Radiometric measurements and helioseismology

Getting ready for PICARD helioseismology - Nice 2008

Wolfgang Finsterle, Rosaria Simoniello, Micha Schöll, and Alexander Shapiro

Physikalisch-Meteorologisches Observatorium Davos
World Radiation Centre

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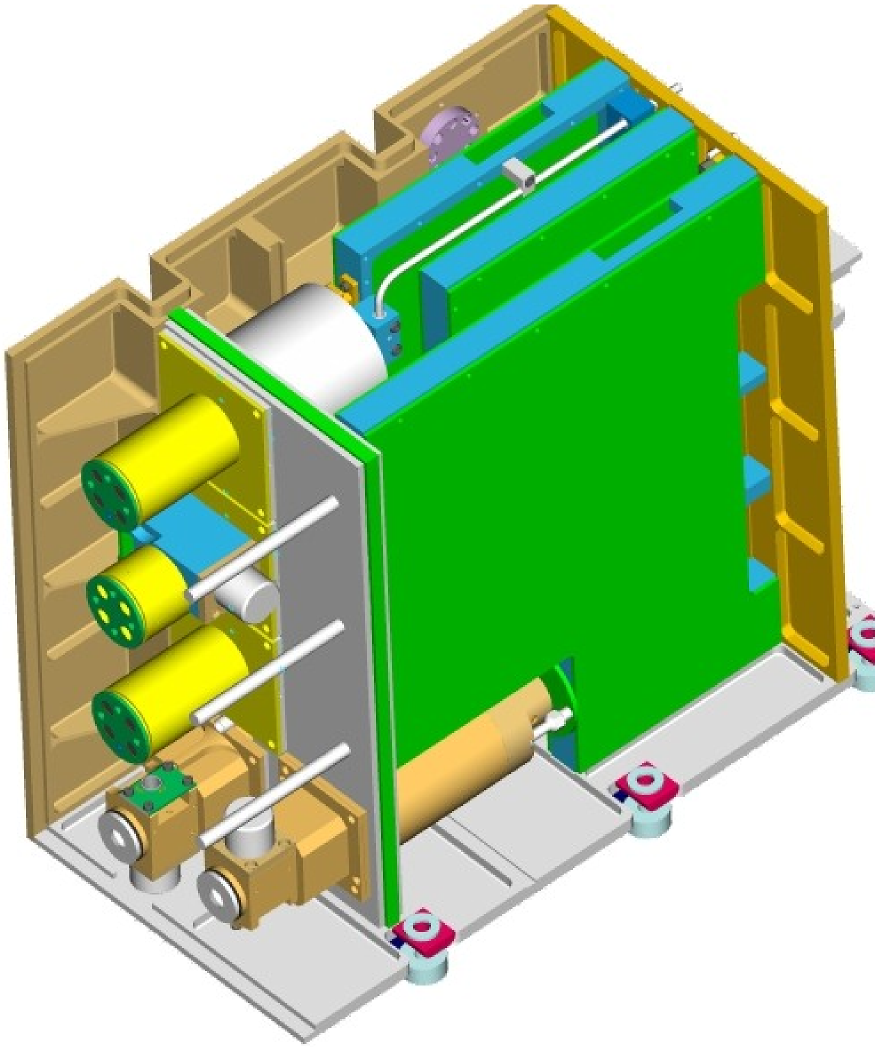
PREMOS Radiometers:

- Three four-channel filter radiometers
  - 210, 215, 266, 536, 607, 782 nm
  - SI calibrated filters/detectors
  - Ten seconds sampling rate
- Two PMO6-type absolute cavity radiometers
  - SI traceable
  - Two minutes sampling rate



Helioseismology

- Low degree p modes
  - Asymmetries → Coherent noise
  - Phase angle → Non-adiabaticity
  - Splitting → Rotation profile
  - Solar cycle dependency → Magnetic interaction
  - Sun as a star → Asteroseismology
- Low degree g modes
  - ...difficult

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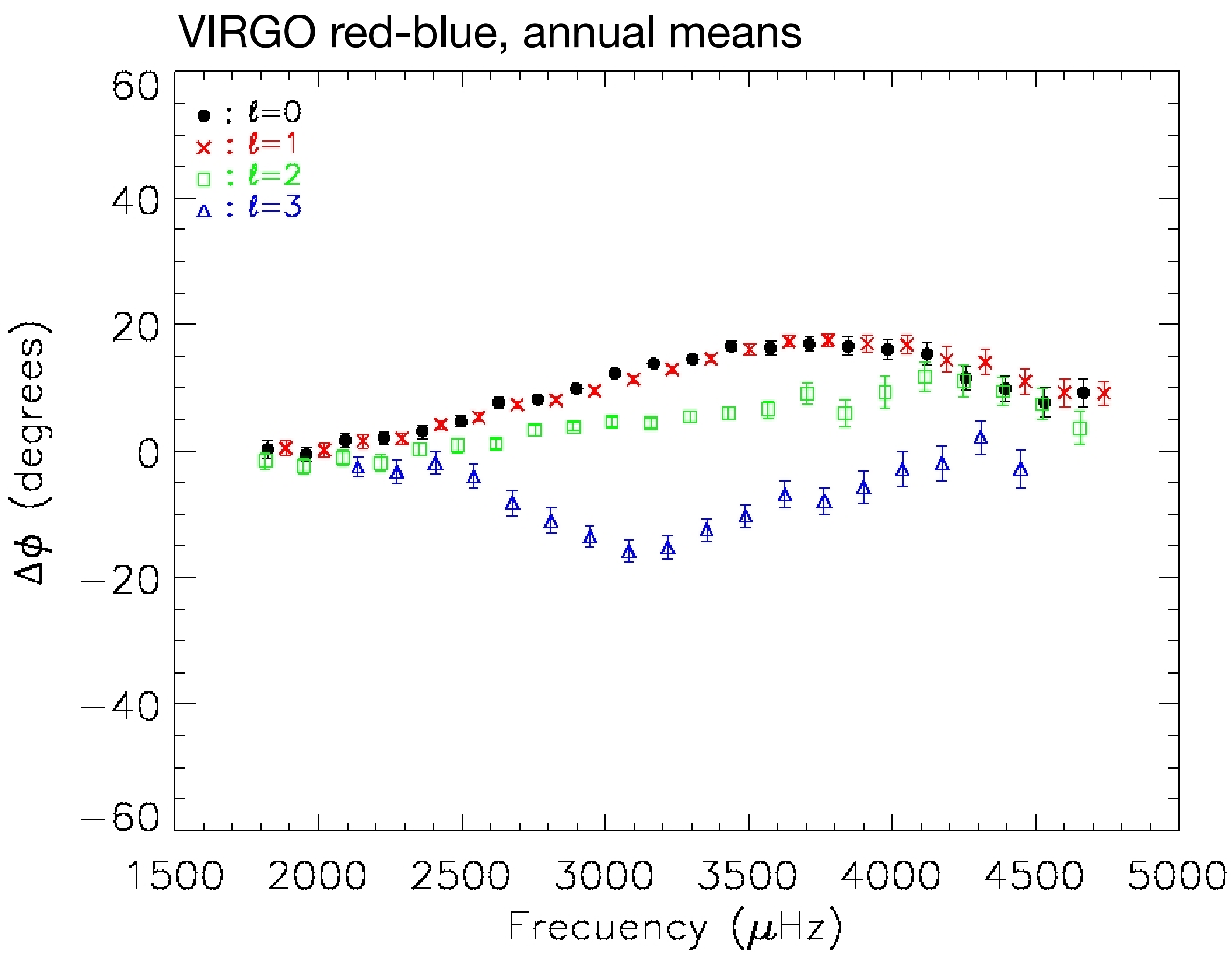
What's new about PREMOS (compared to VIRGO)

- Sampling rate 10 seconds
  - Nyquist frequency at 50 mHz
  - Pseudo modes
  - Traveling waves
- Include UV wavelengths
  - Wavelengths dependency of p-mode phase

Intensity – intensity phase angle



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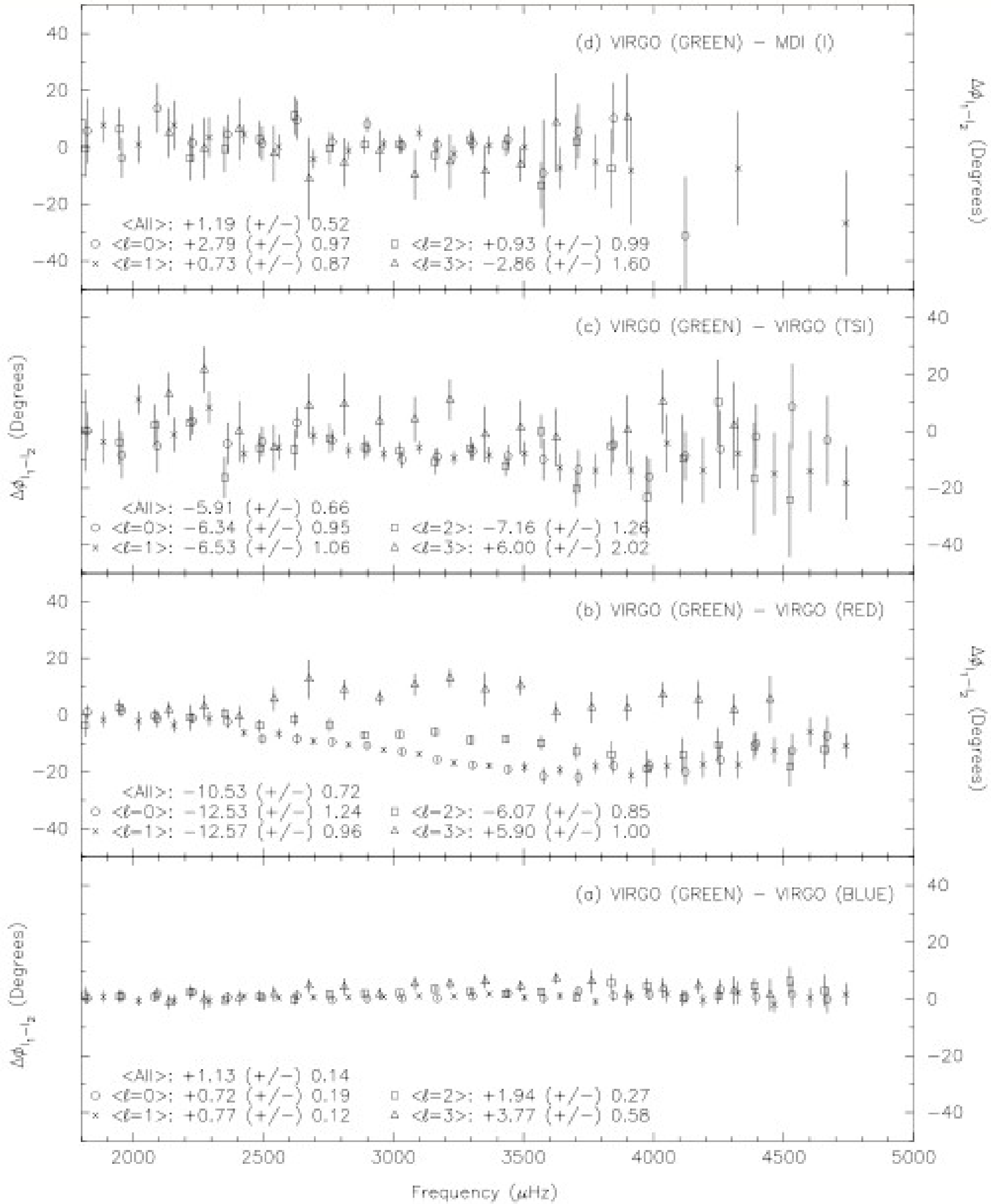

FIG. 7.—Phase differences between VIRGO(green) and (*a*) VIRGO(blue), (*b*) VIRGO(red), (*c*) VIRGO(TSI), and (*d*) MDI(*I*) intensities for degrees $l = 0, 1, 2$, and 3 (averages denoted by angle brackets).

Jiménez et al. 1999

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I-I phase difference

- The p-mode signal in the red channel *leads* the signals in the green and blue channels by ~10-15°(Jiménez et al. 1999, Shrijver et al. 1991) due to:
  - height difference?
  - downward traveling wave?
  - spectral dependency of the influence of the solar background noise?

Phase-shift mechanisms

1) Non-adiabaticity
   - Relaxation time changes with height in the atmosphere
   - ...
2) Traveling wave component
3) What's the phase of a non-sinusoidal wave?

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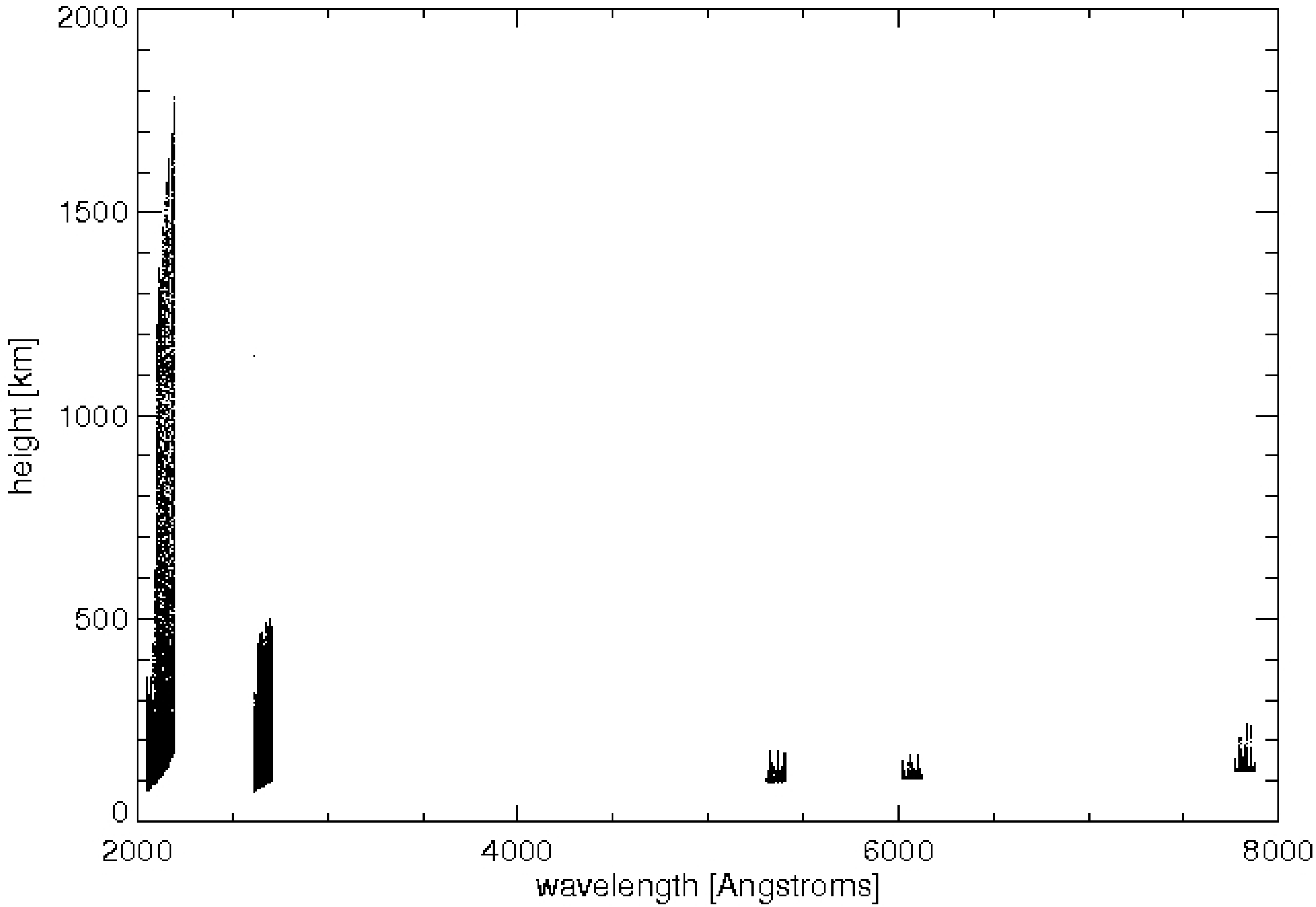
PREMOS observing heights

Wavelenght [nm]	210/215	266	536	607	782
Height [km]	271	190	105	107	126

Simulation results (COSI)



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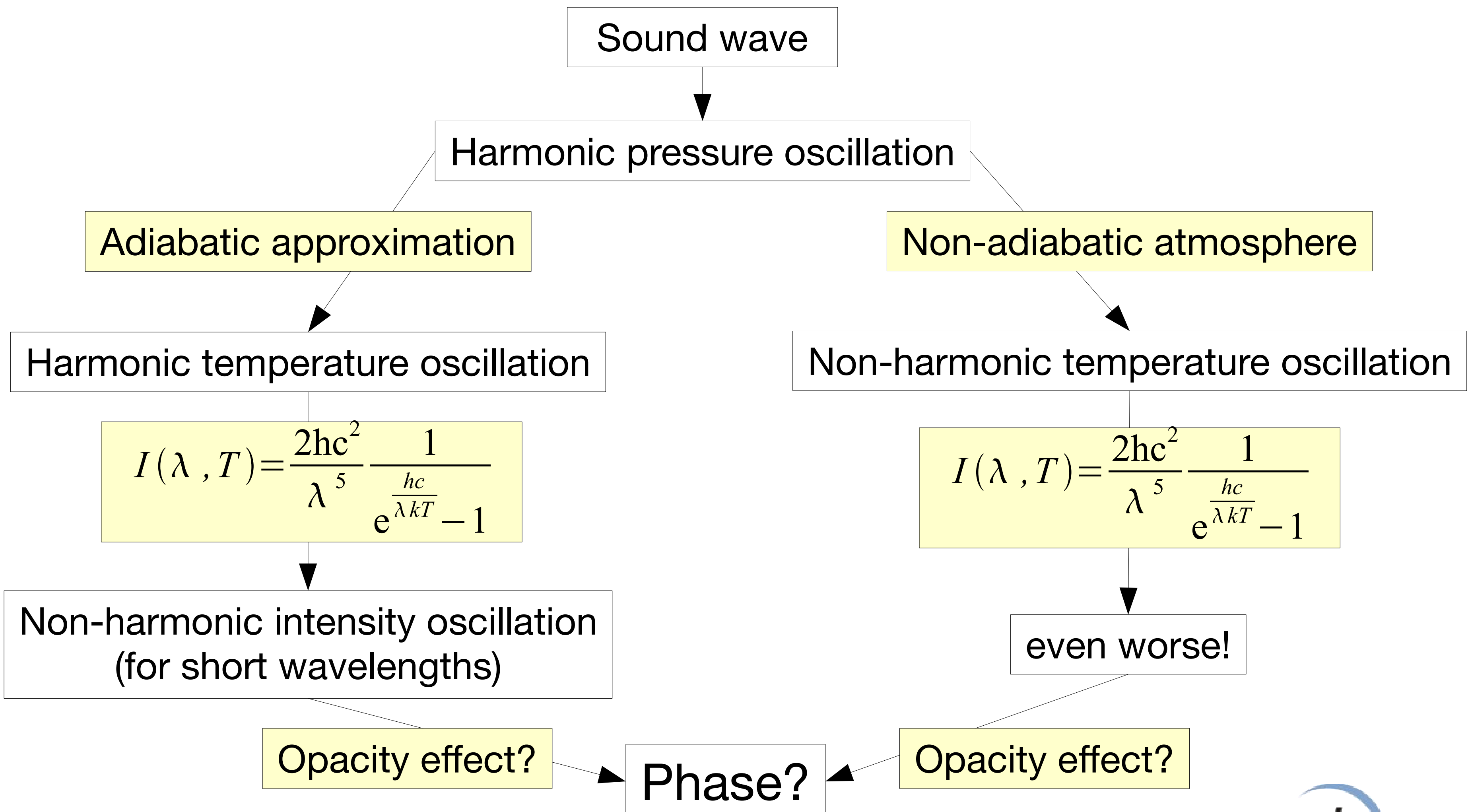
Phase of intensity observations



New constraints to models of the solar atmosphere

1. Careful simulation of the radiative transfer in the solar atmosphere is needed to properly interpret the phase of the intensity signal produced by solar oscillations

but:

2. Atmospheric properties such as (height-dependent) non-adiabaticity and opacity could be derived from studying the phases of intensity oscillations

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Traveling waves (high frequencies)

- Acoustic waves above the cut-off escape the interior and travel upwards in the atmosphere
- Wave travel time between different observing heights
- Velocity-velocity cross correlation drops off above ~10 mHz
  - Observational problem?

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Pseudo modes

- ?