OH Suppression Fibre Test Unit

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OH Airglow: Major Obstacle for Deep NIR Observation

- Numerous OH Emission lines Dominate Night Sky from the Ground at $\lambda<$2$\mu$m
- Very Narrow: FWHM<$0.1\,\text{Å}$ (Dominated by Doppler Broadening)
- Short Time-Scale Variability: $\sim$ 5 min
\[ Y_{\text{fit}} = \frac{\omega^2}{(\lambda - \lambda_0)^2 + \omega^2} + A_B, \]

\[ \omega = \frac{\lambda_0}{N\pi\sqrt{2}}. \]

Scattering

U. Hawaii 2.2m Coudé spectrograph.

600 lines mm\(^{-1}\) B&L grating

Woods et al. 1994

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Canonical interline measurement (Maihara et al. 1993)

Zodiacal scattered light
Fibre Bragg Gratings

- Optical fibres with a periodic variation in refractive index
- Fresnel reflections at each boundary
- Small, but in phase

$\Rightarrow$ high reflection at a single wavelength
Fibre Bragg Grating

• R~10,000 Suppression of OH Line Wavelengths
• Suppress Inter-line Light, which Cannot be Removed by OHS Mask inserted in Dispersed Spectra
• Applicable to Single-Mode Fibres
• In Order to Collect Photons from Astronomical Objects, Multi-mode Fibre is Necessary
• → Need to Convert Multi-mode and Single-mode Fibres
Photonic Lantern

Leon-Saval, Birks, Bland-Hawthorn, 2005
Bland-Hawthorn et al. 2007
FBGs for GNOSIS
Multi-Core Fibre Bragg Grating (FBG)

- Current Test Unit (GNOSIS) uses Photonic Lantern which Converts a Multi-mode Fibre to 19 Independent Single-mode FBGs
- Cumbersome to Make and Expensive
- If We use This Technique to Integral Field Spectroscopy, Too Many FBGs Will be Required.

- Implement FBG on Multi-Core Single-mode Fibres

Leon-Saval et al. 2005, Optics Letters 19, 2545
On-sky demonstration

2 x 60µm core fibres pointed directly at sky

Both fed 1x7 lanterns
  - one with FBGs
  - one control

Lanterns feed IRIS2

H band spectrum with R=2400
GNOSIS - Fore optics

GNOSIS will be mounted at AAT f/8 Cassegrain focus
GNOSIS - relay optics

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Simulated Spectra

- z=3 Passive Galaxy (age=1 Gyr) with H=23 mag. (Vega)
- 8m Telescope
- R=1,000
- 8 hours

Ellis and Bland-Hawthorn 2008
MN 386, 47
Simulated Spectra

- $z=11$ QSO with $H=24.6$ mag. (Vega)
- 8m Telescope
- $R=1,000$
- 70 hours

Ellis and Bland-Hawthorn 2008
MN 386, 47
Test Device Development
Plan for FY2011 (~ March 2012)

• Fabricate a Multi-Core Fibre Bragg Grating Unit
  • Only a part of H-band OH lines will be suppressed
• Test with IRCS
  • Relay Optics Between Nasmyth Focus and IRCS
  • Measure Throughput, by Comparing with and without FBG?
  • Taking Sky Spectrum and Verify OH Suppression
• No Astronomical Object Observation
• Dispersion R~5000 (Echelle mode) with 0.54” Slit
Relay Optics at the position of AO188

No Modification to IRCS
Future Perspective

• Step 1: Multi-Core Test Unit (This Year)
  • Test with IRCS
• Step 2: Full Wavelength Coverage Test Unit
  • Test with IRCS?
  • Kakenhi (JSPS grant-in-aid)
• Step 2.5: Science Operation
  • Require a Target Acquisition Mechanism
• Step 3: New Instrument?
Summary

- OH Suppression Fibre or Fibre Bragg Grating May be a Breakthrough Technology for Deep Observation in Near-IR
  - Lower Cost, Effective Observation
- Test Observations of a Proto-type are On-going at AAO
- Fabricate the First Multi-core FBG for Subaru / IRCS
- Future: Integral-Field Spectroscopy with FBG?