

Rayleigh Scattering and Polarization

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Scattering of Light with Small Particle



Day or Night?

Scattering of Light with Small Particle



With Atmosphere



Without Atmosphere

Scattering of Light with Small Particle



White Cloud and Blue Sky
from Ground



White Sun and Dark Sky
from ISS

Scattering of Light with Small Particle

Scattering of Light with Small Particle

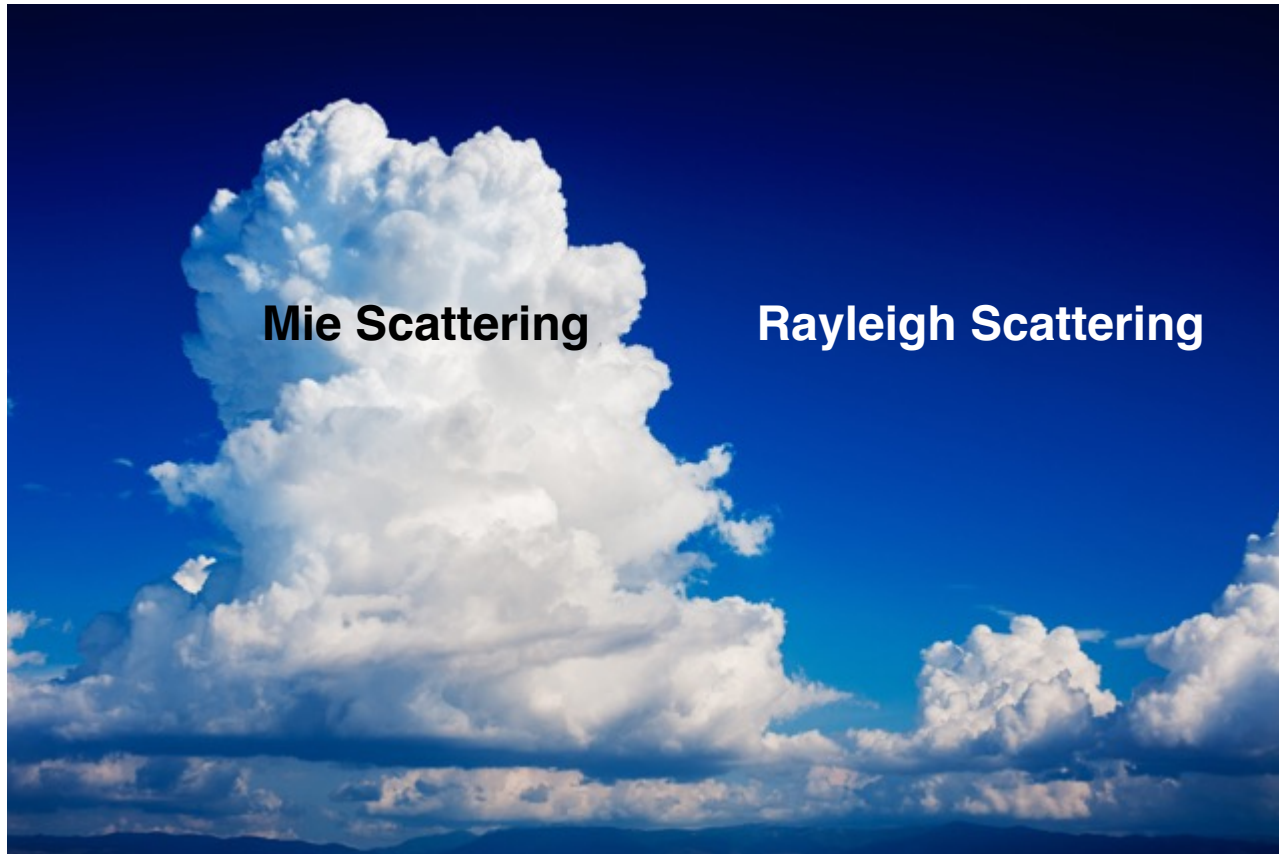


White Cloud and Blue Sky



Change of Sun's Color

Scattering of Light with Small Particle



White Cloud and Blue Sky



Change of Sun's Color

Rayleigh Scattering

$$\alpha = \pi \frac{d^2}{\lambda^2}$$

d : particle size

λ : wavelength

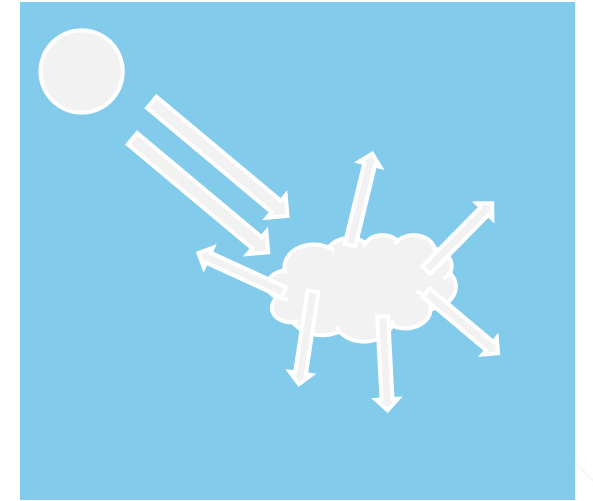
$\alpha \ll 1$: Rayleigh scattering, e.g. molecule

$\alpha \gg 1$: Mie scattering, e.g., water vapor, aerosol

Scattering intensity is proportional to α^4 ($= \lambda^{-4}$)

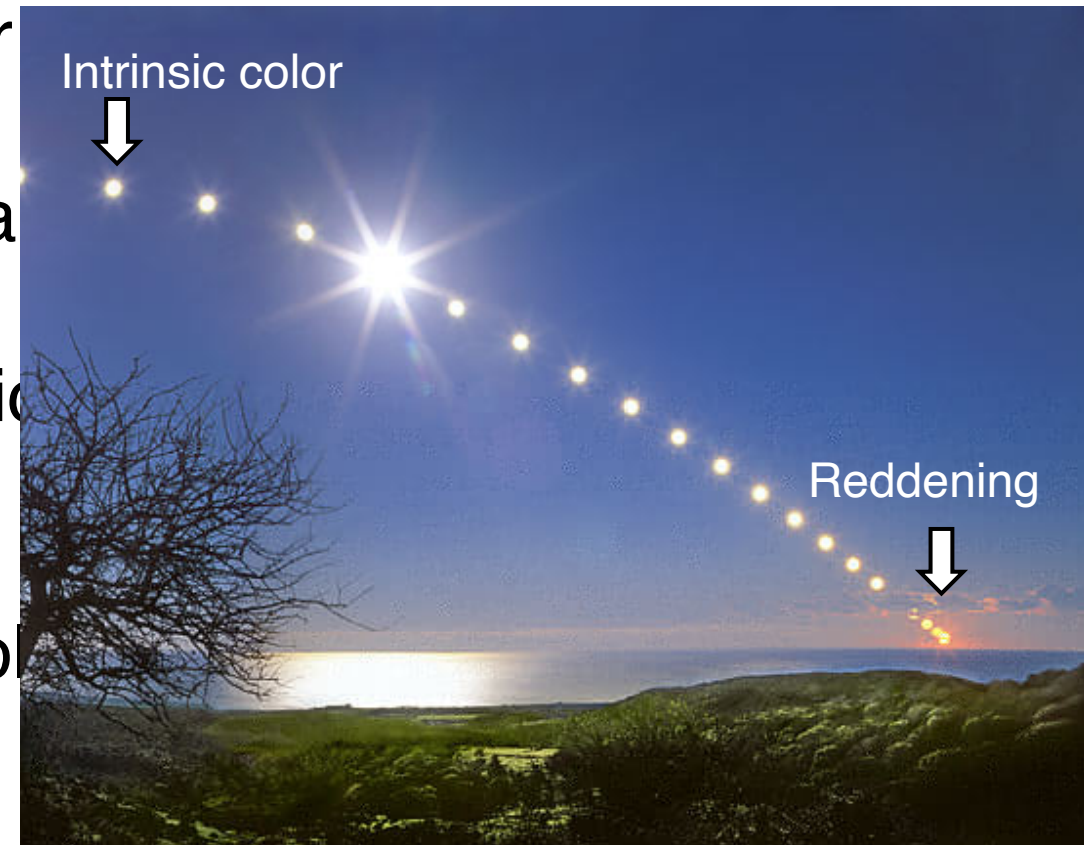
e.g., blue=500nm and red=1000nm

Note: Rayleigh scattering is elastic scattering, but the scattering intensity depends the wavelength.



Darkening and Reddening

- Brightness of star depends on the distance and extinction by inter stellar particles (dust).
- Darkening by extinction is proportional to reddening.
- We can estimate darkening by intrinsic color of the star and measuring the reddening.
- Multi-band photometry is powerful tool to estimate the reddening.



Setup of the Experiment

How to realize the atmospheric phenomena in the room?

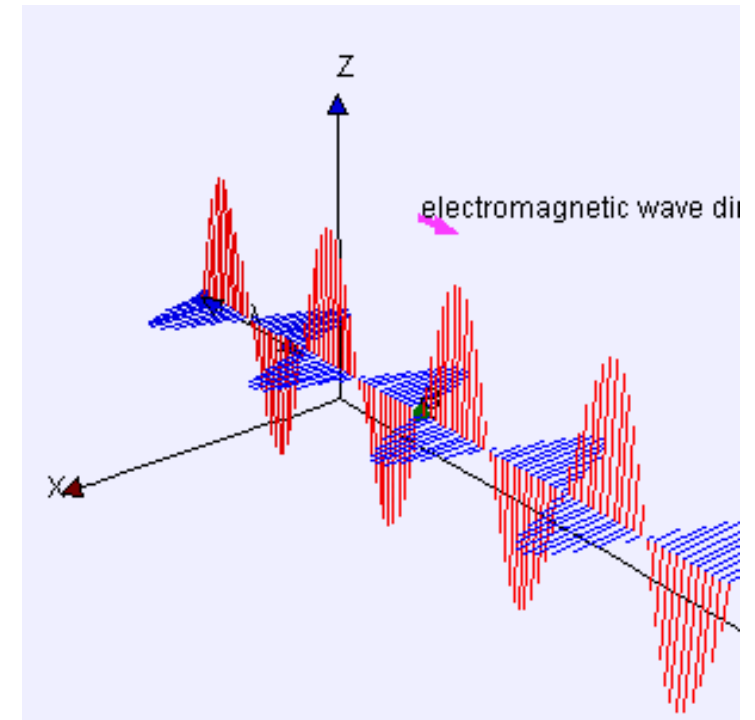
- How is the scaling between the atmosphere and the room?
 - We need to solve the scale difference.
 - Thickness of the atmosphere: 10km
 - Typical size of tools: 1m
- What is the ratio of atmospheric thickness at the zenith to the horizon?
 - The radius of the earth: 6400km
- How to make a small particle?

Observation

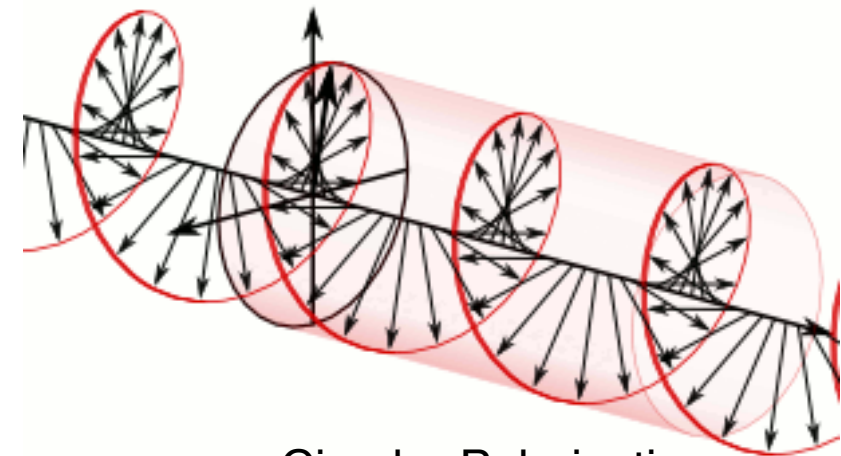
- Camera
 - Point of view
 - Filter
 - Exposure time, Saturation
- Analysis
 - Background
 - Noise, Clipping bad data
 - Fitting theoretical curve
- Discussion
 - Differences between the result and theorem.

Polarization

- Light in nature is unpolarized
- An arbitral photon is polarized in linearly and circularly.
- (We can observe the polarization by polarizer.)
- → Electromagnetic wave is vector component.
- Rayleigh scattering produces polarized light.

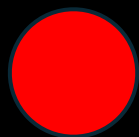


Linear Polarization

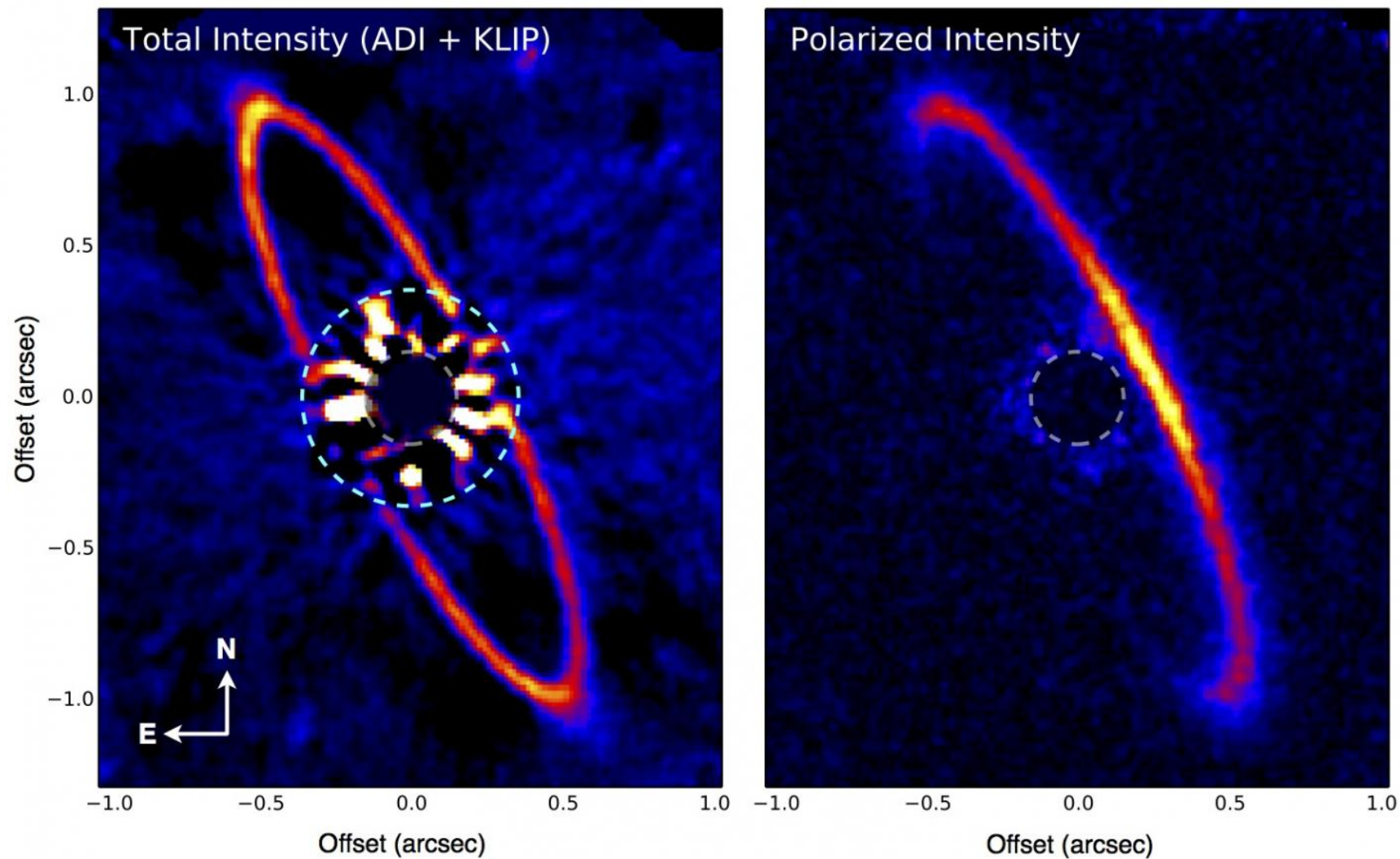


Circular Polarization





Power of Polarimeter



Power of Polarimeter



