Experimental Confirmation of Deep Nulling

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Beam Combination in a Rotational Shearing Interferometer
Laser Diode OPD Scan

Sample Number

Relative Intensity

0 500 1000 1500 2000 2500

Bandwidth = 3.5 nm = 0.5%

Spectrum of Wave Optics Laser Diode

Intensity

580 600 620 640 660 680

Wavelength (nm)
Dither-controlled Laser Null

Environmental Improvements in New Lab:
Diode Laser: Best Null = 206,000

3 Sept. 1999
Diode Laser, Best Null Depth = 260,000
Maximum Null = 2,600

White Light Null (8% BW, Single Pol.)

July 31, 1999

White Light Null, 8% Bandwidth, 1 pol’zn
Average null = 3500:1, Best Null = 8800:1
Sources of null degradation for wider bands

- Input lens decenter
- Input polarizer wedge angle
- Beamsplitter/compensator thickness or rotation mismatch
- Beamsplitter/AR coating phase shifts
- Unequal number of AR coating traversals (BS/Comp)
- Mirror protective coating asymmetry
- Extra reflections in filters, polarizers
- Intensity balance vs. wavelength
**Status**

**Laser diode (0.5% BW):**

- Transient nulls during OPD fluctuations: \(1/206,000\)
- Stable (average over 10 sec) null: \(1/50,000\)
- Controlled null (peak over minute timescales): \(1/10,000\)

**Single-polarization, 8% BW white light:**

- Stable (average over 5 sec) null: \(1/3,500\)
- Best transient null (twice): \(1/7,000\)

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**The Future: Control and Modulation Schemes**

- **Active Intensity Matching**
- **OPD Control:**
  - Control one output by means of the second
  - Control one waveband by means of another
  - Control via metrology
- **Signal Modulation Schemes:**
  - Baseline rotation: fringes sweep across zodi/planet
  - Spatial chopping:
    - nulling removes star; chop on/off zodi/planet
  - OPD fringe scan after multiple baseline nulling
Future Work

- Broaden Bandwidth
- Move into Mid-Infrared (Cryogenic)
- Dual-polarization Nulling
- White-light Null stabilization
- Efficiency optimization
- Control architectures
- Component development (rooftops, beamsplitters, single-mode filters, AR coatings, etc.)
- Null at high altitude
- Null in space