Canada
• Antartica
CMB Balloon Experiments

- ARGO 1988-1993
- FIRS 1989
- BAM 1995-1998
- MAXIMA 1995-1999
- Boomerang 1997-2003
- Archeops 1999-2002
- ARCADE 2001-2006
- TOPHAT 2002
- SPIDER 2011-
Maxima Launch
ARCADE 2 Launch
ARCADE Launch
ARCADE 2
Recovery
ARCADE Interns
Balloon data

• Limited time
• Clean data
• Odd data formats
• Pointing after the fact
Ground Measurements

Look for dry mountains:

Hawaii, Azores, Chile, Antartica

Big telescopes/Small beams = high L

Big question: percpitable water
Atmospheric Windows

- ~10 MHz to 3 GHz (synchrotron radiation)
- 3 GHz-35 GHz classical CMB
- 80 GHz-95 GHz
- ~150 GHz (2 mm)
- ~300 GHz (1 mm)
Ground Observations

- Weather a factor
- Difficult to do large L
- Large data sets
- Complex data cleaning
SCHEDULE – subject to revision

- Sep 9 Introduction and Overview, Astronomy Basics
- Sep 16 Astronomical Sources and Backgrounds
- Sep 23 IR & Microwave Astronomy
- Sep 30 Gamma-ray Generation and Detection
- Oct 7 IR & Microwave Data Analysis
- Oct 14 Gamma-ray Sources and Signatures
- Oct 21 The Research Process
- Oct 28 Foreground Subtraction
- Nov 1 Gamma-ray data analysis
- Nov 11 Microwave Ballooning
- Nov 18 Multi-wavelength Astronomy
- Nov 25 Science Communication and Paper Writing
- Dec 2 Dedicated Time for Research Projects
- Dec 9 Dedicated Time for Research Projects