

Remote Sensing of Atmospheric Aerosols with the Spectropolarimeter SPEX

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COST, Warsaw, May 7, 2012

Fine Dust

Particulate Matter (PM)

Examples of Aerosols:

- soot
- (black/white) smoke
- dust
- waterdroplets
- airborne desert-sand
- pollen or spores
- sea salt
- ...

Fine Dust

Particulate Matter (PM)

Examples of Aerosols:

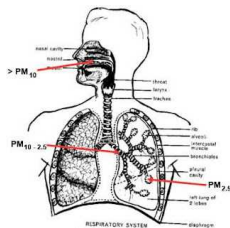
- soot
- (black/white) smoke
- dust

Why Aerosols are Important

Aerosols have impact on:

- Health
- Climate
- Economy

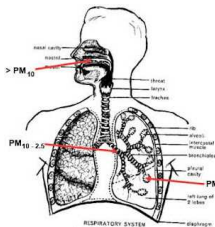
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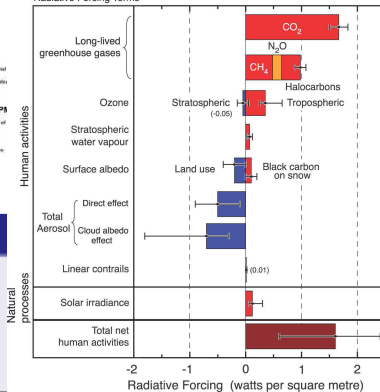


Aerosols have impact on:

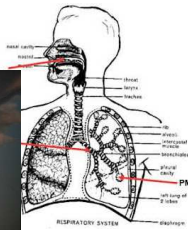
- Health
- Climate
- Economy

Radiative forcing of climate between 1750 and 2005

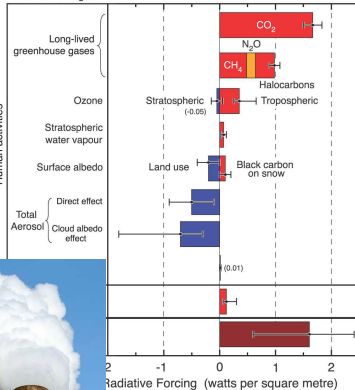
Radiative Forcing Terms



Why Aerosols are Important



Radiative forcing of climate between 1750 and 2005
Radiative Forcing Terms



- Health
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- Economy



What we want to know:

- Column density
- Spatial distribution
- Size Distribution
- Complex refractive index
- Shape

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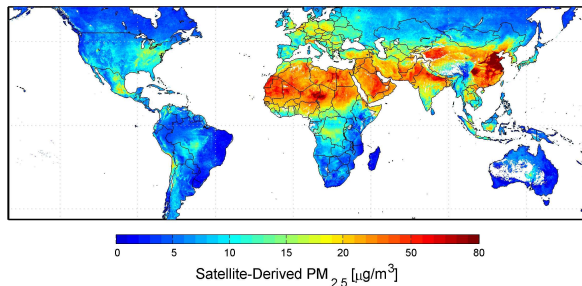


Figure: *PM 2.5 map. Van Donkelaar e.a. (2010)*

What we want to know:

- Column density
- Spatial distribution
- Size Distribution
- Complex refractive index
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Multi-angle spectropolarimetry can provide this information!

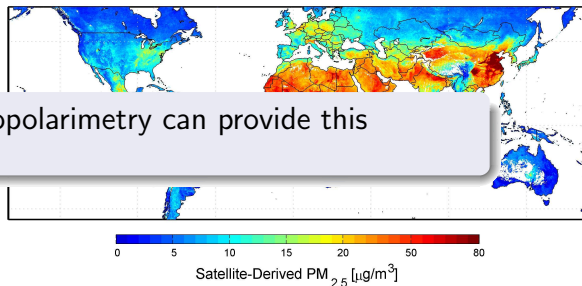
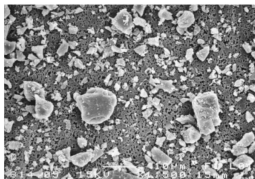
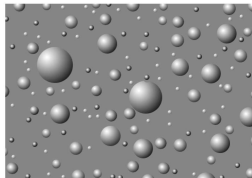


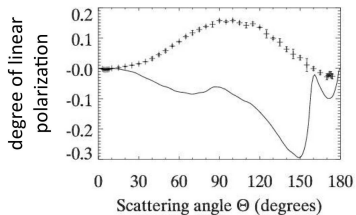
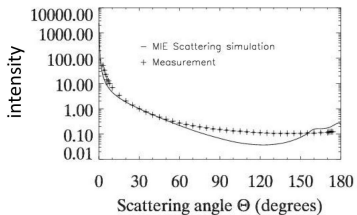
Figure: *PM 2.5 map. Van Donkelaar e.a. (2010)*

Why Spectropolarimetry



+





Laan et al (2007)









Blue-sky SPEX Measurements



Blue Sky SPEX Measurements

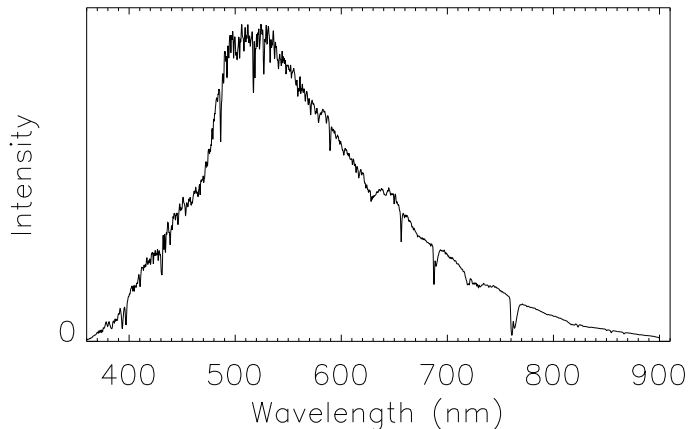


Figure: Scattering angle = $8.4^\circ \pm 1.4^\circ$

Blue Sky SPEX Measurements

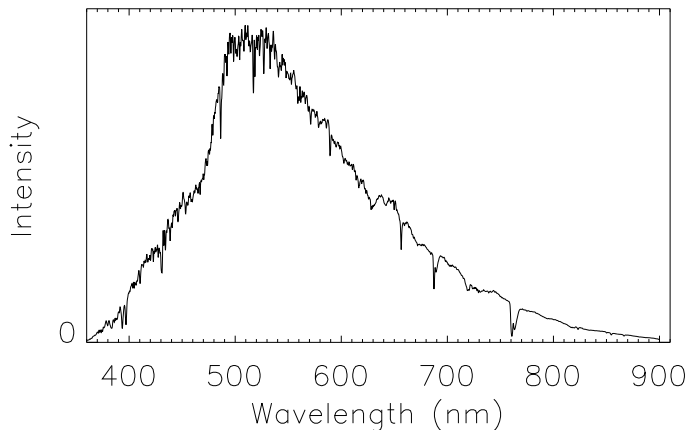


Figure: Scattering angle = $18.6^\circ \pm 0.7^\circ$

Blue Sky SPEX Measurements

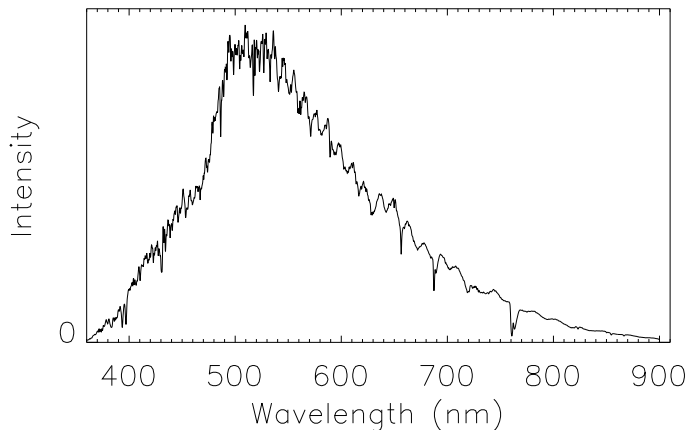


Figure: Scattering angle = $28.8^\circ \pm 0.5^\circ$

Blue Sky SPEX Measurements

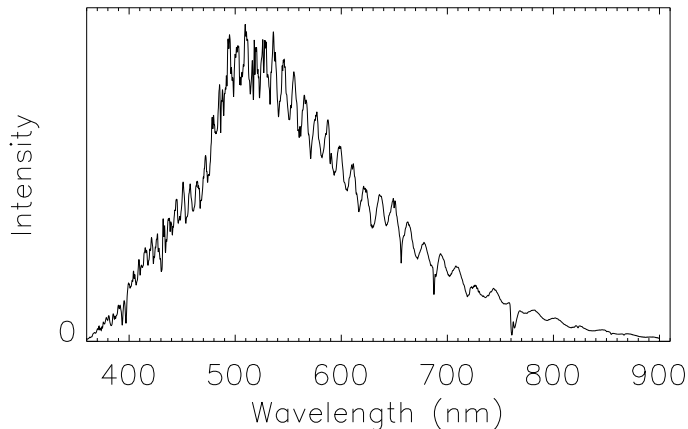


Figure: Scattering angle = $39.1^\circ \pm 0.4^\circ$

Blue Sky SPEX Measurements

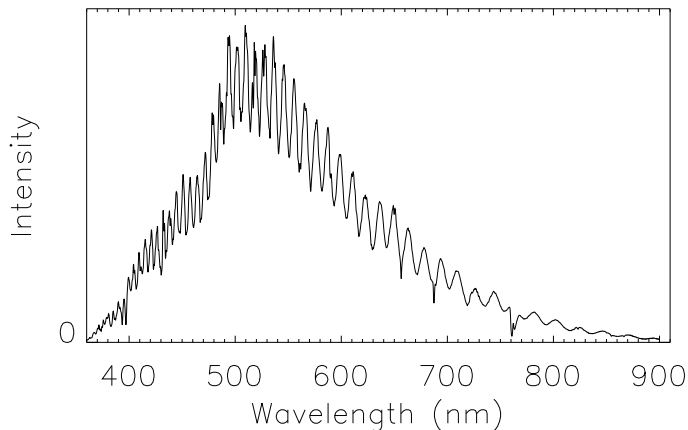


Figure: Scattering angle = $49.4^\circ \pm 0.2^\circ$

Blue Sky SPEX Measurements

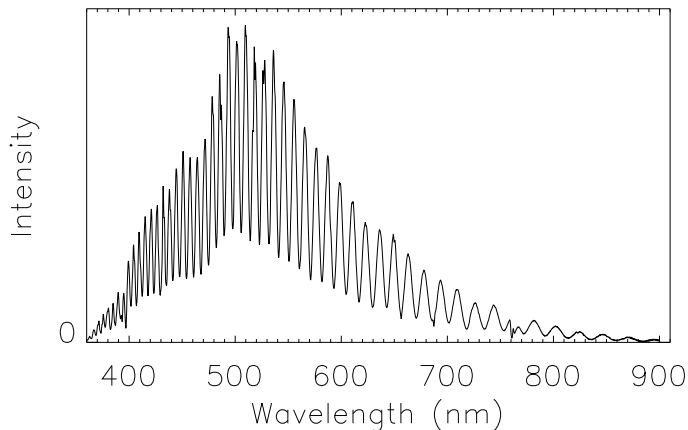


Figure: Scattering angle = $92.8^\circ \pm 0.1^\circ$

Blue Sky SPEX Measurements

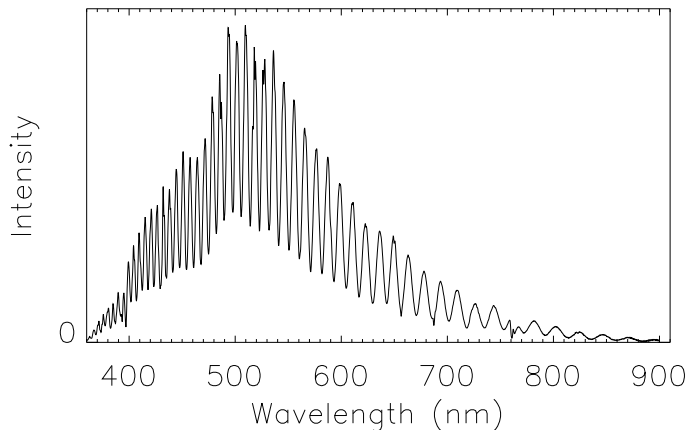


Figure: Scattering angle = $103.0^\circ \pm 0.1^\circ$

Blue Sky SPECT Measurements

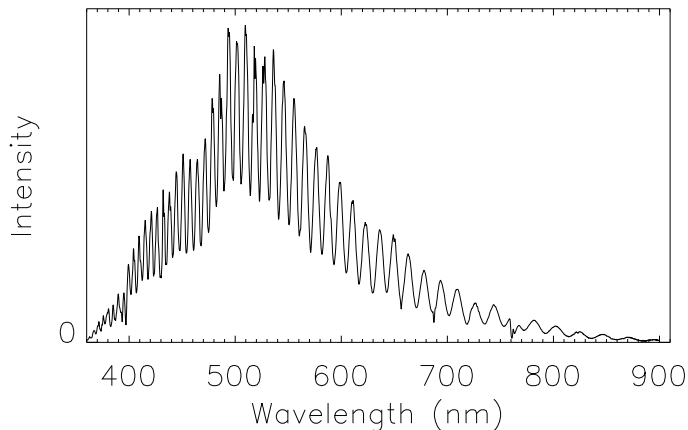


Figure: Scattering angle = $113.1^\circ \pm 0.2^\circ$

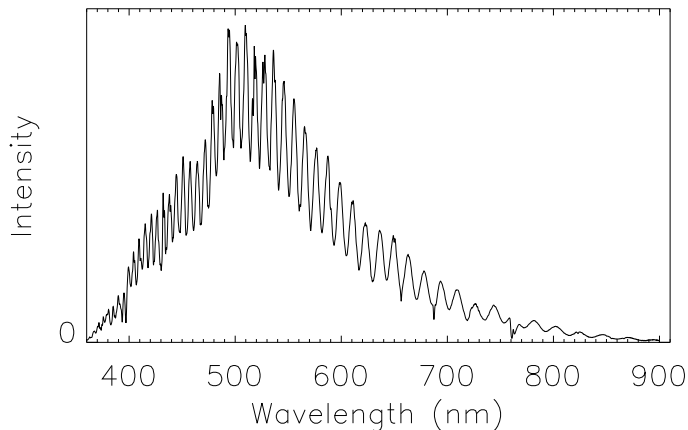


Figure: Scattering angle = $123.4^\circ \pm 0.2^\circ$

Blue Sky SPEX Measurements

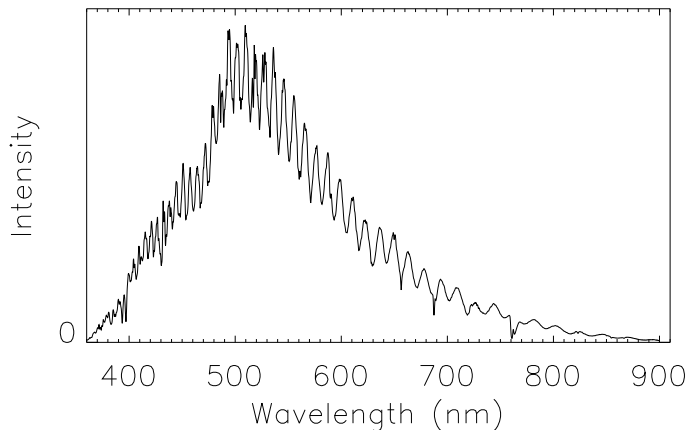


Figure: Scattering angle = $133.5^\circ \pm 0.3^\circ$

Blue Sky Polarization

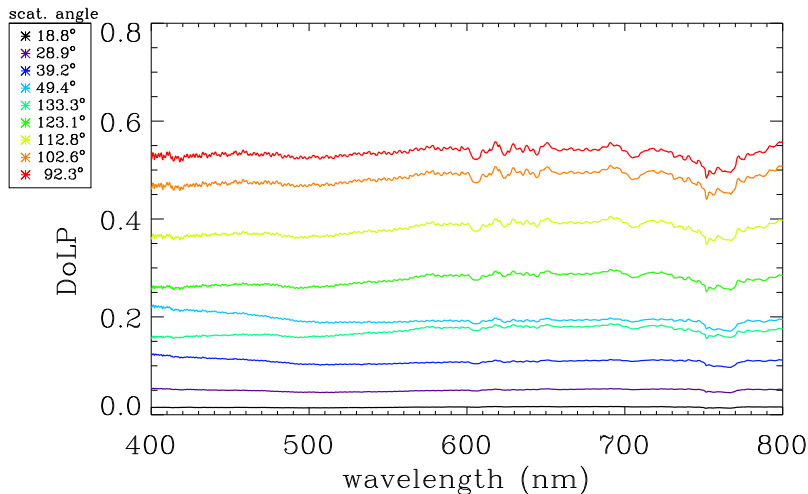


Figure: Degree of Linear Polarization (DoLP) for different scattering angles

Look-up Table Retrieval Code

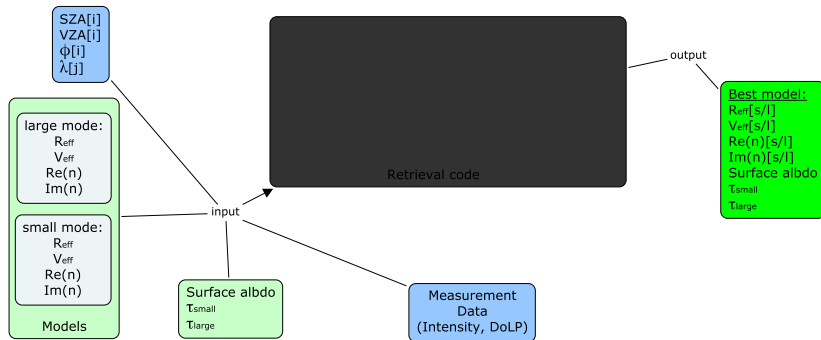


Figure: Block diagram of Aerosol Parameter Retrieval

Look-up Table Retrieval Code

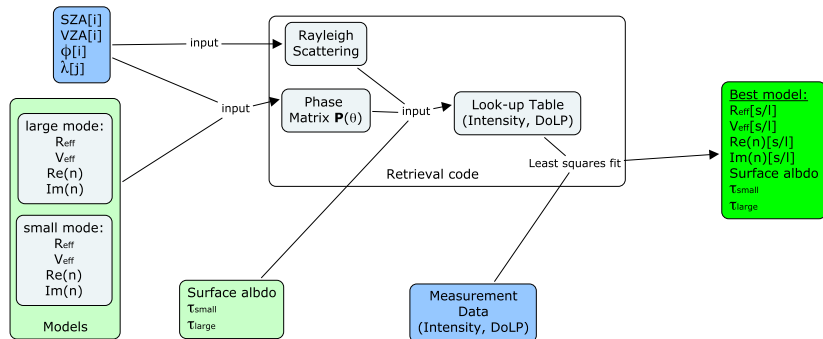
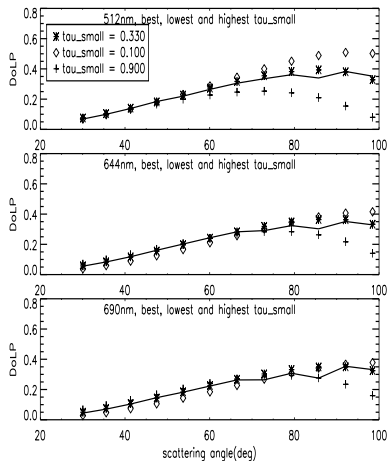
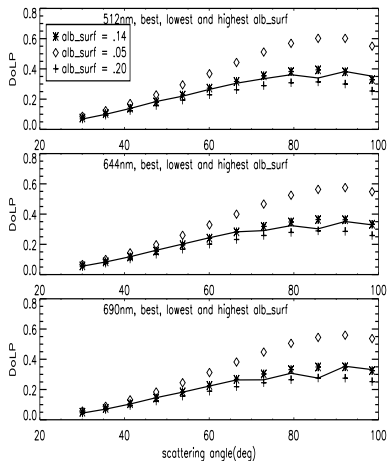


Figure: Look-up table retrieval code as described by Hasekamp et al. (2011)

Surface Albedo and Aerosol Optical Thickness



Retrieval of Aerosol Properties

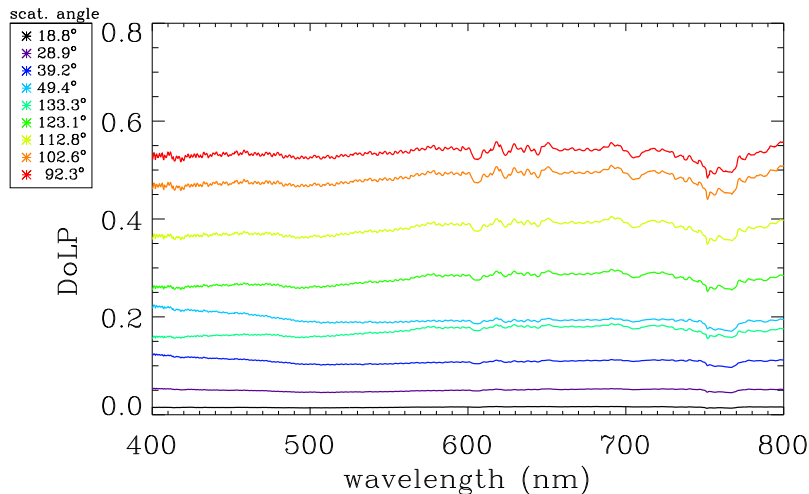


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Retrieval of Aerosol Properties

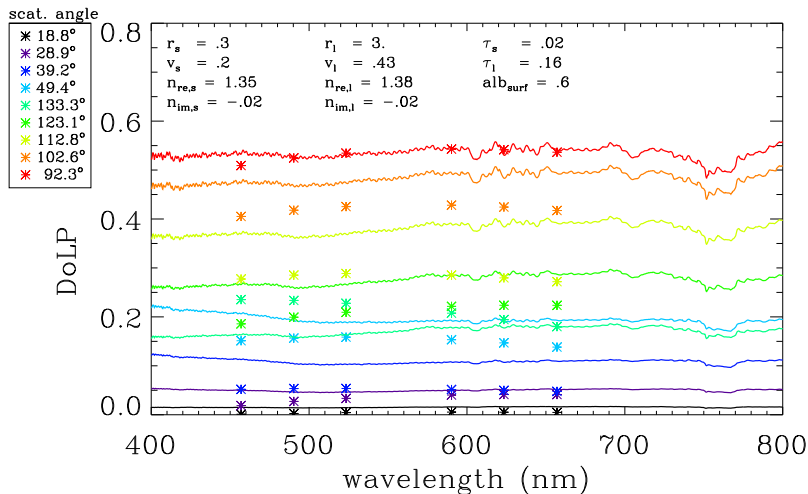
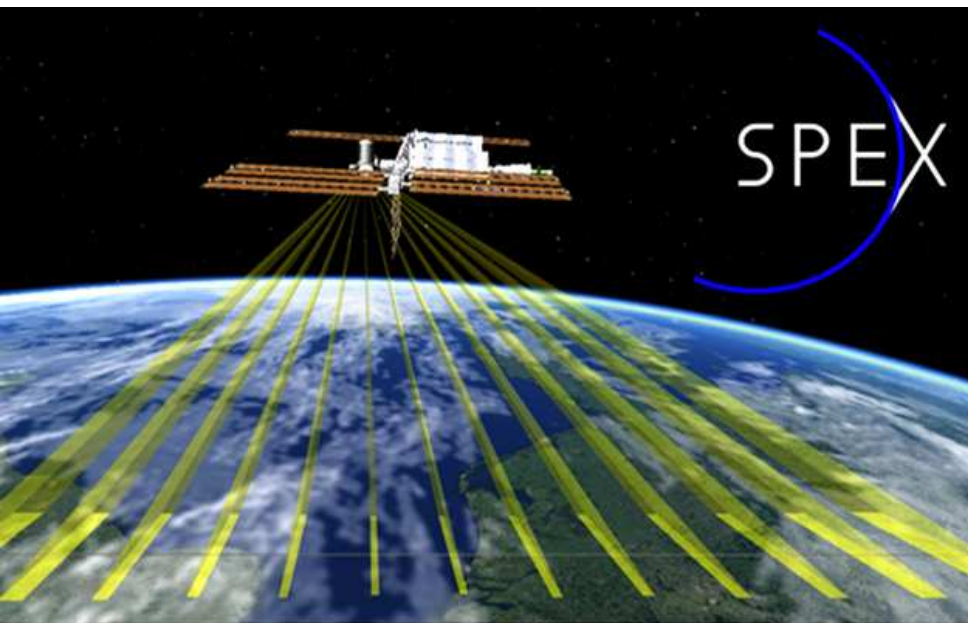


Figure: Degree of Linear Polarization fitted against model

What's next

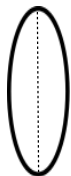


What's next



SPEX Concept

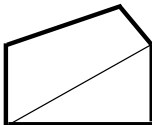
SPEX Concept



lambda/4
retarder
(+Q)



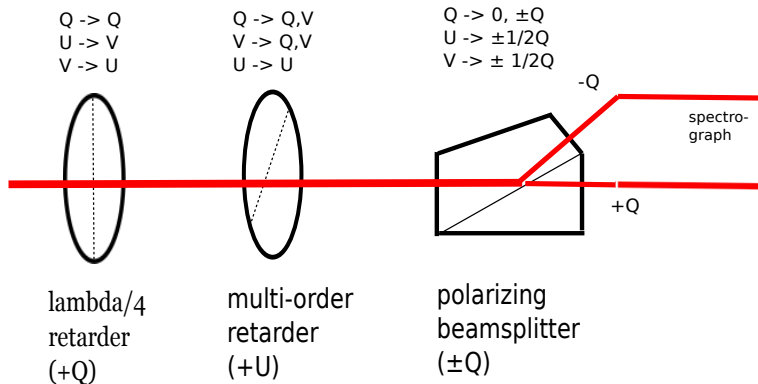
multi-order
retarder
(+U)



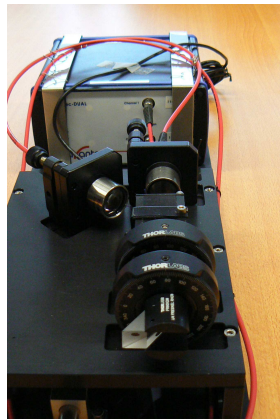
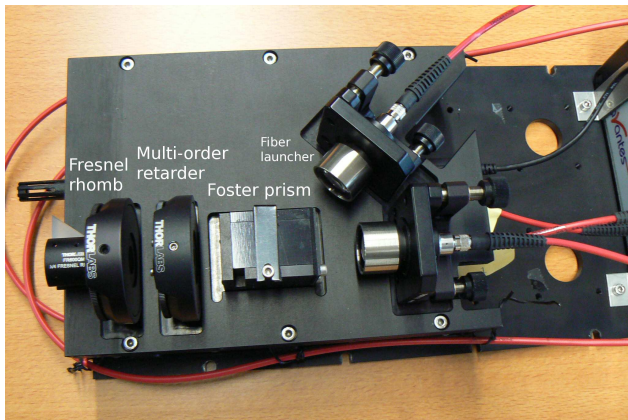
polarizing
beamsplitter
(±Q)

spectro-
graph

SPEX Concept



SPEX_RIVM Design



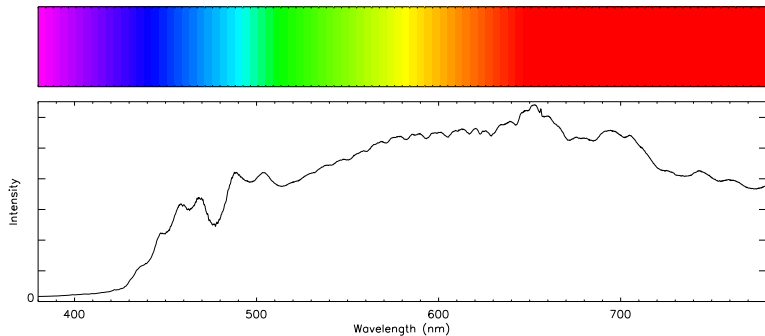


Figure: Spectral modulation of spectrograph channel 1

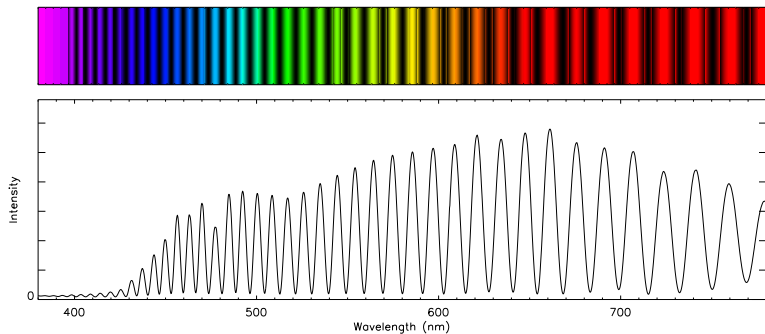


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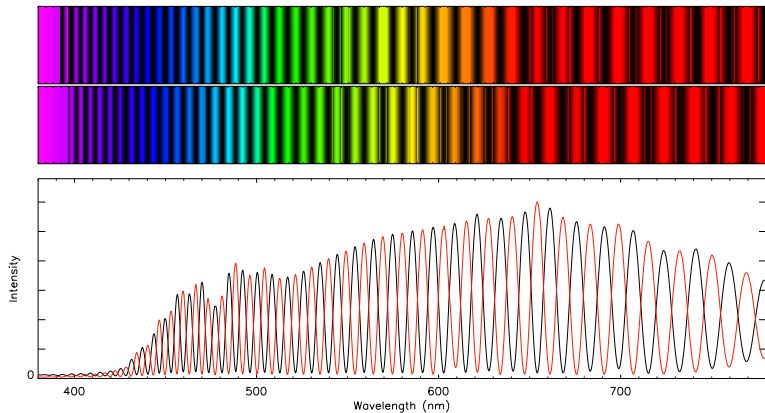


Figure: Spectral modulation of spectrograph channel 1 and 2

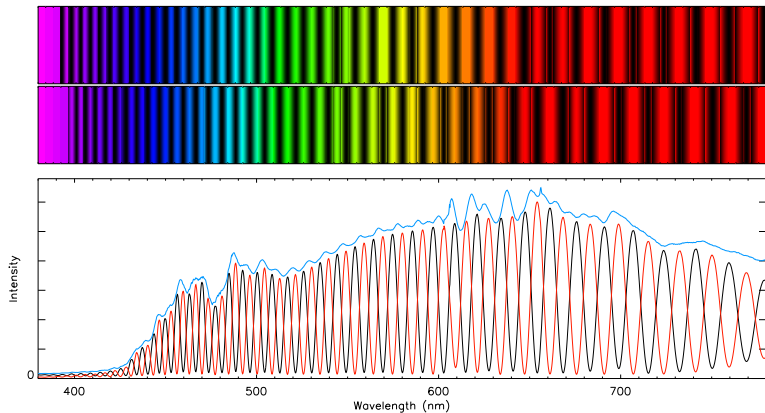


Figure: Spectral modulation of spectrograph channel 1 and 2